MATERIALS SCIENCE AND ENGINEERING UNDERGRADUATE MAJOR

COVID-19-Related Degree Requirement Changes

For information on how Materials Science and Engineering degree requirements have been affected by the pandemic, see the "COVID-19 Policies" (http://exploredegrees.stanford.edu/schoolofengineering/materialsscienceandengineering/#covid19policies) in the "Materials Science and Engineering" of this bulletin. For University-wide policy changes related to the pandemic, see the "COVID-19 and Academic Continuity" (http://exploredegrees.stanford.edu/covid-19-policy-changes) section of this bulletin.

The department offers a B.S. as well as a minor in Materials Science and Engineering.

Bachelor of Science in Materials Science and Engineering (MSE/MATSCI)

Completion of the undergraduate program in Materials Science and Engineering leads to the conferral of the Bachelor of Science in Materials Science and Engineering.

Mission of the Undergraduate Program in Materials Science and Engineering

The mission of the undergraduate program in Materials Science and Engineering is to provide students with a strong foundation in materials science and engineering with emphasis on the fundamental scientific and engineering principles which underlie the knowledge and implementation of material structure, processing, properties, and performance of all classes of materials used in engineering systems. Courses in the program develop students’ knowledge of modern materials science and engineering, teach them to apply this knowledge analytically to create effective and novel solutions to practical problems, and develop their communication skills and ability to work collaboratively. The program prepares students for careers in industry and for further study in graduate school.

The B.S. in Materials Science and Engineering provides training for the materials engineer and also preparatory training for graduate work in materials science. Capable undergraduates are encouraged to take at least one year of graduate study to extend their course work through the coterminal degree program which leads to an M.S. in Materials Science and Engineering. Coterminal degree programs are encouraged both for undergraduate majors in Materials Science and Engineering and for undergraduate majors in related disciplines.

Learning Outcomes (Undergraduate)

The department expects undergraduate majors in the program to be able to demonstrate the following learning outcomes. These learning outcomes are used in evaluating students and the department’s undergraduate program. Students are expected to demonstrate the ability to:

1. Apply the knowledge of mathematics, science, and engineering to assess and synthesize scientific evidence, concepts, theories, and experimental data relating to the natural or physical world.
2. Extend students’ knowledge of the natural or physical world beyond that obtained from secondary education by refining their powers of scientific observation, the essential process by which data is gained for subsequent analysis.
3. Design and conduct experiments, as well as understand and utilize the scientific method in formulating hypotheses and designing experiments to test hypotheses.
4. Function on multidisciplinary teams, while communicating effectively.
5. Identify, formulate, and solve engineering issues by applying conceptual thinking to solve certain problems, bypassing calculations or rote learning and relying on the fundamental meaning behind laws of nature.
6. Understand professional and ethical responsibility.
7. Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
8. Demonstrate a working knowledge of contemporary issues.
9. Recognize the need for, and engage in, lifelong learning.
10. Apply the techniques, skills, and modern engineering tools necessary for engineering practice.
11. Transition from engineering concepts and theory to real engineering applications and understanding the distinction between scientific evidence and theory, inductive and deductive reasoning, and understanding the role of each in scientific inquiry.

Degree Requirements

Mathematics

<table>
<thead>
<tr>
<th>Units</th>
<th>Mathematics</th>
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</thead>
<tbody>
<tr>
<td>20 units minimum</td>
<td>Select one of the following:</td>
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<tr>
<td>5</td>
<td>MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications</td>
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<tr>
<td>5</td>
<td>CME 102/ENGR 154 Vector Calculus for Engineers</td>
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Select one of the following:

<table>
<thead>
<tr>
<th>Units</th>
<th>Science</th>
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<tbody>
<tr>
<td>20 units minimum</td>
<td>Must include a full year (15 units) of calculus-based physics or chemistry, with one quarter of study (5 units) in the other subject.</td>
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Technology in Society

<table>
<thead>
<tr>
<th>Units</th>
<th>Technology in Society</th>
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<tbody>
<tr>
<td>3-5</td>
<td>One course minimum</td>
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Engineering Fundamentals

<table>
<thead>
<tr>
<th>Units</th>
<th>Engineering Fundamentals</th>
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<tbody>
<tr>
<td>4</td>
<td>Two courses minimum</td>
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<tr>
<td>4</td>
<td>Select one of the following:</td>
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<tr>
<td>ENGR 50 Introduction to Materials Science, Nanotechnology Emphasis</td>
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<tr>
<td>ENGR 50E Introduction to Materials Science, Energy Emphasis</td>
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</tbody>
</table>
Materials Science and Engineering Undergraduate Major

ENGR 50M  Introduction to Materials Science, Biomaterials Emphasis 4

At least one additional course 4  3-5

Department Requirements: MSE Fundamentals, Depth & Focus Areas

Materials Science Fundamentals: All of the following courses:  16

MATSCI 142  Quantum Mechanics of Nanoscale Materials
MATSCI 143  Materials Structure and Characterization
MATSCI 144  Thermodynamic Evaluation of Green Energy Technologies
MATSCI 145  Kinetics of Materials Synthesis

Two of the following courses:  8

MATSCI 151  Microstructure and Mechanical Properties
MATSCI 152  Electronic Materials Engineering
MATSCI 156  Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution
MATSCI 158  Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life
MATSCI 190  Organic and Biological Materials
MATSCI 192  Materials Chemistry
MATSCI 193  Atomic Arrangements in Solids
MATSCI 194  Thermodynamics and Phase Equilibria
MATSCI 195  Waves and Diffraction in Solids
MATSCI 196  Defects in Crystalline Solids
MATSCI 197  Rate Processes in Materials
MATSCI 198  Mechanical Properties of Materials
MATSCI 199  Electronic and Optical Properties of Solids

Materials Science & Engineering Depth 16

Four laboratory courses for Sixteen units; Four units must be WIM

MATSCI 160  Nanomaterials Laboratory
MATSCI 161  Energy Materials Laboratory (WIM)
MATSCI 162  X-Ray Diffraction Laboratory
MATSCI 163  Mechanical Behavior Laboratory
MATSCI 164  Electronic and Photonic Materials and Devices Laboratory (WIM)
MATSCI 165  Nanoscale Materials Physics Computation Laboratory
MATSCI 166  Data Science and Machine Learning Approaches in Chemical and Materials Engineering

Focus Area Options 4, 6  13

Total Units  103-107

1 See a list of approved math courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses/). AP/IB Credit (https://ughb.stanford.edu/petitions/ap-credit/) may also be used to meet the 20 units minimum, but cannot replace the three required courses.
2 See a list of approved science courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses/). AP/IB Credit (https://ughb.stanford.edu/petitions/ap-credit/) may also be used to meet the 20 units minimum in some cases; see the AP chart in the Bulletin or check with the School of Engineering in 135 Huang Engineering Center.
3 See a list of approved Technology in Society courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses/). Course chosen must be on the approved list the year taken.
4 See a list of approved Engineering Fundamentals Courses at ughb.stanford.edu. Course chosen must be on the approved list the year taken.
5 Focus Area Options: 13 units from one of the following Focus Area Options below. If the focus area contains only 12 units, but the combined unit total in major (SoE Fundamentals, MSE Fundamentals, MSE Depth and the Focus Area) is at 60 or more, it will be allowed and no petition is necessary.
6 The self-defined focus area option requires additional approval; program deviation forms for this option can be found on the MSE website (https://mse.stanford.edu/student-resources/forms/undergraduate/).
7 A course may only be counted towards one requirement; it may not be double-counted. For the 2020-2021 academic year, all courses taken for the major may be taken for either a letter grade (if offered by the instructor) or for CR and count towards degree requirements. Minimum Combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

Focus Area Options (Four courses for a minimum of 13 units; select from one of the ten Focus Areas.)

Bioengineering

BIOE 80  Introduction to Bioengineering (Engineering Living Matter)
BIOE 220  Introduction to Imaging and Image-based Human Anatomy
BIOE 260  Tissue Engineering
BIOE 281  Biomechanics of Movement
BIOE 381  Orthopaedic Bioengineering
MATSCI 158  Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life
MATSCI 190  Organic and Biological Materials
MATSCI 225  Biochips and Medical Imaging
MATSCI 380  Nano-Biotechnology
MATSCI 381  Biomaterials in Regenerative Medicine
MATSCI 384  Materials Advances for Neurotechnology: Materials Meet the Mind

Chemical Engineering

CHEM 171  Foundations of Physical Chemistry
CHEMENG 130  Micro and Nanoscale Fabrication Engineering
CHEMENG 140  Biochemical Engineering
CHEMENG 150  Biochemical Engineering
MATSCI 158  Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life

Chemistry

CHEM 151  Inorganic Chemistry I
CHEM 153  Inorganic Chemistry II
CHEM 171  Foundations of Physical Chemistry
CHEM 173  Physical Chemistry II
CHEM 175  Physical Chemistry III
CHEM 181  Biochemistry I
CHEM 183  Biochemistry II
CHEM 185  Biophysical Chemistry

Electronics & Photonics

EE 101A  Circuits I
EE 101B  Circuits II
EE 102A  Signal Processing and Linear Systems I
EE 102B  Signal Processing and Linear Systems II
To complete the MATSCI Honors program

- Overall GPA of 3.5 or higher (as calculated on the unofficial transcript) at graduation.
- Complete at least three quarters of research with a minimum of 9 units of MATSCI 150 (students may petition out of unit requirement with faculty advisor approval). All quarters must focus on the same topic. Maintain the same faculty advisor throughout, if possible.
• Present either a poster or oral presentation of thesis work at a Stanford event or, at the faculty advisor's discretion, in a comparable public event.
• Submit final drafts of an honors thesis to two faculty readers (one must be your research advisor, and one must be an MSE faculty member/SoE Academic Council member) at least one quarter prior to graduation. Both must approve the thesis by completing the signature page (https://mse.stanford.edu/student-resources/forms/undergraduate/).
• Submit to MATSCI student services (Durand 113) one copy of the honors thesis and signed signature page (in electronic or physical form) at least one quarter prior to graduation.

Materials Science and Engineering (MATSCI) Minor
A minor in Materials Science and Engineering allows interested students to explore the role of materials in modern technology and to gain an understanding of the fundamental processes that govern materials behavior.

The following courses fulfill the minor requirements:

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<tr>
<td>24</td>
<td>MATSCI 142 Quantum Mechanics of Nanoscale Materials</td>
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<td>MATSCI 144 Thermodynamic Evaluation of Green Energy Technologies</td>
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<td>MATSCI 145 Kinetics of Materials Synthesis</td>
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<td>MATSCI 152 Electronic Materials Engineering</td>
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<td>MATSCI 156 Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution</td>
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<td>MATSCI 158 Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life</td>
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<td>MATSCI 160 Nanomaterials Laboratory</td>
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MATSCI 198 Mechanical Properties of Materials
MATSCI 199 Electronic and Optical Properties of Solids

Total Units 28