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 tab (http://exploredegrees.stanford.edu/schoolofengineering/materialsscienceandengineering/#covid19policiestext)" 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.

See the "Department of Materials Science and Engineering (http://exploredegrees.stanford.edu/schoolofengineering/materialsscienceandengineering/)" section of this bulletin for additional information on the department, and its programs and faculty.

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

		Units
Mathematics		
20 units minimum		
Select one of the following:		5
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
CME 100/ ENGR 154	Vector Calculus for Engineers	
Select one of the following:		5
MATH 52	Integral Calculus of Several Variables	
CME 104/ ENGR 155B	Linear Algebra and Partial Differential Equations for Engineers	
Select one of the following:		5
MATH 53	Ordinary Differential Equations with Linear Algebra	
CME 102/ ENGR 155A	Ordinary Differential Equations for Engineers	
One additional course [1]		5
Science		
20 units minimum		
Must include a full year (15 units) of calculus-based physics or chemistry, with one quarter of study (5 units) in the other subject. [2]		20
Technology in Society		
One course minimum [3]		3-5
Engineering Fundamentals		
Two courses minimum		
Select one of the following:		4
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis [4]	
ENGR 50E	Introduction to Materials Science, Energy Emphasis [4]	

ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis [4]	
At least one additional courses [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 [5, 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 ugh.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	
CHEMENG 140	Micro and Nanoscale Fabrication 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

EE 116	Semiconductor Devices for Energy and Electronics
EE 134	Introduction to Photonics
EE 142	Engineering Electromagnetics (Formerly EE 141)
EE 155	Green Electronics
ME 210	Introduction to Mechatronics
MATSCI 343	Organic Semiconductors for Electronics and Photonics
MATSCI 346	Nanophotonics
Energy Technology	
EE 293B	Fundamentals of Energy Processes
EE 155	Green Electronics
CEE 107A	Understanding Energy
EE 293B	Fundamentals of Energy Processes
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution
MATSCI 302	Solar Cells
MATSCI 303	Principles, Materials and Devices of Batteries
ME 262	Physics of Wind Energy
Materials Characterization Techniques	
MATSCI 320	Nanocharacterization of Materials
MATSCI 321	Transmission Electron Microscopy
MATSCI 322	Transmission Electron Microscopy Laboratory
MATSCI 323	Thin Film and Interface Microanalysis
MATSCI 326	X-Ray Science and Techniques
CHEMENG 345	Fundamentals and Applications of Spectroscopy
BIO 232	Advanced Imaging Lab in Biophysics
APPPHYS 201	Electrons and Photons (PHOTON 201)
Mechanical Behavior & Design	
AA 240	Analysis of Structures
AA 256	Mechanics of Composites
MATSCI 198	Mechanical Properties of Materials
MATSCI 241	Mechanical Behavior of Nanomaterials
MATSCI 358	Fracture and Fatigue of Materials and Thin Film Structures
ME 80	Mechanics of Materials
or CEE 101A	Mechanics of Materials
ME 203	Design and Manufacturing
Nanoscience	
ENGR 240	Introduction to Micro and Nano Electromechanical Systems
MATSCI 241	Mechanical Behavior of Nanomaterials
MATSCI 316	Nanoscale Science, Engineering, and Technology
MATSCI 320	Nanocharacterization of Materials
MATSCI 346	Nanophotonics
MATSCI 347	Magnetic materials in nanotechnology, sensing, and energy
MATSCI 380	Nano-Biotechnology
Physics	
PHYSICS 70	Foundations of Modern Physics
PHYSICS 110	Advanced Mechanics
PHYSICS 120	Intermediate Electricity and Magnetism I
PHYSICS 121	Intermediate Electricity and Magnetism II
PHYSICS 130	Quantum Mechanics I
PHYSICS 131	Quantum Mechanics II
PHYSICS 134	Advanced Topics in Quantum Mechanics
PHYSICS 170	Thermodynamics, Kinetic Theory, and Statistical Mechanics I
PHYSICS 171	Thermodynamics, Kinetic Theory, and Statistical Mechanics II
PHYSICS 172	Solid State Physics
Self-Defined Option	
Petition for a self-defined cohesive program. [7]	

For additional information and sample, programs see the Handbook for Undergraduate Engineering Programs (http://ughb.stanford.edu).

Honors Program

The Materials Science and Engineering honors program offers an opportunity for undergraduate Materials Science and Engineering majors with a GPA of 3.5 or higher to pursue independent research at an advanced level, supported by a faculty advisor and graduate student mentors. The main requirements are as follows:

1. Application to the honors program (must be pre-approved by faculty advisor)
2. Enrollment in MATSCI 150 Undergraduate Research and participation in an independent research project over three sequential full quarters
3. Completion of a faculty-approved thesis
4. Participation in either a poster or oral presentation of thesis work at a Stanford Symposium/event or, at your faculty advisor's discretion, in a comparable public event.

Since this requires three full quarters of research in addition to a final written thesis and presentation following completion of the work, students must apply to the program no less than four quarters prior to their planned graduation date. Materials Science and Engineering majors pursuing a typical four-year graduation timeline should meet with student services no later than the Winter Quarter of their junior year to receive information on the application process.

All requirements for the honors program are in addition to the normal undergraduate program requirements.

To apply to the MATSCI Honors program

- Have an overall GPA of 3.5 or higher (as calculated on the unofficial transcript) prior to application.
- Seek out a faculty research advisor and agree on a proposed research topic. If the research advisor is not a member of the MSE faculty or not a member of the School of Engineering Academic Council, students must have a second advisor who fulfills these requirements.
- Compose a brief (less than 1 page) summary of proposed research, including a proposed title, and submit along with unofficial transcript and signed application/faculty endorsement (https://mse.stanford.edu/student-resources/forms/undergraduate/).
- Submit application to MATSCI student services (Durand 113) at least four quarters prior to planned graduation.

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 adviser approval). All quarters must focus on the same topic. Maintain the same faculty adviser 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:

		Units
Engineering Fundamentals		
Select one of the following:		4
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis	
ENGR 50E	Introduction to Materials Science, Energy Emphasis	
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis	
Materials Science Fundamentals and Engineering Depth		
Select six of the following:		24
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	
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 160	Nanomaterials Laboratory	
MATSCI 161	Energy Materials Laboratory	
MATSCI 162	X-Ray Diffraction Laboratory	
MATSCI 163	Mechanical Behavior Laboratory	
MATSCI 164	Electronic and Photonic Materials and Devices Laboratory	
MATSCI 165	Nanoscale Materials Physics Computation Laboratory	
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	
Total Units		28