

MATERIALS SCIENCE AND ENGINEERING

Materials Science and Engineering is concerned with the relation between the structure, processing and properties of useful materials. One important goal of this work involves the development of processes for altering the structure of materials and thereby controlling their properties. This field brings together, in a unified discipline, developments in Physics, Chemistry and Biology that can be, and in fact are, applied to modern materials of technological, engineering, and scientific significance. Materials scientists and engineers utilize a distinctive suite of characterization techniques that probe materials structure down to the atomic level. Moreover, our faculty is becoming increasingly involved with nano-technology, energy-related materials and bio-chemical processing.

Students who are interested in both science and its application to important technological problems should consider a career in Materials Science and Engineering. The Undergraduate Program described here has a dual function. It provides basic training for those who wish to become materials engineers, and it provides a foundation for more advanced work in the field. Such advanced study enables students to respond effectively to technological change. Able undergraduate Materials Science and Engineering students are encouraged to take at least one year of graduate study in the Stanford co-terminal degree program (see Chapter 7: Other Degree Programs) to extend their coursework and to obtain training in research. Current research strengths of the department include nano-scale materials, energy and environmental materials, transmission electron microscopy, microelectronic materials science, structure and properties of thin film materials, semiconductors, magnetic materials, photovoltaic and photonic materials, mechanics and mechanical properties of solids, synthesis and applications of nanostructured materials, and computer modeling of materials behavior and processing of metals and alloys.

RESEARCH EXPERIENCE FOR UNDERGRADUATES

It is also possible for students to participate in current research projects with the department faculty and their research groups. The department plans to continue its summer research program through a grant from the Vice Provost for Undergraduate Education in the 2008-2009 year. Information about individual programs may be obtained from the MSE department home page. Arrangements may also be made by direct consultation with the

relevant professor. Please contact Prof. Seung Min Han at smhan@stanford.edu for any questions.

MAJOR REQUIREMENTS FOR MSE UNDERGRADUATES

MSE has recently changed the undergraduate major requirements through the introduction of a new 150 series of lecture courses that are designed primarily for the undergraduate students. The new curriculum also provides more research exposure to the students through several new 160 series of laboratory courses. The science requirements have been changed to require either a full year of physics or chemistry, with a quarter of study in the other subject. Mathematics is required through Math 51 and 52, or CME 100/ENGR154 and CME 104/ENGR155B; AND Math 53 or CME 102/ENGR155A. Please note that undergraduates may complete a major in Materials Science and Engineering using the requirements in any one handbook that is published while they are undergraduates.

Students who wish to receive further information about the programs in Materials Science and Engineering should contact:

Professor Bob Sinclair (bobsinc@stanford.edu) or
Professor Seung Min Han (smhan@stanford.edu)
Department of Materials Science and Engineering (MSE)
496 Lomita Mall, William F. Durand Building
Stanford University
Stanford, CA 94305-4034

REQUIREMENTS FOR UNDERGRADUATES IN MATERIALS SCIENCE AND ENGINEERING

School of Engineering Requirements

This group of requirements (math, science, TIS, and Engineering Fundamentals) is monitored by the SoE and is required for all engineering majors. Petitions to transfer credit, deviate from the requirements, or approve appropriate AP credit must be made to the SoE Dean's office in 201 Terman.

Mathematics and Science (40 units combined, minimum)

- Math (20 units minimum): Must include Math 51 and 52 or CME100/ENGR 154 and CME 104/ENGR 155B AND Math 53 or CME 102/ENGR 155A (See Figure 3-1 for SoE approved list of courses)
- Science (20 units minimum): Must include a full year of either physics or chemistry, with at least one quarter of study in the other subject. AP credit is also acceptable and must be approved by the Dean's office. (see Figure 3-2 for a list of SoE approved courses).

Technology In Society (1 course; 3-5 units)

See the "Approved Courses" section of this handbook, Figure 3-4, for courses that fulfill the TIS requirement.

Engineering Fundamentals

(3 Courses minimum: ENGR 50 or 50M and two electives)

Course	Title	Units
ENGR 14 <i>OR</i> 15	Applied Mechanics: Statics <i>or</i> :Dynamics	3
ENGR 20	Introduction to Chemical Engineering	3
ENGR 25	Biotechnology	3
ENGR 30	Engineering Thermodynamics	3
ENGR 40	Introductory Electronics	5
ENGR 50 <i>OR</i> 50M (required)	Introduction to Materials Science, Nanotechnology <i>OR</i> Biomaterials Emphasis	4
ENGR 60 <i>OR</i> 62	Engineering Economy <i>or</i> Introduction to Optimization	3-4
ENGR 70A <i>OR</i> 70X	Programming Methodology or Abstractions (same as CS 106A <i>OR</i> CS 106X)	3-5

TOTAL SCHOOL OF ENGINEERING UNITS

53-59

Departmental Requirements: MatSci Depth, Fundamentals, & Options

These requirements are specified and monitored by the department of Materials Science and Engineering. Petitions for exceptions and transfer of credit must be made to the department.

The MATSCI 150 series represents a stand alone curriculum which is recommended for undergraduates. The 190 series courses can be substituted for the equivalent 150 series courses, or can be taken as follow-on courses. MATSCI 153, 154 and 155 are strongly recommended as fundamental to the field.

MSE FUNDAMENTALS (24 UNITS, CHOOSE 6 OF THE FOLLOWING LECTURE-BASED COURSES)

Course	Title	Units
<i>Undergraduate Core Courses:</i>		
ENGR 50/50M OR MATSCI 70N ** See note below	Introduction to Materials Science OR Building Future – Invention and Innovation with Engineering Materials	4
MATSCI 151	Microstructure and Mechanical Properties	4
MATSCI 152	Electronic Materials Engineering	4
MATSCI 153	Nanostructure and Characterization	4
MATSCI 154	Solid State Thermodynamics ***	4
MATSCI 155	Nanomaterials Synthesis	4
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	4
MATSCI 157	Quantum Mechanics of Nanoscale Materials	4
<i>Advanced Level Courses:</i>		
MATSCI 190	Organic and Biological Materials	4
MATSCI 192	Materials Chemistry	4
MATSCI 193	Atomic Arrangements in Solids	4
MATSCI 194	Thermodynamics and Phase Equilibria	4
MATSCI 195	Waves and Diffraction in Solids	4
MATSCI 196	Imperfections in Crystalline Solids	4
MATSCI 197	Rate Processes in Materials	4
MATSCI 198	Mechanical Properties of Materials	4
MATSCI 199	Electronic and Optical Properties of Solids	4

** Students may choose to count the second ENGR 50/50M course (after taking one as part of the engineering fundamental requirements) OR MATSCI 70N as part of the MSE fundamental requirements.

*** ENGR 30 can be substituted for MATSCI 154, but cannot be used for both engineering fundamentals and MSE fundamentals requirements.

DEPTH (16 UNITS; CHOOSE FOUR OF THE FOLLOWING LABORATORY-BASED COURSES)

Course	Title	Units
MATSCI 160	Nanomaterials Laboratory	4
MATSCI 161	Nanocharacterization Laboratory (Satisfies WIM requirement)	4

MATSCI 162	X-Ray Diffraction Laboratory	4
MATSCI 163	Mechanical Behavior Laboratory	4
MATSCI 164	Electronic and Photonic Materials and Devices Laboratory (Satisfies WIM requirement)	4

OPTIONS (CHOOSE 10 UNITS FROM ONE OF THE FOLLOWING 8 OPTION AREAS)

BIOENGINEERING OPTION

Course	Title	Units
BIOE 220	Imaging Anatomy	3
BIOE 222A/B	Multi-Modality Molecular Imaging in Living Subjects I/II	4-8
BIOE 281	Biomechanics of Movement	3
BIOE 284A/B	Cardiovascular Bioengineering	3-6
MATSCI 380	Nano-Biotechnology	3
MATSCI 381	Biomaterials in Regenerative Medicine	3
ME 80	Strength of Materials	4

CHEMICAL ENGINEERING OPTION

Course	Title	Units
CHEM 171	Physical Chemistry	3
CHEMENG 130	Separation Processes	3
CHEMENG 140	Microelectronics Processing Technology	3
CHEMENG 150	Biochemical Engineering	3
CHEMENG 160	Polymer Science and Engineering	3

CHEMISTRY OPTION

Course	Title	Units
CHEM 151, 153	Inorganic Chemistry I & II	6
CHEM 171, 173, 175	Physical Chemistry	9

ELECTRONICS AND PHOTONICS OPTION

Course	Title	Units
EE 101A/B	Circuits I/II	4-8
EE 102A/B	Signal Processing and Linear Systems I/II	4-8
EE 116	Semiconductor Device Physics	3
EE 134	Introduction to Photonics	4
EE 136	Introduction to Nanophotonics and Nanostructures	3
EE 141	Engineering Electromagnetics	4

ENERGY TECHNOLOGY OPTION

Course	Title	Units
EE 293A/B	Fundamentals of Energy Processes	3-6
MATSCI 302	Solar Cells	3
ME 260	Fuel Cell Science Technology	3

MATERIALS CHARACTERIZATION TECHNIQUES OPTION

Course	Title	Units
MATSCI 320	Nanocharacterization of Materials	3
MATSCI 321	Transmission Electron Microscopy	3
MATSCI 323	Thin Film and Interface Microanalysis	4

MATSCI 325	X-Ray Diffraction	3
MATSCI 326	X-Ray Science and Techniques	3
MATSCI 405	Seminar in Applications of Transmission Electron Microscopy	1

MECHANICAL BEHAVIOR AND DESIGN OPTION

Course	Title	Units
AA 240A/B	Analysis of Structures	3-6
AA 256	Mechanics of Composites	3
ME 80 <i>OR</i> CEE 101A	Strength of Materials <i>OR</i> Mechanics of Materials	4
ME 203	Manufacturing and Design (was ME 103)	3-4
ME 294	Medical Device Design	3

PHYSICS OPTION

Course	Title	Units
PHYSICS 70	Foundations of Modern Physics	4
PHYSICS 110	Intermediate Mechanics	4
PHYSICS 120, 121	Intermediate Electricity and Magnetism	8
PHYSICS 130, 131	Quantum Mechanics	8
PHYSICS 134	Advanced Topics in Quantum Mechanics	4
PHYSICS 170, 171	Thermodynamics, Kinetic Theory & Statistical Mechanics	8
PHYSICS 172	Solid State Physics	3

SELF-DEFINED OPTION (MUST CONTAIN 10 UNITS)

Student may petition for approval of a self-defined option containing a minimum of 10 units that comprise a cohesive program of study.

MatSci Major: Minimum Unit Total

Combined units from the following group of courses **MUST TOTAL A MINIMUM OF 60 UNITS:**

Engineering Fundamentals (10-14 units)

MatSci Fundamentals (24 units)

MatSci Depth (16 units)

MatSci Options (10 units)

NO UNITS CAN BE COUNTED UNDER MORE THAN ONE CATEGORY

By adding these 60 units to the 40 required math and science units and the minimum of 3 units for the Technology in Society course, your Materials Science undergraduate major will require a minimum of 103 units of the 180 you need to graduate. Your advanced placement math and science units from high school can count toward the 40 units of basic math and science, thereby allowing you more electives during your Stanford career.

Materials Science and Engineering
Sample 4-Year Plan

	<i>Fall</i>			<i>Winter</i>			<i>Spring</i>					
	Class	Math/ Sci.	Engr.	Other	Class	Math/ Sci.	Engr.	Other	Class	Math/ Sci.	Engr.	Other
<i>Freshman</i>	MATH 51	5	-	-	MATH 52	5	-	-	MATH 53	5	-	-
	IHUM	-	-	5	IHUM	-	-	5	IHUM	-	-	5
	E31	4	-	-	Chem 33	4	-	-	PHYS 43	4	-	-
	Fr. Seminar	-	-	4	PHYS 41	4	-	-	PWR 1	-	-	4
	<i>Subtotals</i>	<i>9</i>	<i>0</i>	<i>9</i>	<i>Subtotals</i>	<i>13</i>	<i>0</i>	<i>5</i>	<i>Subtotals</i>	<i>9</i>	<i>0</i>	<i>9</i>
	Total			18	Total			18	Total			18
<i>Sophomore</i>	E50M	-	4	-	MATSCI 161	-	4	-	MATSCI 160	-	4	-
	PHYS 45	4	-	-	MATSCI 153	-	4	-	Engr. Fund	-	3	-
	PWR2	-	-	4	Engr. Fund	-	3	-	Soph. Seminar	-	-	3
	Language	-	-	5	Language	-	-	5	Language	-	-	5
	<i>Subtotals</i>	<i>4</i>	<i>4</i>	<i>9</i>	<i>Subtotals</i>	<i>0</i>	<i>11</i>	<i>5</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>8</i>
	Total			17	Total			16	Total			15
<i>Junior</i>	MATSCI 151	-	4	-	MATSCI 157	-	4	-	MATSCI 152	-	4	-
	MATSCI 154	-	4	-	Option Sequenc	-	3	-	MATSCI 155	-	4	-
	MATSCI 163	-	4	-	GER	-	-	3	GER	-	-	3
	GER	-	-	3	GER	-	-	3	GER	-	-	3
	<i>Subtotals</i>	<i>0</i>	<i>12</i>	<i>3</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>6</i>	<i>Subtotals</i>	<i>0</i>	<i>8</i>	<i>6</i>
	Total			15	Total			13	Total			14
<i>Senior</i>	MATSCI 156	-	4	-	MATSCI 162	-	4	-	Option Sequence		4	-
	MATSCI 164	-	4	-	Tech in Society	-	3	-	190s series	-	4	-
	Option Sequence	-	3	-	GER	-	-	3	GER	-	-	3
	<i>Subtotals</i>	<i>0</i>	<i>11</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>3</i>	<i>Subtotals</i>	<i>0</i>	<i>8</i>	<i>3</i>
	Total			11	Total			10	Total			11

AP Math Units: 5
 UG Math & Science Units: 35
 Total Engineering Units: 75
 Total Other Units: 66
Total Units: 181

INSTRUCTIONS FOR DECLARING MAJOR IN MATERIALS SCIENCE AND ENGINEERING

1. Declare major in Axess.*
2. Send email notice to Doris Chan, Student Services Specialist, at dschan@stanford.edu, notifying her of your major declaration and preference for a major advisor, if any.
3. Obtain your student file from your undergraduate advisor and bring it to Doris's office at Durand Building Room 111..
4. Download the MSE program sheet from <http://ughb.stanford.edu/> and fill it out. Print your unofficial Stanford transcript from Axess and attach to it.
5. Meet with your major advisor to review the program sheet and have your advisor sign approve it.
6. Get Transfer/AP credit approval from the SoE Dean's Office if applicable.
7. Return completed program sheet to Doris Chan.

WE RECOMMEND THAT THE MAJOR PROGRAM SHEET BE COMPLETED WITHIN THE SAME QUARTER OF YOUR MAJOR DECLARATION OR NO LATER THAN THE END OF JUNIOR YEAR, IN ORDER TO ASSURE THAT YOU GRADUATE ON TIME.

* Stanford requires the declaration of a major by the end of sophomore year. The department will, of course, accept later declarations from students who change majors.

Stanford University ♦ School of Engineering
Materials Science and Engineering
2008–2009 Program Sheet

Final version of completed and signed program sheet due to the department no later than one month prior to the last quarter of senior year.

Follow all requirements as stated for the year of the program sheet used.

Name: _____ SU ID: _____
 Email: _____ Local Phone: _____
 Date: _____ Date B.S. expected: _____

Mathematics and Science Requirements

Dept	Course	Title	Transfer/AP Approval			Unit	Grade
			✓ if Transfer	Initials	Date		
<i>Mathematics (20 units minimum)</i>							
MATH	51 and 52 or CME 100/ENGR 154 and CME 104/ENGR 155B (required)					10	
MATH	53 or CME 102/ENGR 155A (required)					5	
<i>Mathematics Unit Total (20 units minimum)</i>							

Science (20 units minimum; see note 1)

<i>Science Unit Total (20 units minimum)</i>							
<i>(40 units minimum)</i>							

Technology in Society Requirement (1 course required; see Figure 3-3 in UGHB for SoE approved list)

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Engineering Fundamentals (3 courses required; see note 2)

ENGR	50 or 50M	Introduction to Materials Science (required)				4	
<i>Engineering Fundamentals Total</i>							

NOTES

- * This form is available as an Excel file at <http://ughb.stanford.edu/>. The printed form must be signed by the advisor and, if required, by the departmental representative. Changes must be initialed in ink.
 - * Read all emails from the Office of Student Affairs; this is the SoE's only method of conveying key information to Eng
 - * All courses listed on this form must be taken for a letter grade if offered by the instructor.
 - * Minimum Grade Point Average (GPA) for all courses in Engineering Fundamentals and Materials Science and Engineering Depth (combined) is 2.0.
 - * Transfer and AP credits in Math, Science, Funds., & TIS must be approved by the SoE Dean's Office. Transfer credits in Engineering Depth must be approved by the Advisor. Transfer credit information and petitions are available at <http://ughb.stanford.edu/transfer.html>.
 - * All courses listed on this form must only be included under one category; no double-counting.
- (1) Must include a full year of physics or chemistry, with at least one quarter of study in the other subject.
 (2) If both ENGR 50 and 50M are taken, one may be used for Engr Funds and the other for MatSci Fundamentals.

program sheet continues on page 2

Materials Science and Engineering Program Sheet (continued)

Materials Science and Engineering Depth (50 units minimum)

Dept	Course	Title	Transfer/AP Approval			Units	Grade
			✓ if Transfer	Initials	Date		

Materials Science Fundamentals (choose six lecture courses for 24 units)

Materials Science Fundamentals Unit Total (24 units)

Engineering Depth (choose four laboratory courses for 16 units)

MATSCI	161 or 164	WIM				4	

Engineering Depth Unit Total (16 units)

Option Area (10 units minimum; select from one of the nine Options Areas)

Option Area Unit Total (10 units minimum)

Materials Science Engineering Depth Total (50 units minimum)

Program Totals

<i>Mathematics and Science (40 units minimum)</i>	<input type="text"/>
<i>TIS and Engineering Fundamentals (13 units minimum)</i>	<input type="text"/>
<i>Materials Science and Engineering Depth (50 units minimum)</i>	<input type="text"/>

Program Approvals

Advisor

Printed Name: _____

Date: _____

Signature: _____

Departmental

Printed Name: _____

Date: _____

Signature: _____

School of Engineering (signature not required prior to graduation)

Printed Name: _____

Date: _____

Signature: _____

MECHANICAL ENGINEERING

— ABET ACCREDITATION CRITERIA APPLY —

The undergraduate program in Mechanical Engineering at Stanford exposes each student to intellectual and practical experiences, and provides an environment that allows for the accumulation of knowledge and self discovery. Ultimately each graduate will acquire the ability to apply this knowledge to a variety of societal needs. Graduates have many options, from entry-level work as mechanical engineers to graduate studies in either an engineering discipline or in another field where a broad engineering background is useful. Regardless of the ultimate career choice, graduates leave the program with a solid grounding in the principals and practice of mechanical engineering, equipped to embark upon a lifetime of learning, while employing new concepts, technologies and methodologies.

STANFORD UNIVERSITY/ÉCOLE CENTRALE PARIS JUNIOR YEAR ABROAD PROGRAM

Although not formally part of the Overseas Studies Program, Stanford mechanical engineering undergraduates can receive credit for study abroad at École Centrale Paris. École Centrale Paris is one of the best known science and engineering schools in France and Europe. Stanford students are enrolled in engineering program classes with French and International students. Instruction is mostly in French. For more information, see the “Overseas Studies” section of this handbook or contact Prof. Mark Cappelli, Bldg. 520-520J, or at cap@stanford.edu.

RESEARCH EXPERIENCE FOR UNDERGRADUATES

The Mechanical Engineering department offers a Summer Undergraduate Research Institute (http://me.stanford.edu/current/ug/ug_research.html). The 2009 program will include student research training in team settings (e.g., students working together on larger projects directed by staff and faculty), and in individually-directed research settings (e.g., the student will work closely with a faculty advisor or senior graduate student).

The program is open only to Stanford Undergraduate students who will be in their senior year (or earlier) in the fall quarter following the summer research experience. Students do not necessarily have to be declared ME majors. There is no formal application for participation in the ME SURI.