

MATERIALS SCIENCE AND ENGINEERING

Materials Science and Engineering is concerned with the relation between the structure, processing and properties of 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. Conterminal degree programs are also recommended for any related undergraduate majors. Current research strengths of the department include transmission electron microscopy, microelectronic materials science, structure and properties of thin film materials, semiconductors, magnetic materials, photoelectronic 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 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 2006-2007 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.

MAJOR REQUIREMENTS FOR MSE UNDERGRADUATES

Requirements for the MSE undergraduate major have changed significantly. The 150 series of courses has been expanded to provide an undergraduate major that does not require that courses be taken with graduate students (as does the 190 series), and more laboratory courses are being offered. 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
Prof. Seung Min Han (smhan@stanford.edu)
Department of Materials Science and Engineering (MSE)
Building 550, 416 Escondido Mall
Stanford University
Stanford, CA 94305-2205

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 (One course; 3-5 units)

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

Engineering Fundamentals

(Three courses minimum: ENGR 50 or 50M and two electives)

Course	Title	Units
ENGR 14 OR 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 OR 50M	Introduction to Materials Science, Nanotechnology OR Biomaterials Emphasis (required)	4
ENGR 60 OR 62	Engineering Economy <i>or</i> Introduction to Optimization	3-4
ENGR 70A OR 70X	Programming Methodology (same as CS 106A OR CS 106X)	3-5

TOTAL SCHOOL OF ENGINEERING UNITS

53-59

Departmental Requirements: MatSci Fundamentals, Depth, & Options

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

Materials Science majors may choose to take both ENGR 50 and ENGR 50M. One course would fulfill one of the three required engineering fundamentals courses and the other may be included in the 24 units total for lecture-based depth courses. MATSCI 70N may be substituted for either ENGR 50 or ENGR 50M, although either ENGR 50 or ENGR 50M must be taken.

Undergraduates are strongly encouraged to begin with the 150 series of courses and consider some of the 190 series of courses in their senior year as appropriate.

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

Course	Title	Units
<i>Lecture-based courses offered exclusively to undergraduates</i>		
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	Applied Quantum Mechanics (to be offered 2007-08)	4
<i>Lecture-based courses offered to undergraduates and graduate students:</i>		
MATSCI 190	Organic Materials	4
MATSCI 192	Materials Chemistry	4
MATSCI 193	Atomic Arrangements in Solids	4
MATSCI 194	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	Electrical, Optical and Magnetic Properties of Materials	4

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 & Photonic Materials and Devices Lab (to be offered 07-08)	4

OPTIONS (CHOOSE 10 UNITS FROM ONE OF THE FOLLOWING 9 OPTION AREAS)

BIOENGINEERING OPTION

Course	Title	Units
BIOE 220	Introduction to Imaging and Image-Based Human Anatomy	3
BIOE 222	Multi-Modality Molecular Imaging in Living Subjects	4

BIOE 280	Skeletal Development and Evolution	3
BIOE 281	Biomechanics of Movement	3
BIOE 284A/B	Cardiovascular Bioengineering	6-8
MATSCI 380	Molecular Biomaterials	3
ME 80/81	Stress, Strain, and Strength	4

CHEMICAL ENGINEERING OPTION

Course	Title	Units
CHEM 171	Physical Chemistry	4
CHEMENG 130	Separation Processes	3
CHEMENG 140	Microelectronics Processing Technology	3
CHEMENG 150	Biochemical Engineering	3
CHEMENG 150A	BioProcess Design Laboratory	1
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	Circuits I	4
EE 101B	Circuits II	4
EE 102A	Signal Processing and Linear Systems I	4
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	Energy Processes	6-8
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 324	Topics in Thin Film Microcharacterization	3
MATSCI 325	X-Ray Diffraction	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	6
AA 256	Mechanics of Composites	3
MATSCI 170	Materials Selection in Design	4
MATSCI 358	Fracture and Fatigue of Engineering Materials	3

ME 80/81 <i>OR</i> CEE 101A	Stress, Strain, and Strength <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	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	Physics of Solids I	3
PHYSICS 173	Magnetism and Long-Range Order in Solids	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)

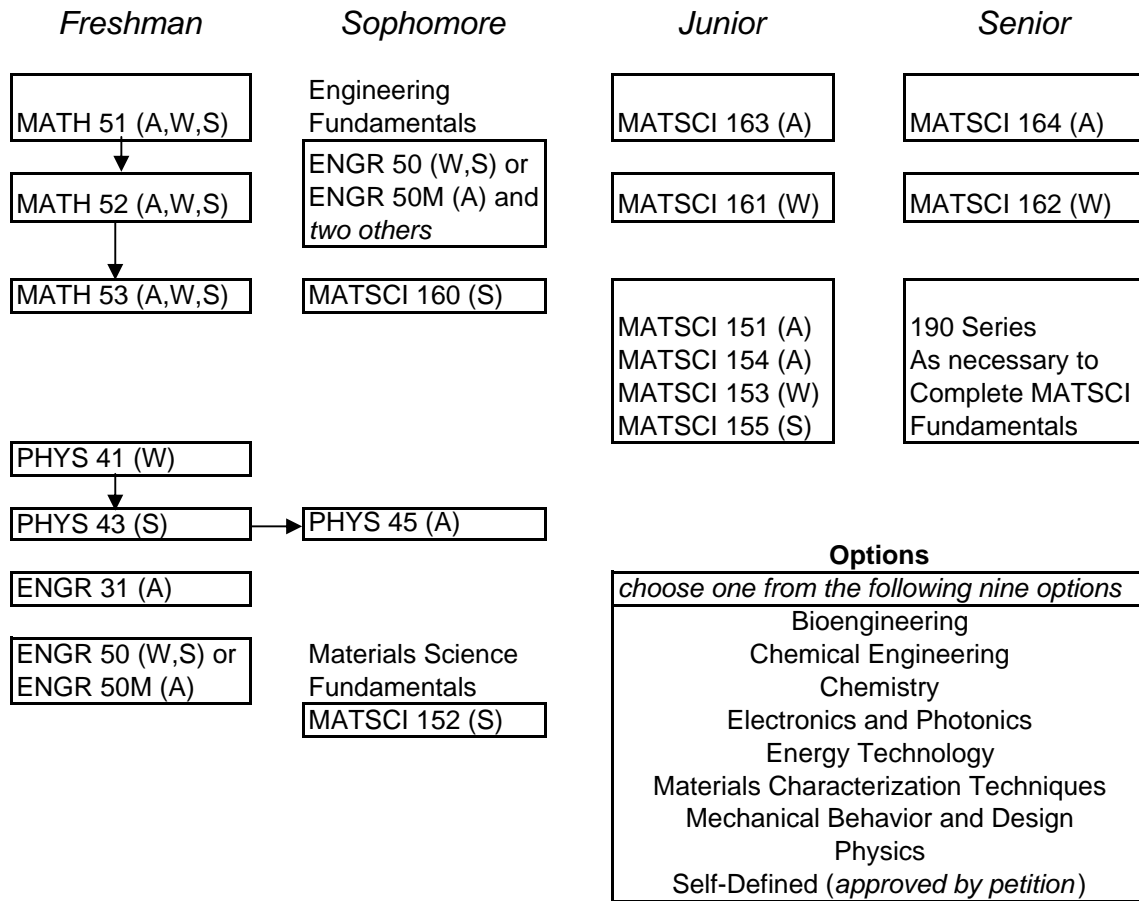
MatSci Depth (16 units)

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
Typical Sequence of Courses



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>	PHYS 45	4	-	-	E50	-	4	-	MATSCI 160	-	4	-
	Engr. Fund	-	3	-	Engr. Fund	-	3	-	MATSCI 152	-	4	-
	PWR 2	-	-	4	Language	-	-	5	Language	-	-	5
	Language	-	-	5	Soph. Seminar	-	-	3	Engr. Fund	-	3	-
	<i>Subtotals</i>	<i>4</i>	<i>3</i>	<i>9</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>8</i>	<i>Subtotals</i>	<i>0</i>	<i>11</i>	<i>5</i>
	Total			16	Total			15	Total			16
<i>Junior</i>	MATSCI 151	-	4	-	MATSCI 161	-	4	-	MATSCI 155	-	4	-
	MATSCI 154	-	4	-	MATSCI 153	-	4	-	GER	-	-	3
	MATSCI 163	-	4	-	GER	-	-	3	GER	-	-	3
	GER	-	-	3	Math Elective	3	-	-	Option Sequence	-	3	-
	<i>Subtotals</i>	<i>0</i>	<i>12</i>	<i>3</i>	<i>Subtotals</i>	<i>3</i>	<i>8</i>	<i>3</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>6</i>
	Total			15	Total			14	Total			13
<i>Senior</i>	Option Sequence	-	4	-	MATSCI 162	-	4	-	Option Sequence	-	3	-
	190s series	-	4	-	Option Sequence	-	3	-	GER	-	-	3
	GER	-	-	3	Tech in Society	-	4	-	GER	-	4	-
	<i>Subtotals</i>	<i>0</i>	<i>8</i>	<i>3</i>	<i>Subtotals</i>	<i>0</i>	<i>11</i>	<i>0</i>	<i>Subtotals</i>	<i>0</i>	<i>7</i>	<i>3</i>
		Total			11	Total			11	Total		

AP Math Units: 5
 UG Math & Science Units: 38
 Total Engineering Units: 74
 Total Other Units: 63
Total Units: 180

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 Building 550, Room 551E.
4. Download the MSE program sheet from <http://ughb.stanford.edu/> and fill it out.
5. Meet with your major advisor to review the program sheet and sign approve it. Return completed program sheet to Doris Chan.

WE RECOMMEND THAT THE MAJOR PROGRAM SHEET BE COMPLETED WITHIN THE SAME QUARTER OF YOUR MAJOR DECLARATION (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.

Materials Science and Engineering Program Sheet (continued)

Materials Science and Engineering Depth (50 units minimum)

Dept	Course	Title	Units	Grade	✓ if Transfer	Transfer/AP Approval	
						Initials	Date
<i>Materials Science Fundamentals (choose six lecture courses for 24 units)</i>							
<i>Materials Science Fundamentals Unit Total</i>				<i>(24 units)</i>			
<i>Engineering Depth (choose four laboratory courses for 16 units)</i>							
MATSCI	161	Nanocharacterization Laboratory (WIM: see note 3)	4				
<i>Engineering Depth Unit Total</i>				<i>(16 units)</i>			
<i>Option Area (10 units minimum; select from one of the nine Options Areas)</i>							
<i>Option Area Unit Total</i>				<i>(10 units minimum)</i>			
<i>Materials Science Engineering Depth Total</i>				<i>(50 units minimum)</i>			

Program Totals

<i>Mathematics and Science</i>		<i>(40 units minimum)</i>
<i>TIS and Engineering Fundamentals</i>		<i>(13 units minimum)</i>
<i>Materials Science and Engineering Depth</i>		<i>(50 units minimum)</i>

Program Approvals

Advisor

Printed Name: _____
Signature: _____

Date: _____

Departmental

Printed Name: _____
Signature: _____

Date: _____

School of Engineering

Printed Name: _____
Signature: _____

Date: _____

NOTES (continued from page 1)

(3) Fulfills "Writing in the Major" requirement.