3. COURSES APPROVED FOR SCHOOL OF ENGINEERING REQUIREMENTS

Nearly all engineering majors share similar requirements in Mathematics, Science, Technology in Society, and Engineering Fundamentals. The Undergraduate Council of the School of Engineering is responsible for establishing lists of courses certified as satisfying these requirements, which appear in the tables included in this section. Other appropriate courses—such as more advanced courses—may be used to satisfy these requirements, but their use must be approved by petition. Petition forms can be found in the "Forms" section of this handbook and are also on the Undergraduate Handbook website (http://ughb.stanford.edu). All petitions should be submitted to the Office of Student Affairs, Terman 201. **A student must obtain petition approval prior to enrolling in any course she or he wishes to use in satisfying one of these requirements.** Further information is available in the Office of Student Affairs.

THE MATHEMATICS REQUIREMENT

The mathematics requirements for departmental and School of Engineering majors are delineated by major in the detailed "Program Requirements" section in this Handbook. In general, each program requires a number of specific and elective courses from the list of approved courses shown in Figure 3-1 on the next page. Individually Designed Majors must include at least 21 units from the list. All engineering students should check the "Program Requirements" pages for their major to see which mathematics courses are recommended or required.

FIGURE 3-1. COURSES APPROVED FOR THE MATHEMATICS REQUIREMENT

Course	Title	Units
MATH 19, 20, 21	Calculus of a Single Variable	3, 3, 4
MATH 41, 42	Calculus of a Single Variable	5, 5
MATH 51, 52, 53	Calculus of Several Variables with Linear Algebra	5, 5, 5
MATH 51H, 52H, 53H	Honors Calculus	5, 5, 5
MATH 103	Matrix Theory and Its Applications	3
MATH 106	Functions of a Complex Variable	3
MATH 109	Applied Group Theory	3
MATH 113, 114	Linear Algebra and Matrix Theory	3, 3
MATH 115	Functions of a Real Variable	3
MATH 120, 121	Modern Algebra I, II	3, 3
MATH 131, 132	Differential Equations	3, 3
or more advanced Mathematics courses.		
STATS 60/160	Introduction to Statistical Methods: Precalculus	5
STATS 110	Statistical Methods in Engineering and the Physical Sciences	4-5
STATS 116	Theory of Probability	3-5
or more advanced Statistics courses numbered over 100.		
AA 192	Vector and Tensor Analysis	3
CEE 101D	Mathematical Lab Applications in CEE	3
CEE 203	Statistical Models in Civil Engineering	4
CME 100 (same as E 154)	Vector Calculus for Engineers	5
CME 102 (same as E 155A)	Ordinary Differential Equations for Engineers	5
CME 104 (same as E 155B)	Linear Algebra and Partial Differential Equations for Engineers	5
CME 106 (same as E 155C)	Introduction to Probability and Statistics for Engineers	3-4
CME 108	Introduction to Scientific Computing	3-4
EE 178	Introduction to Probabilistic Systems Analysis	3
ENGR 62	Introduction to Optimization	4
ENGR 154 (same as CME 100)	Vector Calculus for Engineers	5
ENGR 155A (same as CME 102)	Ordinary Differential Equations for Engineers	5
ENGR 155B (same as CME 104)	Linear Algebra and Partial Differential Equations for Engineers	5
ENGR 155C (same as CME 106)	Introduction to Probability and Statistics for Engineers	3-4
GES 160	Introduction to Statistical Methods for Earth and Environmental Sciences	3
MS&E 120	Probabilistic Analysis	5
MS&E 121	Intro to Stochastic Modeling	4

THE SCIENCE REQUIREMENT

The science requirements for departmental and School of Engineering majors are delineated in the detailed "Program Requirements" section at the back of the Handbook. In general, each program requires a number of specific and elective courses from the list of approved courses shown in Figure 3-2. Individually Designed Majors must include at least 17 units from the list. All engineering students should check the "Program Requirements" pages for their major to see which science courses are recommended or required.

FIGURE 3-2. COURSES APPROVED FOR THE SCIENCE REQUIREMENT

Course	Title	Expr. Units	Total Units
BIOSCI 41	Genetics, Biochemistry, and Molecular Biology	–	5
BIOSCI 42	Cell Biology and Animal Physiology	–	5
BIOSCI 43	Plant Biology, Evolution, and Ecology.	–	5
CEE 63	Weather and Storms	–	3
CEE 64	Air Pollution: From Urban Smog to Global Change	–	3
CEE 70	Environmental Science and Technology	-	3
CEE 179A	Water Chemistry Lab	3	3
CHEM 31A, B	Chemical Principles	–	4, 4
CHEM 31X	Chemical Principles	–	4
CHEM 33	Structure and Reactivity	–	4
CHEM 35	Organic Monofunctional Compounds	–	4
CHEM 36	Organic Chemistry Lab I	2	3
CHEM 131	Organic Poly Compounds	-	3
CHEM 135	Physical Chemical Principles	–	3
EARTHSYS 10	Introduction to Earth Systems	1	4
ENGR 31	Intro to Solid State Chem w/Applications to Materials Technology	–	4
GES 1 *	Dynamic Earth: Fundamentals of Earth Sciences	1	4
GES 2 *	Earth System History	–	3
GES 3 *	Current Research Topics in Earth & Environmental Sciences		1
PHYSICS 41	Mechanics	2	4
PHYSICS 43	Electricity, Magnetism	–	4
PHYSICS 45	Light and Heat	–	4
PHYSICS 44, 46	Physics Labs	1,1	1,1
PHYSICS 61–65	Advanced Freshman Physics and labs	3	15

** A maximum of 5 units of coursework from these courses may be counted toward the Science Requirement.*

THE TECHNOLOGY IN SOCIETY REQUIREMENT

It is important for the student to obtain a broad understanding of engineering as a social activity. To foster this aspect of intellectual and professional development, all engineering majors must take one course devoted to exploring issues arising from the interplay of engineering, technology, and society. Individual courses approved for the Technology in Society Requirement are listed in

Figure 3-3. Note that some of the approved courses are limited-enrollment offerings, which means that you need to take this into account when creating your course schedule. Petitions to use other courses to fulfill the Technology in Society Requirement will be considered strictly on their merits and will not be approved simply because the student has left the fulfillment of this requirement until her or his last quarter at Stanford.

FIGURE 3-3. COURSES APPROVED FOR THE TECHNOLOGY IN SOCIETY REQUIREMENT

Note: CE, EnvE, ME, and MS&E majors must choose from among the courses marked "X" in the appropriate columns. Students in other engineering majors may choose from any of the following courses, although ME majors have priority in ME 190, a limited-enrollment seminar.

Course	Title	Qtr	Units		CE/EnvE	ME	MS&E
STS 101/201 (ENGR 130)	Science, Technology, and Contemporary Society	A	4-5		X	X	X
STS 110 (MS&E 197)	Ethics and Public Policy	W	5		X	X	X
STS 115 (ENGR 131)	Ethical Issues in Engineering	S	4		X		
STS 128	Science & Technology In WWII (and What Happened Afterward)	W	3				
STS 144	Game Studies: Issues in Design, Technology, & Player Creativity	S	4				
STS 160	Controversy and Closure: The Politics of Technical Expertise	W	4				
STS 210	Ethics, Science., & Tech. (Prerequisite: STS 110 or other ethics course)	S	4				
COMM 169	Computers and Interfaces: Psychological and Social Issues	W	5		X		X
CS 201	Computers, Ethics and Social Responsibility	W	3-4		X	X	X
ENGR 145	Technology Entrepreneurship	A,W	4				
MS&E 181	Issues of Technology and Work in a Post-Industrial Economy	S	3		X		X
MS&E 193	Technology in National Security	A	3		X	X	X
ME 190	Ethical Issues in Mechanical Engineering (for ME majors only)					X	
POLISCI 114S	International Security in a Changing World	W	5		X	X	
POLISCI 116	History of Nuclear Weapons	S	5				
PP 194	Technology Policy	W	5			X	

In addition to the courses shown in Figure 3-3, students can also fulfill the Technology in Society Requirement by taking part in the Stanford Center for Technology and Innovation (SCTI) program, which is offered by Overseas Studies at the Kyoto campus. NOTE: This option is not

open to CE, EnvE, or ME majors, who must who must satisfy their TIS by taking one of the courses indicated in the designated CEE or ME columns above.

THE ENGINEERING FUNDAMENTALS REQUIREMENT

The Engineering Fundamentals requirement is satisfied by a set of technically rigorous introductory courses chosen from the various engineering disciplines, as shown in Figure 3-4. These courses serve several purposes. First, they provide a breadth of knowledge about some of the major fields within engineering. Second, they furnish students with an opportunity to explore a number of engineering topics before embarking on a specific engineering major. Third, the individual classes each offer a reasonably deep insight into a contemporary technological subject for the interested non-engineer.

FIGURE 3-4. COURSES APPROVED FOR THE ENGINEERING FUNDAMENTALS REQUIREMENT

Course	Title	Engr. Science	Engr. Design	Expr. Units	Total Units
ENGR 10	Introduction to Engineering Analysis	4	–	–	4
ENGR 14	Applied Mechanics: Statics	2	1	-	3
ENGR 15	Dynamics	2	1	–	3
ENGR 20	Introduction to Chemical Engineering	2	1	–	3
ENGR 25	Bioengineering	2	1	–	3
ENGR 30	Engineering Thermodynamics	3	–	–	3
ENGR 40	Introductory Electronics	3	2	2	5
ENGR 50/50M *	Introductory Science of Materials	4	–	–	4
ENGR 60	Engineering Economy	3	–	–	3
ENGR 62	Introduction to Optimization	4	-	-	4
ENGR 70A,B ** *or* ENGR 70X **	Programming Methodology Programming Methodology and Abstractions	3 3	2 2	– –	5 5

Note:

* Only one of the ENGR 50 courses may be applied toward the Engineering Fundamentals requirement.

** Same as CS 106A,B or CS 106X. Electrical Engineering majors must complete either CS 106X, or CS 106A *and* CS 106B. However, if a student elects to take CS 106A and CS 106B, CS 106B does not count toward the 45 units of Engineering Depth in Electrical Engineering.

Engineering majors must complete a minimum of three Engineering Fundamentals courses, at least one of which is left up to the student to choose.

THE EXPERIMENTATION REQUIREMENT

The departmental majors in Chemical, Civil, Electrical, Environmental, Materials Science and Engineering, and Mechanical Engineering require 8 units of Experimentation, which is normally included within the units taken for Science, Engineering Fundamentals, and Engineering Depth. Thus, with careful planning of the courses taken in those portions of the curriculum, the Experimentation requirement should not involve additional coursework.

The experimentation content of undergraduate engineering and science courses is shown, in units, in Figure 3-5 on the following page. Students may also petition to receive experimentation units for work performed in other courses (including individual research projects) or even for appropriate summer work, with the approval of their Academic Advisor.

FIGURE 3-5. COURSES APPROVED FOR THE EXPERIMENTATION REQUIREMENT

Course	Title	Expr. Units
BIOSCI 44	Core Experimental Laboratory	3
CEE 100	Managing Sustainable Building Projects	1
CEE 101A	Mechanics of Materials	1
CEE 101C	Geotechnical Engineering	1
CEE 140	Field Surveying Lab	3
CEE 141	Project for ASCE: Design & Construction of Steel Bridge	1
CEE 147	Cases in Personality, Leadership, and Negotiation	1
CEE 148	Design/Construction of Affordable Housing	1
CEE 161A	Rivers, Streams, and Canals (for 4 units)	1
CEE 176A,B	Energy Efficient Buildings, Electric Power: Renewables and Efficiency	1, 1
CEE 178	Intro to Human Exposure Analysis	1
CEE 179A	Water Chemistry Lab	3
CEE 179B	Process Design for Biotechnology (alternate years)	3
CEE 195A,B	Structural Geology	1
CEE 242	Organization Design for Projects and Companies	1
CHEM 36	Chemical Separations	2
CHEM 130	Organic Chemistry Lab II	4
CHEMENG 185A	Chemical Engineering Laboratory – A	4
CHEMENG 185B	Chemical Engineering Laboratory – B	4
CHEMENG 185	Chemical Engineering Laboratory	4
CS 48N	The Science of Art	3
EE 41	Physics of Electrical Engineering	2
EE 101A,B	Circuits	1, 1
EE 102A,B	Signal Processing and Linear Systems	1, 1
EE 108A,B	Digital Systems	1, 1
EE 109	Digital Systems Design Laboratory	4
EE 122	Analog Circuits Laboratory	3
EE 133	Analog Communications Design Laboratory	2
EE 134	Introduction to Photonics	3
EE 144	Wireless Electromagnetic Design Laboratory	1.5
EE 265	Signal Processing Lab	3
ENGR 40	Introductory Electronics	2
GES 1	Fundamentals of Geology	1
GES 3	Earth History Laboratory	2
MATSCI 161,162,163	Experimental Methods in Materials Science	4, 4, 4
ME 70	Introductory Fluids Engineering	1
ME 80	Strength of Materials	1
ME 131A	Heat Transfer	2
ME 131B	Fluid Mechanics	1
ME 140	Advanced Thermal Systems	2
ME 210	Introduction to Mechatronics	3
ME 220	Introduction to Sensors	1
ME 227	Vehicle Dynamics	1
ME 281	Biomechanics of Movement	1.5
ME 203	Manufacturing and Design	1
MS&E 108	Senior Project	3, 3, 3
MS&E 160	Analysis of Production and Operating Systems	1
MS&E 169	Quality Control and Management	1
MS&E 180	Organizations: Theory and Management	1
MS&E 265	Supply Chain Logistics	2
MS&E 277	Creativity and Innovation	1
PHYSICS 46	Light & Heats Lab	1

THE ENGINEERING SCIENCE AND ENGINEERING DESIGN REQUIREMENT

In order to satisfy ABET (Accreditation Board for Engineering and Technology) requirements, a student majoring in Chemical, Civil, Electrical, Environmental, or Mechanical Engineering must complete one and a half years of Engineering Science and Engineering Design, also called engineering topics, in order to graduate. This requires a minimum of 68 units of Engineering Science and Design appropriate to the student's field of study. In most cases, students meet this requirement by completing the major program core and elective requirements in Fundamentals and Depth. For example, ENGR 40 is a 5-unit course; 3 of these 5 units are assigned to Engineering Science and the remaining 2 units are assigned to Engineering Design. A student may need to take additional courses in Depth in order to fulfill the minimum requirement.

The engineering science and design units assigned to each major's depth courses are listed in tables within the applicable major program descriptions in Chapter 5 and online at **http://ughb.stanford.edu/**. See Chapter 2 on *Accreditation* for more information.