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 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	4-5
STATS 116	Theory of Probability	3-5
or more advanced Statistics courses numbered over 100.		
AA 192	Vector and Tensor Analysis	3
CHEMENG 220	Applied Mathematics in Chemical Engineering	3
CEE 101D	Seminar on Mathematical Lab Applications in CEE	2
CEE 203	Statistical Models in Civil Engineering	4
CME 100 (same as ENGR 154)	Introduction to Engineering Mathematics	5
CME 102, 104, 106 (same as ENGR 155A, 155B, 155C)	Mathematical and Computational Methods for Engineers	5, 5, 4
CS 137	Introduction to Scientific Computing	4
CS 237A, B, C	Advanced Numerical Analysis	3, 3, 3
CS 260	Concrete Mathematics	3
EE 178	Introduction to Probabilistic Systems Analysis	3
ENGR 62	Introduction to Optimization	4
ENGR 154 (same as CME 100)	Introduction to Engineering Mathematics	5
ENGR 155A, 155B, 155C (same as CME 102, 104, 106)	Mathematical and Computational Methods for Engineers	5, 5, 4
ENGR 160	Ordinary Differential Equations and Their Applications	3
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
MATSCI 191	Mathematical Methods in Materials Science	3

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: Urban Smog to Global Change	–	3
CEE 70	Environmental Science and Technology	-	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	Chemical Separations	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 *	Fundamentals of Earth Sciences	1	5
GES 2 *	History of Life on Earth	?	4
PHYSICS 41	Mechanics	2	4
PHYSICS 43	Electricity, Magnetism	–	4
PHYSICS 45	Light and Heat	–	4
PHYSICS 44, 46	Physics Lab	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

Course	Title	Quarter	Units
STS 101/201 (ENGR 130) *†	Science, Technology, and Contemporary Society	A	4-5
STS 110 (MS&E 197) *†	Ethics and Public Policy	W	5
STS 112	Ten Things: Science, Technology, and Design	W	4-5
STS 115 (ENGR 131) *	Ethical Issues in Engineering	S	4
STS 125	Science, Technology, and Art: the Worlds of Leonardo	W	5
STS 160	Controversy and Closure: The Politics of Technical Expertise	W	4
STS 163	Risk in Contemporary Culture	S	4
STS 170 *	Technology in Modern Security Discourse	A	4
POLISCI 114S	International Security in a Changing World	W	5
COMM 120/220	Social Impact of Digital Media	S	5
COMM 169 *	Computers and Interfaces: Psychological and Social Issues	W	5
MS&E 193 *	Technology in National Security	A	3
MS&E 181 *	Issues of Technology and Work in a Post-Industrial Economy	S	3
ENGR 145	Introduction to High-Technology Entrepreneurship	W	3
PP 194 †	Technology Policy	W	5
CS 201X (OS; Berlin) *†	Computers and Ethics	S	3-4
Notes:			
* Approved STS courses for MS&E majors.			
† Approved STS courses for Environmental Engineering majors.			

In addition to the courses shown in Figure 3-3, you 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.

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	4 4	1 1	– –	5 5

Note:

* 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.

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

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
AA 131	Experimentation in Aero/Astro	3
BIOSCI 44	Core Experimental Laboratory	3
CEE 100	Managing Civil Engineering Projects	1
CEE 101A	Structural Systems	1
CEE 101C	Geotechnical Engineering	1
CEE 140	Field Surveying Lab	4
CEE 141	Concrete Canoe for ASCE Competition	1
CEE 147	Cases in Personality, Leadership, and Negotiation	1
CEE 148	Design/Construction of Affordable Housing	1
CEE 160	Mechanics of Fluids Laboratory	2
CEE 161A	Rivers, Channels and Streams	1
CEE 176A,B	Energy Efficient Buildings	1, 1
CEE 178	Intro to Human Exposure Analysis	1
CEE 179A	Water Chemistry Lab	2
CEE 179B	Process Design for Biotechnology (alternate years)	3
CEE 195	Structural Geology and Rock Mechanics	1
CEE 242	Organization Design for Projects and Companies	1
CHEM 36	Chemical Separations	2
CHEM 130	Theory and Practice of Identification	4
CHEM 132	Qualitative Organic Analysis	4
CHEMENG 185A,B	Chemical Engineering Laboratory	4, 2
CS 48N	The Science of Art	3
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 Laboratory	3
EE 133	Analog Communications Design Laboratory	2
EE 144	Electromagnetic Waves Design Laboratory	1.5
EE 181	Computer Organization, Machine and Assembly Language	1
EE 218	Semi-custom VLSI Systems	1
EE 281	Microcomputer-Based System Design	3
ENGR 40	Introductory Electronics	2
ENGR 75	Intro to Small Computer Interfacing	3
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 33	Introductory Fluids Engineering	1
ME 103	Manufacturing and Design	1
ME 117	Introduction to Sensors	.5
ME 118	Introduction to Mechatronics	3
ME 130	Internal Combustion Engines	3
ME 131A	Heat Transfer	2
ME 132	Thermosciences Laboratory	3
ME 217A	Design for Manufacturability	1
MS&E 108	Senior Project	3, 3, 3
MS&E 160	Analysis of Production and Operating Systems	1
MS&E 164	Work Design and Measurement	2
MS&E 169	Quality Assurance and Control	1
MS&E 180	Organizations: Theory and Management	1
MS&E 265	Reengineering the Manufacturing Function	2
MS&E 277	Creativity and Innovation in Organizations	1
PHYSICS 52	Physics 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 Design, also called engineering topics, in order to graduate. For all these majors (except Chemical Engineering, which requires a minimum of 63 units) 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://soe.stanford.edu/ughb**. See Chapter 2 on *Accreditation* for more information.