3. APPROVED COURSES

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, for example—may be used to satisfy these requirements, but their use must be approved by petition. Petition forms are on the Undergraduate Handbook website (`http://ughb.stanford.edu`) and should be submitted to the Office of Student Affairs, Terman 201. **We recommend strongly that a student 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 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 3-1. 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	5, 5, 5
MATH 51H, 52H, 53H	Honors Calculus	5, 5, 5
MATH 103, 104	Matrix Theory and Its Applications	3, 3
MATH 106	Intro. to Theory of Functions of a Complex Variable	3
MATH 109	Modern Algebra and Its Applications	3
MATH 113, 114	Linear Algebra and Matrix Theory	3, 3
MATH 115	Fundamental Concepts of Analysis	3
MATH 120, 121	Modern Algebra I, II	3
MATH 130, 131, 132	Differential Equations	3, 3, 3
or more advanced Mathematics courses.		
STATS 60/160	Introduction to Statistical Methods: Precalculus	5
STATS 110	Statistical Methods in Engineering	4
STATS 116	Theory of Probability	3-4
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
CS 137	Introduction to Scientific Computing	4
CS 237A, B, C	Advanced Numerical Analysis	3, 3, 3
CS 260	Concrete Mathematics	3
ENGR 62	Introduction to Optimization	4
ENGR 154	Introduction to Engineering Mathematics	5
ENGR 155A, 155B, 155C	Mathematical and Computational Methods for Engineers	5,5,4
ENGR 160	Ordinary Differential Equations and Their Applications	3
GES 160	Statistical Methods for Earth and Environmental Sciences	4
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	Exper. Units	Total Units
BIOSCI 51, 52, 53	Principles of Biology	–	5, 5, 5
CEE 63	Weather and Storms	–	3
CEE 64	Air Pollution: Urban Smog to Global Change	–	3
CHEM 31	Chemical Principles	–	4
CHEM 32	The Frontiers of Chemical Science	–	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	3–5
GES 1	Fundamentals of Geology	1	5
GES 2, 3	Earth History	0, 2	3, 2
PHYSICS 51	Light and Heat	–	4
PHYSICS 52	Physics Lab	1	1
PHYSICS 53	Mechanics	–	4
PHYSICS 55	Electricity, Magnetism	–	4
PHYSICS 61–66	Advanced Freshman Physics and labs	2	14

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 factor 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	Units
STS 101/201 (ENGR 130) *†	Science, Technology, and Contemporary Society	4–5
STS 102 (HISTORY 14)	Science, Technology, and Art: Worlds of Leonardo	5
STS 107 (ECON 113)	Technology and Economic Change	5
STS 110 (MS&E 197) *†	Ethics and Public Policy	5
STS 115 (ENGR 131)	Ethical Issues in Engineering	4
STS 121 (HISTORY 115)	Technology and Culture in 19th-Century America	4–5
STS 123	The Scientific Revolution	5
STS 137 (COMM 137)	Telecommunication Policy and the Internet	5
STS 138 (POLISCI 138)	International Security in a Changing World	5
STS 145	History of Computer Game Design: Technology, Culture, and Business	4
STS 148	Programming in Society	4
STS 150 (CASA 181)	Car Culture	5
STS 162 (COMM 169) *	Computers and Interfaces: Psychological and Social Issues	4
STS 170 (MS&E 182)	Work, Technology, and Society	4
STS 171 (MS&E 193) *	Technology in National Security	3
STS 172 (MS&E 181) *	Issues of Technology and Work in a Post-Industrial Economy	4
STS 173 (ENGR 145)	Introduction to High-Technology Entrepreneurship	3
STS 185	Intellectual Property and the Information Era	4
STS 215 (CS 201) *†	Computers, Ethics, and Social Responsibility	4
STS 279 (MS&E 298) *	Technology, Policy, and Management in Newly Industrializing Countries	3–4
CS 48N	The Science of Art	3

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 FOR THE ENGINEERING FUNDAMENTALS REQUIREMENT

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

Note:
* Enroll in CS 106A 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 must be unspecified by the department.

THE EXPERIMENTATION REQUIREMENT

The Departmental Majors in **Chemical, Civil, Electrical, Industrial, 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. 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 Adviser.

FIGURE 3-5. COURSES APPROVED FOR THE EXPERIMENTATION REQUIREMENT

Course	Title	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 114	Symbolic Modeling in Engineering	2
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 161	Open Channel and Pipe Flows	1
CEE 176A,B	Energy Efficient buildings	1, 1
CEE 179A	Water Chemistry Lab	2
CEE 179B	Process Design for Biotechnology (alternate years)	2
CEE 195	Structural Geology and Rock Mechanics	1
CEE 242	Org.anization 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 180A,B	Chemical Engineering Laboratory	2, 2
CS 48N	The Science of Art	3
EE 121	Digital Design Laboratory	3
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 182	Digital Computer Organization	2
EE 183	Digital Logic Laboratory	3
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	Fundamental 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