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. These lists are presented in the following sections. Other appropriate courses (for example, more advanced courses) may be used to satisfy these requirements. However, 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 highly recommend that a student obtain petition approval prior to enrolling in a 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

Most students interested in an Engineering Major should begin a calculus sequence in their freshmen year. The Department of Mathematics offers four entry sequences into the calculus: the Math 20 series and the Math 40 series for single variable calculus, and the Math 50 and the Math 50H series for multivariable calculus.

- **Math 41 and 42** present single variable calculus. Differential calculus is covered in the first quarter and integral calculus in the second.
- **Math 19, 20, and 21** cover the same material as Math 41 and 42, in three quarters instead of two.
- **Math 51, 52, and 53** cover differential and integral calculus in several variables, linear algebra, and ordinary differential equations. These courses are taught in an integrated fashion, with differential calculus of several variables and linear algebra being taught in Math 51, integral calculus with linear algebra in Math 52, and differential equations, including matrix methods for solving systems, in Math 53. These courses are designed for incoming freshmen with 10 units of AP credit. They are rigorous and challenging, so students who are unsure of their mathematics preparation should consult with an advisor in the mathematics

department. A strong foundation in Mathematics is the basis for a successful major in Engineering.

- **Engineering 155A, and E155B** have Math 51 as a prerequisite. They cover analytical and numerical methods for solving ordinary differential equations, partial differential equations, and linear algebra arising in engineering applications. This includes Laplace transform, complex numbers, solution of initial value problems, solution of boundary value problems, eigenvalue problems in differential equations, solution of nonlinear equations, finite-difference methods, numerical interpretation, and integration in E155A and separation of variables for partial differential equations, Fourier series, elementary vector and matrix operations, Gauss elimination, banded matrices, systems of ordinary differential equations, matrix eigenvalue problems, and introduction to numerical solution of partial differential equations in E155B. Both classes address problems from various engineering fields.
- **Math 51H, 52H, and 53H** covers the same material as in 51, 52, and 53, but with more emphasis on theory and rigor.

The introductory courses in Linear Algebra are Math 103 and Math 113. The material in Math 103 is covered in the sequence Math 51, 52, and 53.

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 they require a number of specific and elective courses from the following list of approved courses. **Individually Designed Majors** must include at least 21 units from the list. All engineering students should check the detailed *Program Requirements* pages for their major to see which math courses are recommended or required (such courses are usually prerequisites for required courses in Engineering Depth).

In ABET Accredited programs, mathematics through differential and integral calculus and differential equations must be included. The accredited engineering programs at Stanford are **Chemical Engineering, Civil Engineering, Electrical Engineering, Management Science and Engineering,** and **Mechanical Engineering**, all at the Bachelor of Science level.

COURSES APPROVED FOR THE MATHEMATICS REQUIREMENT

Note: Students in ABET Accredited programs are required to complete a minimum of 45 units combined in Math and Science.

COURSE	TITLE	UNITS
Mathematics		
19, 20, 21	Calculus of a Single Variable	3, 3, 4
41, 42	Calculus of a Single Variable	5, 5
51, 52, 53	Calculus of Several Variables	5, 5, 5
51H, 52H, 53H	Honors Calculus	5, 5, 5
103, 104	Matrix Theory and Its Applications	3, 3
106	Intro. to Theory of Functions of a Complex Variable	3
109	Modern Algebra and Its Applications	3
113, 114	Linear Algebra and Matrix Theory	3, 3
115	Fundamental Concepts of Analysis	3
120, 121	Modern Algebra I, II	3
130, 131, 132	Differential Equations	3, 3, 3
or more advanced courses.		
Statistics		
60 (same as 160)	Introduction to Statistical Methods: Precalculus	5
110	Statistical Methods in Engineering	4
116	Theory of Probability	3-4
or more advanced courses. (Note: statistics courses numbered below 100 are <u>not</u> acceptable)		
School of Engineering		
E155AB	Mathematical and Computational Methods for Engineers	4,4
ME 200ABC		3, 3, 3
AA 192	Vector and Tensor Analysis	3
ChE 220	Applied Mathematics in Chemical Engineering	3
CE 101D	Seminar on Mathematical Lab Applications in CEE	2
CE 203	Statistical Models in Civil Engineering	4
CS 137	Introduction to Scientific Computing	4
CS 237ABC	Advanced Numerical Analysis	3, 3, 3
CS 260	Concrete Mathematics	3
E 62	Introduction to Optimization	4
E 160	Ordinary Differential Equations and Their Applications	3
EESOR 121	Introduction to Stochastic Processes and Models	4
MS&E 120	Probabilistic Analysis	5
MS&E 121	Intro to Stochastic Modeling	4
MSE 191	Mathematical Methods in Materials Science	3
Other		
GES 160	Intro to Statistical Methods for Earth and Environmental Sciences	4
ChE 220	Applied Mathematics in Chemical Engineering	3

THE SCIENCE REQUIREMENT

The Science requirements for Departmental and School of Engineering majors are delineated in the detailed *Program Requirement* section at the back of the Handbook. In general they include a number of specific and elective courses from the following list of approved courses. **Individually Designed Majors** must include at least 17 units from the list. All engineering students should check the detailed *Program Requirements* pages for their major to see which science courses are recommended or required (such courses are usually prerequisites for required courses in Engineering Depth). Science courses on this list emphasize basic science rather than applied science.

In ABET Accredited Programs, science coursework must include a year of either chemistry or calculus-based physics, *and* at least one course in both. Accredited engineering programs at Stanford are **Chemical Engineering, Civil Engineering, Electrical Engineering, Management Science and Engineering,** and **Mechanical Engineering**, all at the Bachelor of Science level.

COURSES APPROVED FOR THE SCIENCE REQUIREMENT

Note: Students in ABET Accredited programs are required to complete a minimum of 45 units combined in Math and Science.

COURSE	TITLE	EXPR. UNITS	TOTAL UNITS
Physics			
51	Light and Heat	-	4
53	Mechanics	-	4
55	Electricity, Magnetism	-	4
52	Physics Lab	1	1
61,63,64,65,66[1]	Advanced Freshman Physics and labs	-, -, 1, -, 1	4, 4, 1, 4, 1
Chemistry[2]		-	
31	Chemical Principles	-	4
32	The Frontiers of Chemical Science	-	4
33	Structure and Reactivity	-	4
35	Organic Monofunctional Compounds	-	4
36	Chemical Separations	2	3
135	Physical Chemical Principles	-	3
Biological Science			
51, 52, 53	Principles of Biology	-	5, 5, 5

CONTINUED ON NEXT PAGE…

[1] Advanced sequence for students with AP credit.

[2] Chemistry 30 does not meet the science requirement.

COURSES APPROVED FOR THE SCIENCE REQUIREMENT, CONT.

Geological and Environmental Sciences[3]			
1	Fundamentals of Geology	1	5
2, 3	Earth History	0, 2	3, 2
Earth Systems[1]			
10	Introduction to Earth Systems	1	3-5
Civil Engineering			
CEE 63	Weather and Storms	-	3
CEE 64	Air Pollution: Urban Smog to Global Change	-	3

[3] A maximum of 5 units of coursework 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 below.

COURSES APPROVED FOR THE TECHNOLOGY IN SOCIETY REQUIREMENT

STS COURSE	CROSS-LISTED	TITLE	UNITS	QTR
101/201* ^	E130	Science, Technology, and Contemporary Society	4 - 5	A
102	Hist 14	Science, Technology, and Art: Worlds of Leonardo	5	S
107	Econ 113	Technology and Economic Change	5	W
110 * ^	PP103B/MS&E197	Ethics and Public Policy	5	W
115*not given 01-02* * ^	E131	Ethical Issues in Engineering	4	--
117V	OS	Industrial Revolution: Art, Architecture, and Theory	5	A
119V	OS 143U	Architecture and the City: Berlin as a Nucleus of Modernity	4	S
121	Hist 115	Technology and Culture in 19th-Century America	4 - 5	W
125V	OS 215V	Scientific Revolution: Renaissance to 18th Century	5	A
137	Comm 137	Telecommunication Policy and the Internet	5	A
138	Poli Sci 138	International Security in a Changing World	5	W
145	NA	History of Computer Game Design:Tech, Culture and Business	4	W
148	NA	Programming in Society	4	A
150	CASA 181	Car Culture	5	A
162*	Comm 169	Computers and Interfaces: Psychological and Social Issues	4	S
170*not given 01-02* * ^	MS&E 182	Work, Technology, and Society	4	--
171 *	MS&E 193	Technology in National Security	3	A
172 *	MS&E 181	Issues of Technology and Work in a Post-Industrial Economy	4	S
173	E 145	Introduction to High-Technology Entrepreneurship	3	W
185	NA	Intellectual Property and the Information Era	4	W
215 * ^	CS 201	Computers, Ethics, and Social Responsibility	4	W
279 *	MS&E 298	Tech., Policy, and Mgmt. in Newly Industrializing Countries	3 - 4	A
Additional applicable course without an STS number:				
	CS 99D	The Science of Art	3	W

* Suggested for MS&E Majors

^ Suggested for Environmental Engineering Majors

CONTINUED ON NEXT PAGE…

TECHNOLOGY IN SOCIETY, CONT.

In addition to these courses, participation in the Stanford Center for Technology and Innovation (SCTI) program offered by Overseas Studies at the Kyoto campus satisfies the Technology in Society requirement.

NOTES:

1. Courses whose numbers end in a "V," e.g., 117V, are given at a Stanford overseas campus.
2. Some of the approved courses are limited enrollment offerings. You are advised to take this into account in your planning.
3. 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 the Requirement until her or his last quarter at Stanford.
4. Students are advised to check the Time Schedule at the beginning of each quarter to confirm that a particular course of interest will in fact be offered in the quarter indicated 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. 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. (They each satisfy Area IIb of the General Education Requirements.)

Engineering majors must complete three courses minimum, at least one of which must be unspecified by the department.

COURSES FOR THE ENGINEERING FUNDAMENTALS REQUIREMENT

COURSE	TITLE	ENGR. SCI.	ENGR DSGN.	EXPR.	TOTAL	QTR.
E 10	Introduction to Engineering Analysis	4	-	-	4	A
E 14	Statics & Deformables	2	1	-	3	AS
or E 15	Dynamics	2	1	-	3	AS
E 25	Bioengineering	2	1	-	3	A
E 20	Introduction to Chemical Engineering	2	1	-	3	S
E 30	Engineering Thermodynamics	3	-	-	3	AW
E 40	Introductory Electronics	3	2	2	5	AS
E 50	Introductory Science of Materials	4	-	-	4	WS
E 60	Engineering Economy	3	-	-	3	AWSum
or E 62	Introduction to Optimization	4	-	-	4	AS
E 70A[4]	Programming Methodology	2	1	-	5	AWS
or E 70X[5]	Programming Methodology and Abstractions	2	1	-	5	AWS

[4] Enroll in CS 106A or CS 106X.

[5] 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.

THE EXPERIMENTATION REQUIREMENT

The Departmental Majors in **Chemical, Civil, Electrical, Industrial, Materials Science and Engineering,** and **Mechanical Engineering** require 8 units of Experimentation, normally to be included within the units taken for Science, Engineering Fundamentals, and Engineering Depth. That is, with careful planning of the courses taken in those portions of the curriculum, the Experimentation requirement should not involve additional coursework.

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

COURSES APPROVED FOR THE EXPERIMENTATION REQUIREMENT

COURSES	TITLE	EXPR. UNITS
Phys 52	Physics Lab	1
Chem. 36	Chemical Separations	2
Chem. 130	Theory & Practice of Identification	4
CS 99D	The Science of Art	3
GES 1	Fundamental of Geology	1
GES 3	Earth History Laboratory	2
Bio 44	Core Experimental Laboratory	3
E 40	Introductory Electronics	2
E 75	Intro to Small Computer Interfacing	3
AA 131	Experimentation in Aero/Astro	3
ChE 180A,B	Chemical Engineering Laboratory	2, 2
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 142	Org. Design for Projects and Companies	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 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 & Rock Mechanics	1

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 & Assm Lang	1
EE 182	Digital Computer Organization	2
EE 183	Digital Logic Laboratory	3
EE 218	Semi-custom VLSI Systems (not offered 96/97)	1
EE 281	Microcomputer-Based System Design	3
IE 100	Organizations: Theory and Management	1
IE 121	Quality Assurance & Control	1
IE 125	Work Design and Measurement	2
IE 180,183,186	Senior Project	3, 3, 3
IE 201	Creativity and Innovation in Organizations	1
IE 260	Analysis of Production and Operating Systems	1
IE 265	Reengineering the Manufacturing Function	2
MSE 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 217 A	Design for Manufacturability	1