SCHOOL OF ENGINEERING

Courses offered by the School of Engineering are listed under the subject code ENGR on the Stanford Bulletin's ExploreCourses web site.

The School of Engineering offers undergraduate programs leading to the degree of Bachelor of Science (B.S.), programs leading to both B.S. and Master of Science (M.S.) degrees, other programs leading to a B.S. with a Bachelor of Arts (B.A.) in a field of the humanities or social sciences, dual-degree programs with certain other colleges, and graduate curricula leading to the degrees of M.S., Engineer, and Ph.D.

The school has nine academic departments: Aeronautics and Astronautics, Bioengineering, Chemical Engineering, Civil and Environmental Engineering, Computer Science, Electrical Engineering, Management Science and Engineering, Materials Science and Engineering, and Mechanical Engineering. These departments and one interdisciplinary program, the Institute for Computational and Mathematical Engineering, are responsible for graduate curricula, research activities, and the departmental components of the undergraduate curricula.

In research where faculty interest and expertise embrace both engineering and the supporting sciences, there are numerous interdisciplinary research centers and programs within the school as well as several interschool activities, including the Army High Performance Computing Research Center, Biomedical Informatics Training Program, Center for Integrated Systems, Center for Work, Technology, and Organization, Collaboratory for Research on Global Projects, National Center for Physics-Based Simulation in Biology, Center for Position, Navigation, and Time, the Energy Modeling Forum, the NIH Biotechnology Graduate Training Grant in Chemical Engineering, and the Stanford Technology Ventures Program. Energy Resources Engineering (formerly Petroleum Engineering) is offered through the School of Earth, Energy, and Environmental Sciences.

The School of Engineering's Hasso Plattner Institute of Design (also known as "the d.school," http://dschool.stanford.edu) brings together students and faculty in engineering, business, education, medicine, and the humanities to learn design thinking and work together to solve big problems in a human-centered way.

The Woods Institute for the Environment (http://environment.stanford.edu) brings together faculty, staff, and students from the schools, institutes and centers at Stanford to conduct interdisciplinary research, education, and outreach to promote an environmentally sound and sustainable world.

The Global Engineering Program (https://engineering.stanford.edu/students/global-engineering-programs) offers a portfolio of international opportunities for Stanford undergraduate and graduate students majoring within the School of Engineering. Opportunities range from service learning programs to internships to study tours. These opportunities enhance engineering education by providing students with an opportunity to learn about technology and engineering globally, to build professional networks, and to gain real world experience in a culturally diverse and international environment. For more information and application deadlines, please see gep.stanford.edu

Instruction in Engineering is offered primarily during Autumn, Winter, and Spring quarters of the regular academic year. During the Summer Quarter, a small number of undergraduate and graduate courses are offered.

Undergraduate Programs in the School of Engineering

The principal goals of the undergraduate engineering curriculum are to provide opportunities for intellectual growth in the context of an engineering discipline, for the attainment of professional competence, and for the development of a sense of the social context of technology. The curriculum is flexible, with many decisions on individual courses left to the student and the adviser. For a student with well-defined educational goals, there is often a great deal of latitude.

In addition to the special requirements for engineering majors described below, all undergraduate engineering students are subject to the University general education, writing, and foreign language requirements outlined in the first pages of this bulletin. Depending on the program chosen, students have the equivalent of from one to three quarters of free electives to bring the total number of units to 180.

The School of Engineering's *Handbook for Undergraduate Engineering Programs* is the definitive reference for all undergraduate engineering programs. It is available online at http://ughb.stanford.edu and provides detailed descriptions of all undergraduate programs in the school, as well as additional information about extracurricular programs and services. Because it is revised in the summer, and updates are made to the web site on a continuing basis, the handbook reflects the most up-to-date information on School of Engineering programs for the academic year.

Accreditation

The Accreditation Board for Engineering and Technology (ABET) accredits college engineering programs nationwide using criteria and standards developed and accepted by U.S. engineering communities. At Stanford, the following undergraduate programs are accredited:

- Civil Engineering
- Mechanical Engineering

In ABET-accredited programs, students must meet specific requirements for engineering science, engineering design, mathematics, and science course work. Students are urged to consult the School of Engineering Handbook for Undergraduate Engineering Programs and their adviser.

Accreditation is important in certain areas of the engineering profession; students wishing more information about accreditation should consult their department office or the office of the Senior Associate Dean for Student Affairs in 135 Huang Engineering Center.

Policy on Satisfactory/No Credit Grading and Minimum Grade Point Average

All courses taken to satisfy major requirements (including the requirements for mathematics, science, engineering fundamentals, Technology in Society, and engineering depth) for all engineering students (including both department and School of Engineering majors) must be taken for a letter grade if the instructor offers that option: If in doubt about requirements, courses should always be taken for a letter grade.

For departmental majors, the minimum combined GPA (grade point average) for all courses taken in fulfillment of the Engineering Fundamentals requirement and the Engineering Depth requirement is 2.0. For School of Engineering majors, the minimum GPA on all engineering courses taken in fulfillment of the major requirements is 2.0.

Admission

Any students admitted to the University may declare an engineering major if they elect to do so; no additional courses or examinations are required for admission to the School of Engineering. All students admitted to Stanford as undergraduates can have pathways to success in any engineering major at Stanford.

Recommended Preparation

Freshman

Students who plan to enter Stanford as freshmen and intend to major in engineering are advised to take the highest level of mathematics offered in high school. (See the "AP Credit (http://exploredegrees.stanford.edu/undergraduatedegreesandprograms/#aptext)" section of this bulletin for information on advanced placement in mathematics.) High school courses in physics and chemistry are strongly recommended, but not required. Additional elective course work in the humanities and social sciences is also recommended. Alternately, these courses can be taken after arrival at Stanford, and the best advice would be to begin early and have a detailed plan for completing requirements worked out.

Transfer Students

Students who do the early part of their college work elsewhere and then transfer to Stanford to complete their engineering programs should follow an engineering or pre-engineering program at the first school, selecting insofar as possible courses applicable to the requirements of the School of Engineering, that is, courses comparable to those mentioned under the Majors tab. In addition, students should work toward completing the equivalent of Stanford's foreign language requirement and as many of the University's General Education Requirements (GERs) as possible before transferring. Some transfer students may require more than four years (in total) to obtain the B.S. degree. However, Stanford affords great flexibility in planning and scheduling individual programs, which makes it possible for transfer students, who have wide variations in preparation, to plan full programs for each quarter and to progress toward graduation without undue delay.

Transfer credit is given for courses taken elsewhere whenever the courses are equivalent or substantially similar to Stanford courses in scope and rigor. The policy of the School of Engineering is to study each transfer student's preparation and make a reasonable evaluation of the courses taken prior to transfer by means of a petition process. Inquiries may be addressed to the Office of Student Affairs in 135 Huang Engineering Center. For more information, see the transfer credit section of the Handbook for Undergraduate Engineering Programs at http://ughb.stanford.edu.

Degree Program Options

In addition to the B.S. degrees offered by departments, the School of Engineering offers two other types of B.S. degrees:

- Bachelor of Science in Engineering (see subplan majors listed below)
- Bachelor of Science for Individually Designed Majors in Engineering (IDMEN)

There are six Engineering B.S. subplans that have been proposed by cognizant faculty groups and approved by the Undergraduate Council:

- Architectural Design
- Atmosphere/Energy
- Biomechanical Engineering
- Biomedical Computation
- Engineering Physics
- Product Design

The B.S. for an Individually Designed Major in Engineering has also been approved by the council.

Curricula for majors are offered by the departments of:

- Aeronautics and Astronautics
- Bioengineering
- Chemical Engineering
- Civil and Environmental Engineering
- Computer Science
- Electrical Engineering
- Management Science and Engineering
- Materials Science and Engineering
- Mechanical Engineering

Curricula for majors in these departments have the following components:

- 36-45 units of mathematics and science (see Basic Requirements 1 and 2 at the end of this section)
- Engineering fundamentals (two-three courses minimum, depending up individual program requirements; see Basic Requirement 3)
- Technology in Society (TIS) (one course minimum, see Basic Requirement 4)
- Engineering depth (courses such that the total number of units for Engineering Fundamentals and Engineering Depth is between 60 and 72)
- ABET accredited majors must meet a minimum number of Engineering Science and Engineering Design units; (see Basic Requirement 5)

Consult the 2017-18 Handbook for Undergraduate Engineering Programs (http://ughb.stanford.edu) for additional information.

Dual and Coterminal Programs

A Stanford undergraduate may work simultaneously toward two bachelor's degrees or toward a bachelor's and a master's degree, that is, B.A. and M.S., B.A. and M.A., B.S. and M.S., or B.S. and M.A. The degrees may be granted simultaneously or at the conclusion of different quarters. Five years are usually required for a dual or coterminal program or for a combination of these two multiple degree programs. For further information, inquire with the School of Engineering's student affairs office, 135 Huang Engineering Center, or with department contacts listed in the Handbook for Undergraduate Engineering Programs, available at http://ughb.stanford.edu.

Dual B.A. and B.S. Degree Program—To qualify for both degrees, a student must:

1. complete the stated University and department requirements for each degree
2. complete 15 full-time quarters (3 full-time quarters after completing 180 units)
3. complete a total of 225 units (180 units for the first bachelor's degree plus 45 units for the second bachelor's degree)

Coterminal Bachelor's and Master's Degree Program—A Stanford undergraduate may be admitted to graduate study for the purpose of working simultaneously toward a bachelor's degree and a master's degree, in the same or different disciplines. To qualify for both degrees, a student must:

1. complete, in addition to the units required for the bachelor's degree, the number of units required by the graduate department for the master's degree which in no event is fewer than the University minimum of 45 units
2. complete the requirements for the bachelor's degree (department, school, and University) and apply for conferral of the degree at the appropriate time
3. complete the department and University requirements for the master's degree and apply for conferral of the degree at the appropriate time

A student may complete the bachelor's degree before completing the master's degree, or both degrees may be completed in the same quarter.

Procedure for Applying for Admission to Coterminal Degree Programs

Stanford undergraduates apply to the pertinent graduate department using the University coterminal application. Application deadlines and admissions criteria vary by department, but in all cases the student must apply early enough to allow a departmental decision at least one quarter in advance of the anticipated date of conferral of the bachelor's degree.

Students interested in coterminal degree programs in Engineering should refer to our departments' sections of this bulletin for more detailed information. The University requirements for the coterminal master's degree are described in the "Coterminal Master's Degrees (http://exploredegrees.stanford.edu/cotermdegrees/#text)" section of this bulletin.

Graduate Programs in the School of Engineering

Admission

Application for admission with graduate standing in the school should be made to the graduate admissions committee in the appropriate department or program. While most graduate students have undergraduate preparation in an engineering curriculum, it is feasible to enter from other programs, including chemistry, geology, mathematics, or physics.

For further information and application instructions, see the department sections in this bulletin or http://gradadmissions.stanford.edu. Stanford undergraduates may also apply as coterminal students; details can be found under "Degree Program Options" in the "Undergraduate Programs in the School of Engineering (http://www.stanford.edu/dept/registrar/bulletin/5144.htm)" section of this bulletin.

Fellowships and Assistantships

Departments and divisions of the School of Engineering award graduate fellowships, research assistantships, and teaching assistantships each year.

Curricula in the School of Engineering

For further details about the following programs, see the department sections in this bulletin.

Related aspects of particular areas of graduate study are commonly covered in the offerings of several departments and divisions. Graduate students are encouraged, with the approval of their department advisers, to choose courses in departments other than their own to achieve a broader appreciation of their field of study. For example, most departments in the school offer courses concerned with nanoscience, and a student interested in an aspect of nanotechnology can often gain appreciable benefit from the related courses given by departments other than her or his own.

Departments and programs of the school offer graduate curricula as follows:

Aeronautics and Astronautics

- Aeroelasticity and Flow Simulation
- Aircraft Design, Performance, and Control
- Applied Aerodynamics
- Autonomy
- Computational Aero-Acoustics
- Computational Fluid Dynamics
- Computational Mechanics and Dynamical Systems
- Control of Robots, including Space and Deep-Underwater Robots
- Conventional and Composite Materials and Structures
- Decision Making under Uncertainty
- Direct and Large-Eddy Simulation of Turbulence
- High-Lift Aerodynamics
- Hybrid Propulsion
- Hypersonic and Supersonic Flow
- Micro and Nano Systems and Materials
- Multidisciplinary Design Optimization
- Navigation Systems (especially GPS)
- Optimal Control, Estimation, System Identification
- Sensors for Harsh Environments
- Space Debris Characterization
- Space Environment Effects on Spacecraft
- Space Plasmas
- Spacecraft Design and Satellite Engineering
- Turbulent Flow and Combustion

Bioengineering

- Biomedical Computation
- Biomedical Devices
- Biomedical Imaging
- Cell and Molecular Engineering
- Regenerative Medicine

Chemical Engineering

- Applied Statistical Mechanics
- Biocatalysis
- Biochemical Engineering
- Bioengineering
- Biophysics
- Computational Materials Science
- Colloid Science
- Dynamics of Complex Fluids
- Energy Conversion
- Functional Genomics
- Hydrodynamic Stability
- Kinetics and Catalysis
- Microrheology
- Molecular Assemblies
- Nanoscience and Technology
- Newtonian and Non-Newtonian Fluid Mechanics
- Polymer Physics
- Protein Biotechnology
- Renewable Fuels
- Semiconductor Processing
- Soft Materials Science
- Solar Utilization
- Surface and Interface Science
- Transport Mechanics

Civil and Environmental Engineering

- Atmosphere/Energy
- Environmental Engineering
- Environmental and Water Studies
- Geomechanics
- Structural Engineering
- Sustainable Design and Construction

Computational and Mathematical Engineering

- Applied and Computational Mathematics
- Computational Biology
- Computational Fluid Dynamics
- Computational Geometry and Topology
- Computational Geosciences
- Computational Medicine
- Data Science
- Discrete Mathematics and Algorithms
- Numerical Analysis
- Optimization
- Partial Differential Equations
- Stochastic Processes
- Uncertainty Quantification
- Financial Mathematics

Computer Science

See http://forum.stanford.edu/research/areas.php for a comprehensive list.

- Algorithmic Game Theory
- Algorithms
- Artificial Intelligence
- Autonomous Agents
- Biomedical Computation
- Compilers
- Complexity Theory
- Computational and Cognitive Neuroscience
- Computational Biology
- Computational Geometry and Topology
- Computational Logic
- Computational Photography
- Computational Physics
- Computational Social Science
- Computer Architecture
- Computer Graphics
- Computer Security
- Computer Science Education
- Computer Sound
- Computer Vision
- Crowdsourcing
- Cryptography
- Database Systems
- Data Center Computing
- Data Mining
- Design and Analysis of Algorithms
- Distributed and Parallel Computation
- Distributed Systems
- Education and Learning Science
- Electronic Commerce
- Formal Verification
- General Game Playing
- Haptic Display of Virtual Environments
- Human-Computer Interaction
- Image Processing
- Information and Communication Technologies for Development
- Information Management
- Learning Theory
- Machine Learning
- Mathematical Theory of Computation
- Mobile Computing
- Multi-Agent Systems
- Nanotechnology-enabled Systems
- Natural Language and Speech Processing
- Networking and Internet Architecture
- Operating Systems
- Parallel Computing
- Probabilistic Models and Methods
- Programming Systems/Languages
- Robotics
- Robust System Design
- Scientific Computing and Numerical Analysis
- Sensor Networks
- Social and Information Networks
- Social Computing
- Ubiquitous and Pervasive Computing
- Visualization
- Web Application Infrastructure

Electrical Engineering

- Biomedical Devices, Sensors and Systems
- Biomedical Imaging
- Communications Systems
- Control and Optimization
- Data Science
- Data Science
- Electronic Devices
- Embedded Systems
- Energy Harvesting and Conversion
- Energy-Efficient Hardware Systems
- Information Theory and Applications
- Integrated Circuits and Power Electronics
- Integrated Circuits and Power Electronics
- Mobile Networking
- Nanotechnology and NEMS/MEMS
- Photonics, Nanoscience and Quantum Technology
- Secure Distributed Systems
- Signal Processing and Multimedia
- Societal Networks
- Software Defined Networking

Management Science and Engineering

- Decision and Risk Analysis
- Dynamic Systems
- Economics
- Entrepreneurship
- Finance
- Information
- Marketing
- Optimization
- Organization Behavior
- Organizational Science
- Policy
- Production

- Stochastic Systems
- Strategy

Materials Science and Engineering

- Biomaterials
- Ceramics and Composites
- Computational Materials Science
- Electrical and Optical Behavior of Solids
- Electron Microscopy
- Fracture and Fatigue
- Imperfections in Crystals
- Kinetics
- Magnetic Behavior of Solids
- Magnetic Storage Materials
- Nanomaterials
- Photovoltaics
- Organic Materials
- Phase Transformations
- Physical Metallurgy
- Solid State Chemistry
- Structural Analysis
- Thermodynamics
- Thin Films
- X-Ray Diffraction

Mechanical Engineering

- Biomechanics
- Combustion Science
- Computational Mechanics
- Controls
- Design of Mechanical Systems
- Dynamics
- Environmental Science
- Experimental Stress and Analysis
- Fatigue and Fracture Mechanics
- Finite Element Analysis
- Fluid Mechanics
- Heat Transfer
- High Temperature Gas Dynamics
- Kinematics
- Manufacturing
- Mechatronics
- Product Design
- Robotics
- Sensors
- Solids
- Thermodynamics
- Turbulence

Bachelor of Science in the School of Engineering

Departments within the School of Engineering offer programs leading to the Bachelor of Science degree in the following fields:

- Aeronautics and Astronautics (http://exploredegrees.stanford.edu/soe-ug-majors/aeroastro)
- Bioengineering (http://exploredegrees.stanford.edu/soe-ug-majors/bioengineering)
- Chemical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/chemeng)
- Civil Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/civilengineering)
- Computer Science (http://exploredegrees.stanford.edu/soe-ug-majors/cs)
- Electrical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/ee)
- Environmental Systems Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/ese)
- Management Science and Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/msande)
- Materials Science and Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/matsci)
- Mechanical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/mecheng)

The School of Engineering itself offers interdisciplinary programs leading to the Bachelor of Science degree in Engineering with specializations in:

- Architectural Design (http://exploredegrees.stanford.edu/soe-ug-majors/archdesign)
- Atmosphere/Energy (http://exploredegrees.stanford.edu/soe-ug-majors/atmos-energy)
- Biomechanical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/biomechanicalengineering)
- Biomedical Computation (http://exploredegrees.stanford.edu/soe-ug-majors/biomedicalcomputation)
- Engineering Physics (http://exploredegrees.stanford.edu/soe-ug-majors/engrphysics)
- Product Design (http://exploredegrees.stanford.edu/soe-ug-majors/productdesign)

In addition, students may elect a Bachelor of Science in an Individually Designed Major in Engineering.

Bachelor of Arts and Science (B.A.S.) in the School of Engineering

This degree is available to students who complete both the requirements for a B.S. degree in engineering and the requirements for a major or program ordinarily leading to the B.A. degree. For more information, see the "Undergraduate Degrees (http://exploredegrees.stanford.edu/undergraduatedegreesandprograms/#bachelorstext)" section of this bulletin.

Undergraduate Honors in the School of Engineering

The following bachelor's programs in the School of Engineering offer an honors option for qualified students:

- Aeronautics and Astronautics (http://exploredegrees.stanford.edu/soe-ug-majors/aeroastro)
- Architectural Design (http://exploredegrees.stanford.edu/soe-ug-majors/archdesign)
- Atmosphere/Energy (http://exploredegrees.stanford.edu/soe-ug-majors/atmos-energy)
- Bioengineering (http://exploredegrees.stanford.edu/soe-ug-majors/bioengineering)
- Biomechanical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/biomechanicalengineering)
- Biomedical Computation (http://exploredegrees.stanford.edu/soe-ug-majors/biomedicalcomputation)

- Computer Science (http://exploredegrees.stanford.edu/soe-ug-majors/cs)
- Electrical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/ee)
- Engineering Physics (http://exploredegrees.stanford.edu/soe-ug-majors/engrphysics)
- Environmental Systems Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/ese)
- Materials Science and Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/matsci)
- Mechanical Engineering (http://exploredegrees.stanford.edu/soe-ug-majors/mecheng)

Independent Study, Research, and Honors

The departments of Aeronautics and Astronautics, Bioengineering, Chemical Engineering, Civil and Environmental Engineering, Computer Science, Electrical Engineering, Materials Science and Engineering, and Mechanical Engineering, as well as the faculty overseeing the Architectural Design, Atmosphere/Energy, Biomechanical Engineering, Biomedical Computation, and Engineering Physics majors, offer qualified students opportunities to do independent study and research at an advanced level with a faculty mentor in order to receive a Bachelor of Science with honors. An honors option is also available to students pursuing an independently designed major, with the guidance and approval of their adviser.

Petroleum Engineering

Petroleum Engineering is offered by the Department of Energy Resource Engineering in the School of Earth, Energy, and Environmental Sciences. Consult the "Energy Resources Engineering (http://exploredegrees.stanford.edu/schoolofearthsciences/energyresourcesengineering)" section of this bulletin for requirements. School of Engineering majors who anticipate summer jobs or career positions associated with the oil industry should consider enrolling in ENGR 120.

Programs in Manufacturing

Programs in manufacturing are available at the undergraduate, master's, and doctorate levels. The undergraduate programs of the departments of Civil and Environmental Engineering, Management Science and Engineering, and Mechanical Engineering provide general preparation for any student interested in manufacturing. More specific interests can be accommodated through Individually Designed Majors in Engineering (IDMENs).

Basic Requirements

Basic Requirement 1 (Mathematics)

Engineering students need a solid foundation in the calculus of continuous functions, linear algebra, differential equations, an introduction to discrete mathematics, and an understanding of statistics and probability theory. Students are encouraged to select courses on these topics. Courses that satisfy the math requirement are listed in the Undergraduate Handbook (http://ughb.stanford.edu) on the Approved Courses page of the Courses and Planning section.

Basic Requirement 2 (Science)

A strong background in the basic concepts and principles of natural science in such fields as physics, chemistry, geology, and biology is essential for engineering. Most students include the study of physics and chemistry in their programs. Courses that satisfy the science requirement are listed in the Undergraduate Handbook (http://ughb.stanford.edu) on the Approved Courses page of the Courses and Planning section.

Basic Requirement 3 (Engineering Fundamentals)

The Engineering Fundamentals requirement is satisfied by a nucleus of technically rigorous introductory courses chosen from the various engineering disciplines. It is intended to serve several purposes. First, it provides students with a breadth of knowledge concerning the major fields of endeavor within engineering. Second, it allows the incoming engineering student an opportunity to explore a number of courses before embarking on a specific academic major. Third, the individual classes each offer a reasonably deep insight into a contemporary technological subject for the interested non-engineer.

The requirement is met by taking two to three courses from the following list (the number depends upon the individual requirements of each major program):

		Units
ENGR 10	Introduction to Engineering Analysis	4
ENGR 14	Intro to Solid Mechanics	3
ENGR 15	Dynamics	3
ENGR 20	Introduction to Chemical Engineering	4
ENGR 21	Engineering of Systems	3
ENGR 25B	Biotechnology [1]	3
ENGR 25E	Energy: Chemical Transformations for Production, Storage, and Use (same as CHEMENG 25E) [1]	3
ENGR 40	Introductory Electronics [1,2]	5
ENGR 40A	Introductory Electronics	3
ENGR 40M	An Intro to Making: What is EE	3-5
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis [1,2]	4
ENGR 50E	Introduction to Materials Science, Energy Emphasis [1]	4
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis [1]	4
ENGR 60	Engineering Economics and Sustainability	3
ENGR 62	Introduction to Optimization (same as MS&E 111)	4
ENGR 70A/CS 106A	Programming Methodology [1]	5
ENGR 70B/CS 106B	Programming Abstractions [1]	5
ENGR 70X/CS 106X	Programming Abstractions (Accelerated) [1]	5
ENGR 80	Introduction to Bioengineering (Engineering Living Matter) (same as BIOE 80)	4
ENGR 90	Environmental Science and Technology (same as CEE 70)	3

1 Only one course from each numbered series can be used in the Engineering Fundamentals category within a major program.

2 ENGR 40M Making Stuff: What is EE and ENGR 50 Introduction to Materials Science, Nanotechnology Emphasis may be taken on video at some of Stanford's Overseas Centers.

Basic Requirement 4 (Technology in Society)

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. Courses that fulfill this requirement are listed in the Undergraduate Handbook (http://ughb.stanford.edu) on the Approved Courses page of the Courses and Planning section.

Basic Requirement 5 (Engineering Topics)

In order to satisfy ABET (Accreditation Board for Engineering and Technology) requirements, a student majoring in Civil or Mechanical

Engineering must complete one and a half years of engineering topics, consisting of a minimum of 68 units of Engineering Fundamentals and Engineering Depth appropriate to the student's field of study. In most cases, students meet this requirement by completing the major program core and elective requirements. A student may need to take additional courses in Depth in order to fulfill the minimum requirement. Appropriate courses assigned to fulfill each major's program are listed in the Undergraduate Handbook (http://ughb.stanford.edu) on the individual major page as listed in the Degree Programs section.

Experimentation

Civil Engineering and Mechanical Engineering must include experimental experience appropriate to the discipline. Lab courses taken in the sciences, as well as experimental work taken in courses within the School of Engineering, will fulfill this requirement.

Overseas Studies Courses in Engineering

For course descriptions and additional offerings, see the listings in the Stanford Bulletin's ExploreCourses (http://explorecourses.stanford.edu) web site or the Bing Overseas Studies (http://bosp.stanford.edu) web site. Students should consult their department or program's student services office for applicability of Overseas Studies courses to a major or minor program.

See the "Undergraduate Majors and Minors (http://exploredegrees.stanford.edu/soe-ug-majors)" menu item on the left side of this page for program-by-program descriptions of major degree requirements. All programs are listed below to facilitate export as a pdf; use the Print option in the right hand menu of this page to create such a pdf for all the tabs in the School of Engineering.

Aeronautics and Astronautics (AA)

Mission of the Undergraduate Program in Aeronautics and Astronautics

The mission of the undergraduate program in Aeronautics and Astronautics Engineering is to provide students with the fundamental principles and techniques necessary for success and leadership in the conception, design, implementation, and operation of aerospace and related engineering systems. Courses in the major introduce students to engineering principles. Students learn to apply this fundamental knowledge to conduct laboratory experiments, and aerospace system design problems. Courses in the major include engineering fundamentals, mathematics, and the sciences, as well as in-depth courses in aeronautics and astronautics, dynamics, mechanics of materials, autonomous systems, computational engineering, embedded programming, fluids engineering, and heat transfer. The major prepares students for careers in aircraft and spacecraft engineering, autonomy, robotics, unmanned aerial vehicles, drones, space exploration, air and space-based telecommunication industries, computational engineering, teaching, research, military service, and other related technology-intensive fields.

Completion of the undergraduate program in Aeronautics and Astronautics leads to the conferral of the Bachelor of Science in Aeronautics and Astronautics.

Requirements

		Units
Mathematics		
24 units minimum		
MATH 19	Calculus (required) [2]	3
MATH 20	Calculus (required) [2]	3
MATH 21	Calculus (required) [2]	4
CME 100/ENGR 154	Vector Calculus for Engineers (required) [3]	5
or MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
CME 102/ENGR 155A	Ordinary Differential Equations for Engineers (required) [3]	5
or MATH 53	Ordinary Differential Equations with Linear Algebra	
CME 106/ENGR 155C	Introduction to Probability and Statistics for Engineers (required)	4-5
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or CS 109	Introduction to Probability for Computer Scientists	
CME 104	Linear Algebra and Partial Differential Equations for Engineers (recommended) [3]	5
or MATH 52	Integral Calculus of Several Variables	
CME 108	Introduction to Scientific Computing (recommended)	3
Science		
20 units minimum		
PHYSICS 41	Mechanics (required) [4]	4
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
PHYSICS 43	Electricity and Magnetism (required) [4]	4
PHYSICS 45	Light and Heat (required)	4
CHEM 31X	Chemical Principles Accelerated (or CHEM 31A and CHEM 31B, or AP Chemistry) (required)	5
ENGR 80	Introduction to Bioengineering (Engineering Living Matter) (recommended)	4
School of Engineering approved Science Electives: See Undergraduate Handbook, Figure 4-2		3-5
Technology in Society (one course required)		
School of Engineering approved Technology in Society courses: See Undergraduate Handbook, Figure 4-3. The course must be on the School of Engineering approved list the year you take it.		3-5
ENGR 131	Ethical Issues in Engineering (recommended)	4
AA 252	Techniques of Failure Analysis (recommended)	3
Engineering Fundamentals (three courses required)		
11 units minimum		
ENGR 21	Engineering of Systems (required)	3
ENGR 70A/CS 106A	Programming Methodology (required)	5
ENGR 10	Introduction to Engineering Analysis (recommended)	4
ENGR 40M	An Intro to Making: What is EE (recommended)	3-5
Fundamentals Elective; see list of Approved Courses in Undergraduate Engineering Handbook website at ughb.stanford.edu, Figure 4-4		3-5
Aero/Astro Depth Requirements		
27 units minimum		
ENGR 14	Intro to Solid Mechanics (required)	3
ENGR 15	Dynamics (required)	3
ENGR 105	Feedback Control Design (required)	3
ME 30	Engineering Thermodynamics (required)	3
AA 100	Introduction to Aeronautics and Astronautics (required)	3
AA 101 Introduction to Aero Fluid Mechanics, required [1]		
AA 102	Introduction to Applied Aerodynamics	3
AA 103	Air and Space Propulsion	3
AA 131	Space Flight (required)	3

AA 141	Atmospheric Flight (required)	3
AA 171 Autonomous Systems, required [1]		
AA 190	Directed Research and Writing in Aero/Astro	3-5
Aero/Astro Focus Electives		
15 units minimum		
AA 111 Introduction to Aerospace Computational Engineering [1]		
AA 135 Introduction to Space Policy [1]		
AA 151	Lightweight Structures	3
AA 156	Mechanics of Composite Materials	3
AA 173 Flight Mechanics and Controls [1]		
AA 175 Embedded Programming [1]		
AA 272C	Global Positioning Systems	3
AA 279A	Space Mechanics	3
AA 199	Independent Study in Aero/Astro	1-5
MS&E 178	The Spirit of Entrepreneurship	2
Aero/Astro Suggested Courses (not required)		
AA 149	Operation of Aerospace Systems	1
Aero/Astro Capstone Requirement		
7 units minimum		
AA 123A Air Capstone I, satisfies the Writing in the Major requirement, (WIM) [1]		
AA 123B Air Capstone II [1]		
AA 124A Space Capstone I, satisfies the Writing in Major requirement, (WIM) [1]		
AA 124B Space Capstone II [1]		

For additional information and sample programs see the Handbook for Undergraduate Engineering (http://ughb.stanford.edu) and the Aeronautics and Astronautics Undergraduate Program Sheet (https://ughb.stanford.edu/program-sheets).

All courses taken for the major must be taken for a letter grade if that option is offered by the instructor.

Minimum Combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

Transfer and AP credits in Math, Science, Fundamentals, and the Technology in Society course must be approved by the School of Engineering Dean's office.

1 This course will be offered in the near future. See the department's web site for more information about our future course offerings (https://aa.stanford.edu/academics/undergraduate-program). For courses yet not offered please contact the Aero/Astro Student Services Office (https://aa.stanford.edu/academics/student-services-office) for a list of approved replacement courses.

2 A score of 4 on the Calculus BC test or 5 on the AB test only gives students 8 units, not 10 units, so is equal to MATH 19 + MATH 20, but not MATH 21. The Math Placement Exam determines what math course the student starts with.

3 It is recommended that the CME series (100, 102, 104) be taken rather than the MATH series (51, 52, 53). It is recommended that students taking the MATH series also take CME 192 Introduction to MATLAB.

4 A score of 5 on the AP Physics C Mechanics test places the student out of PHYSICS 41. Similarly, a score of 5 on the AP Physics Electricity and Magnetism test places the student out of PHYSICS 43.

Honors Program

The Department of Aeronautics and Astronautics honors program has been designed to allow undergraduates with strong records and enthusiasm for independent research to engage in a significant project leading to a degree with departmental honors.

Students who meet the eligibility criteria and wish to be considered for the honors program should apply to the program by the end of the junior year. All applications are subject to the review and final approval by the Aero/Astro Undergraduate Curriculum Committee.

Application Requirements:

- One-page written statement describing the research topic and signed adviser form
- GPA of 3.5 or higher in the major
- Unofficial Stanford transcript (from Axess)
- Signature of thesis adviser

Honors criteria:

- Maintain the 3.5 GPA required for admissions to the honors program.
- Arrangement with an Aero/Astro faculty member who agrees to serve as the thesis adviser. The adviser must be a member of the Academic Council.
- Under the direction of the thesis adviser, complete at least two quarters of research with a minimum of 9 units of independent research; 3 of these units may be used towards a student's Aero/Astro Focus Elective requirement.
- Submit an honors thesis (20-30 pages). Thesis is due by April 30th of senior year in order to be eligible for University prizes.
- Attend Research Experience for Undergraduates Poster Session or present in another suitable forum approved by the faculty adviser.

Architectural Design (AD)

Completion of the undergraduate program in Architectural Design leads to the conferral of the Bachelor of Science in Engineering. The subplan "Architectural Design" appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Architectural Design

The mission of the undergraduate program in Architectural Design is to develop students' ability to integrate engineering and architecture in ways that blend innovative architectural design with cutting-edge engineering technologies. Courses in the program combine hands-on architectural design studios with a wide variety of other courses. Students can choose from a broad mix of elective courses concerning energy conservation, sustainability, building systems, and structures, as well as design foundation and fine arts courses. In addition to preparing students for advanced studies in architecture and construction management, the program's math and science requirements prepare students well for graduate work in other fields such as civil and environmental engineering, law, and business.

Requirements

		Units
Mathematics and Science (36 units minimum) [1]		
Mathematics		
MATH 19	Calculus	3
MATH 20	Calculus	3
MATH 21	Calculus	4
Or 10 units AP Calculus or MATH 41 & MATH 42		
CME 100	Vector Calculus for Engineers (Recommended)	5

One course in Statistics (required)		3-5
Science		
PHYSICS 41	Mechanics (or PHYSICS 41E (requires Physics diagnostic test or application))	4/5
Recommended:		
EARTHSYS 101	Energy and the Environment	
EARTHSYS 102	Fundamentals of Renewable Power	
CEE 64	Air Pollution and Global Warming: History, Science, and Solutions	
CEE 70	Environmental Science and Technology	
PHYSICS 23	Electricity, Magnetism, and Optics	
or PHYSICS 43	Electricity and Magnetism	
Or from School of Engineering approved list		
Technology in Society		
One course required; course chosen must be on the SoE Approved Courses list at <ughb.stanford.edu> the year taken.		3-5
Engineering Fundamentals		
Two courses minimum, see Basic Requirement 3		6-8
ENGR 14	Intro to Solid Mechanics	3
AD Depth Core [2]		
CEE 31	Accessing Architecture Through Drawing	5
or CEE 31Q	Accessing Architecture Through Drawing	
CEE 100	Managing Sustainable Building Projects (or CEE 32B or CEE 32D)	4
CEE 120A	Building Information Modeling Workshop	2-4
CEE 130	Architectural Design: 3-D Modeling, Methodology, and Process	5
CEE 137B	Advanced Architecture Studio	6
ARTHIST 3	Introduction to World Architecture	5
Depth Options		12
See Note 2 for course options		
Depth Electives		
Elective units must be such that courses in ENGR Fundamentals, Core, Depth Options, and Depth Electives total at least 63 units. One of the following must be taken:		
CEE 131C	How Buildings are Made -- Materiality and Construction Methods	4
CEE 131D	Urban Design Studio	5
CEE 32D	Construction: The Writing of Architecture	
CEE 32G	Architecture Since 1900	
CEE 32H	Responsive Structures	
CEE 32V	Architectural Design Lecture Series Course	
CEE 32T	Making and Remaking the Architect: Edward Durell Stone and Stanford	
CEE 32U	California Modernism: The Web of Apprenticeship	
CEE 32W	Making Meaning: A Purposeful Life in Design	
CEE 133F		
CEE 139	Design Portfolio Methods	
Total Units		78-90

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (http://ughb.stanford.edu).

1 School of Engineering approved list of math and science courses available in the Handbook for Undergraduate Engineering Programs at http://ughb.stanford.edu.

2 Engineering depth options: Choose at least 12 units from the following courses: CEE 101A, CEE 101B, CEE 101C, CEE 120B, CEE 120C, CEE 134B, CEE 156, CEE 159, CEE 172, CEE 172A, CEE 176A, CEE 180, CEE 181, CEE 182, CEE 183, CEE 226, CEE 241, OR CEE 242; ME 203. Students should investigate any prerequisites for the listed courses and carefully plan course sequences with the AD director.
Electives:

- CEE 32A, CEE 32B, CEE 32D, CEE 32F, CEE 32G, CEE 32H, CEE 32Q, CEE 32R, CEE 32S, CEE 32T, CEE 32U, CEE 32V, CEE 101B, CEE 101C, CEE 120A, CEE 120B, CEE 120C, CEE 122A, CEE 122B, CEE 124, CEE 131A, CEE 131B, CEE 131C, CEE 131F, CEE 134B, CEE 139, CEE 172A, CEE 176A, CEE 180, CEE 181, CEE 182, CEE 183
- ENGR 50, ENGR 103, ENGR 131
- ME 101, ME 110, ME 115A/B/C, ME 120, ME 203
- ARTSTUDI 13BX, ARTSTUDI 140, ARTSTUDI 145, ARTSTUDI 151, ARTSTUDI 153, ARTSTUDI 160, ARTSTUDI 162, ARTSTUDI 163, ARTSTUDI 164, ARTSTUDI 168, ARTSTUDI 170, ARTSTUDI 171, ARTSTUDI 181
- ARTHIST 107A, ARTHIST 142, ARTHIST 143A, ARTHIST 188A
- FILMPROD 114
- TAPS 137
- SINY 122; URBANST 110, URBANST 113, URBANST 163, URBANST 171

3 A course may only be counted towards one elective or core requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth/Core is 2.0.

Architectural Design Honors Program

The AD honors program offers eligible students the opportunity to engage in guided original research, or project design, over the course of an academic year. For interested students the following outlines the process:

1. The student must submit a letter applying for the honors option endorsed by the student's primary adviser and honors adviser and submitted to the student services office in CEE. Applications must be received in the fourth quarter prior to graduation. It is strongly suggested that students meet with the Architectural Design Program Director well in advance of submitting an application.
2. The student must maintain a GPA of at least 3.5.
3. The student must complete an honors thesis or project. The timing and deadlines are to be decided by the program or honors adviser. At least one member of the evaluation committee must be a member of the Academic Council in the School of Engineering.
4. The student must present the work in an appropriate forum, e.g., in the same session as honors theses are presented in the department of the advisor. All honors programs require some public presentation of the thesis or project.

Atmosphere/Energy (A/E)

Completion of the undergraduate program in Atmosphere/Energy leads to the conferral of the Bachelor of Science in Engineering. The subplan "Atmosphere/Energy" appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Atmosphere/Energy

Atmosphere and energy are strongly linked: fossil-fuel energy use contributes to air pollution, global warming, and weather modification; and changes in the atmosphere feed back to renewable energy resources, including wind, solar, hydroelectric, and wave resources. The mission of the undergraduate program in Atmosphere/Energy (A/E) is to provide students with the fundamental background necessary to understand large- and local-scale climate, air pollution, and energy problems and solve them through clean, renewable, and efficient energy systems.
To accomplish this goal, students learn in detail the causes and proposed solutions to the problems, and learn to evaluate whether the proposed solutions are truly beneficial. A/E students take courses in renewable energy resources, indoor and outdoor air pollution, energy

efficient buildings, climate change, renewable energy and clean-vehicle technologies, weather and storm systems, energy technologies in developing countries, electric grids, and air quality management. The curriculum is flexible. Depending upon their area of interest, students may take in-depth courses in energy or atmosphere and focus either on science, technology, or policy. The major is designed to provide students with excellent preparation for careers in industry, government, and research; and for study in graduate school.

Requirements

		Units
Mathematics and Science (45 units minimum):		
Mathematics		23
23 units minimum, including at least one course from each group:		
Group A		
MATH 53	Ordinary Differential Equations with Linear Algebra	
CME 102	Ordinary Differential Equations for Engineers	
Group B		
CME 106	Introduction to Probability and Statistics for Engineers	
STATS 60	Introduction to Statistical Methods: Precalculus	
STATS 101	Data Science 101	
STATS 110	Statistical Methods in Engineering and the Physical Sciences	
Science		20
20 units minimum, including all of the following:		
PHYSICS 41	Mechanics	
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
PHYSICS 43	Electricity and Magnetism	
or PHYSICS 45	Light and Heat	
CHEM 31B	Chemical Principles II	
or CHEM 31X	Chemical Principles Accelerated	
CEE 70	Environmental Science and Technology [1]	
Technology in Society (1 course)		3-5
One 3-5 unit course required; must be on School of Engineering Approved List the year taken.		
Writing in the Major (WIM)		
One 3-5 unit course required. Choose a TiS course that fulfills a WIM:		
BIOE 131	Ethics in Bioengineering	
COMM 120W	Digital Media in Society	
OR one of these WIM courses (do not fulfill TiS):		
CEE 100	Managing Sustainable Building Projects	
EARTHSYS 200	Environmental Communication in Action: The SAGE Project	
Fundamentals and Depth: At least 40 units total must be from the School of Engineering		
Engineering Fundamentals		
Two courses minimum (recommend 3), including at least one of the following:		7-9
ENGR 25E	Energy: Chemical Transformations for Production, Storage, and Use	
ENGR 50E	Introduction to Materials Science, Energy Emphasis	
Plus at least one of the following:		
ENGR 10	Introduction to Engineering Analysis	
ENGR 70A	Programming Methodology	
A third Fundamental is optional but recommended (3-4 units)		
Engineering Depth		
Required: 6-8 units. Introductory seminars may not count toward Engineering Depth [2]		
CEE 64	Air Pollution and Global Warming: History, Science, and Solutions (cannot also fulfill science requirement)	3
CEE 107A	Understanding Energy	3-5
or CEE 107S	Understanding Energy - Essentials	
34- 36 units from the following with at least four courses from each group; at least 40 of the units in ENGR Fundamentals and Depth must be from the School of Engineering:		36
Group A: Atmosphere		
AA 100	Introduction to Aeronautics and Astronautics	
CEE 63	Weather and Storms	
CEE 101B	Mechanics of Fluids	
or ME 70	Introductory Fluids Engineering	
CEE 161C		
CEE 161I	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation	
CEE 162I	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation	
CEE 172	Air Quality Management	
CEE 178	Introduction to Human Exposure Analysis	
EARTHSYS 111	Biology and Global Change [5]	
EARTHSYS 142	Remote Sensing of Land [5]	
or EARTHSYS 144	Fundamentals of Geographic Information Science (GIS)	
EARTHSYS 188	Social and Environmental Tradeoffs in Climate Decision-Making [5]	
ME 131B	Fluid Mechanics: Compressible Flow and Turbomachinery	
PHYSICS 199	The Physics of Energy and Climate Change [5]	
EARTH 2	Climate and Society [5]	
EARTHSYS 196	Implementing Climate Solutions at Scale [5]	
Group B: Energy		
CEE 156	Building Systems	
CEE 173S	Electricity Economics	
CEE 176A	Energy Efficient Buildings	
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	
CEE 177S	Engineering and Sustainable Development	
EARTHSYS 101	Energy and the Environment [5]	
EARTHSYS 102	Fundamentals of Renewable Power [5]	
ENERGY 104	Sustainable Energy for 9 Billion	
ENGR 50E	Introduction to Materials Science, Energy Emphasis [3]	
MATSCI 144	Thermodynamic Evaluation of Green Energy Technologies	
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	
ME 182	Electric Transportation	
POLISCI 73	Energy Policy in California and the West [5]	
OSPSANTG 29	Sustainable Cities: Comparative Transportation Systems in Latin America [5]	
OSPSANTG 52	[5]	
Total Units		95-101

[1] Can count as a science requirement or Engineering Fundamental, but not both.
[2] CEE 64 can count as a science requirement or as Engineering Depth, but not both.
[3] ENGR 50E can count as Engineering Fundamental or Engineering Depth, but not both.
[4] A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.
[5] Courses outside of the School of Engineering (SoE) do not count toward the 40 units of engineering coursework required in the Fundamentals plus Depth categories.

Honors Program

The A/E honors program offers eligible students the opportunity to engage in guided original research, or project design, over the course of an academic year. Interested student must adhere to the following requirements:

1. Prospective honors students write up and submit a 1-2 page letter applying to the honors program in A/E describing the problem to be investigated. The letter must be signed by the student, the current primary adviser, and the proposed honors adviser, if different, and submitted to the student services office in the Department of Civil and Environmental Engineering (CEE). The application must include an unofficial Stanford transcript. Applications must be received in the fourth quarter prior to graduation. It is strongly suggested that prospective honors students meet with the proposed honors adviser well in advance of submitting an application.
2. Students must maintain a GPA of at least 3.5.
3. Students must complete an honors thesis or project over a period of three quarters. The typical length of the written report is 15-20 pages. The deadline for submission of the report is to be decided by the honors adviser, but should be no later than the end of the third week in May.
4. The report must be read and evaluated by the student's honors adviser and one other reader. It is the student's responsibility to find and obtain both the adviser and the reader. At least one of the two must be a member of the Academic Council in the School of Engineering.
5. Students must present the completed work in an appropriate forum, e.g. in the same session as honors theses are presented in the department of the adviser. All honors programs require some public presentation of the thesis or project.
6. Students may take up to 10 units of CEE 199H Undergraduate Honors Thesis(optional). However, students must take ENGR 202S Directed Writing Projects or its equivalent (required). Units for the writing class are beyond those required for the A/E major.
7. Two copies of the signed thesis must be provided to the CEE student services office no later than two weeks before the end of the student's graduation quarter.

For additional information and sample programs, see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Bioengineering (BIOE)

Completion of the undergraduate program in Bioengineering leads to the conferral of the Bachelor of Science in Bioengineering.

Mission of the Undergraduate Program in Bioengineering

The Stanford Bioengineering major enables students to combine engineering and the life sciences in ways that advance scientific discovery, healthcare and medicine, manufacturing, environmental quality, culture, education, and policy. Students who major in BioE earn a fundamental engineering degree for which the raw materials, underlying basic sciences, fundamental toolkit, and future frontiers are all defined by the unique properties of living systems.

Students will complete engineering fundamentals courses, including an introduction to bioengineering and computer programming. A series of core BIOE classes beginning in the second year leads to a student-selected depth area and a senior capstone design project. The department also organizes a summer Research Experience for Undergraduates (REU) (http://bioengineering.stanford.edu/student-resources/reu) program. BIOE graduates are well prepared to pursue careers and lead projects in research, medicine, business, law, and policy.

Requirements

Mathematics		
14 units minimum (Prerequisites: 10 units of AP or IB credit or Mathematics 20-series) [1]		
Select one of the following sequences:		
CME 100 & CME 102	Vector Calculus for Engineers and Ordinary Differential Equations for Engineers (Recommended)	10
MATH 51 & MATH 53	Linear Algebra, Multivariable Calculus, and Modern Applications and Ordinary Differential Equations with Linear Algebra	10
Select one of the following:		
CME 106	Introduction to Probability and Statistics for Engineers (Recommended)	4-5
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 141	Biostatistics	
Science		
26 units minimum [2]		
CHEM 31X	Chemical Principles Accelerated	5-10
or CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	
CHEM 33	Structure and Reactivity of Organic Molecules	5
BIO 83	Biochemistry & Molecular Biology (Recommended)	4
or BIO 82	Genetics	
BIO 84	Physiology	4
PHYSICS 41	Mechanics	4
PHYSICS 43	Electricity and Magnetism	4
Technology in Society		
BIOE 131	Ethics in Bioengineering (WIM)	3
Engineering Fundamentals		
BIOE 80	Introduction to Bioengineering (Engineering Living Matter)	4
CS 106A	Programming Methodology (or CS 106B or CS 106X)	5
Fundamentals Elective; see UGHB for approved course list; only one CS class allowed to count toward Fundamentals requirements.		3-5
Bioengineering Core		
BIOE 42	Physical Biology	4
BIOE 44	Fundamentals for Engineering Biology Lab	4
BIOE 101	Systems Biology	3
BIOE 103	Systems Physiology and Design	4
BIOE 123	Biomedical System Prototyping Lab	4
BIOE 141A	Senior Capstone Design I	4

BIOE 141B	Senior Capstone Design II	4
Bioengineering Depth Electives		
Four courses, minimum 12 units:		12
BIOE 115	Computational Modeling of Microbial Communities	
BIOE 122	Biosecurity and Bioterrorism Response	
BIOE 140		
BIOE 201C	Diagnostic Devices Lab	
BIOE 211	Biophysics of Multi-cellular Systems and Amorphous Computing	
BIOE 212	Introduction to Biomedical Informatics Research Methodology	
BIOE 214	Representations and Algorithms for Computational Molecular Biology	
BIOE 217	Translational Bioinformatics	
BIOE 220	Introduction to Imaging and Image-based Human Anatomy	
or BIOE 51	Anatomy for Bioengineers	
BIOE 221	Physics and Engineering of Radionuclide-based Medical Imaging	
BIOE 222	Physics and Engineering Principles of Multi-modality Molecular Imaging of Living Subjects	
BIOE 223	Physics and Engineering of X-Ray Computed Tomography	
BIOE 224	Probes and Applications for Multi-modality Molecular Imaging of Living Subjects	
BIOE 225	Ultrasound Imaging and Therapeutic Applications	
BIOE 227	Functional MRI Methods	
BIOE 231	Protein Engineering	
BIOE 244	Advanced Frameworks and Approaches for Engineering Integrated Genetic Systems	
BIOE 260	Tissue Engineering	
BIOE 279	Computational Biology: Structure and Organization of Biomolecules and Cells	
BIOE 281	Biomechanics of Movement	
BIOE 291	Principles and Practice of Optogenetics for Optical Control of Biological Tissues	

1 It is strongly recommended that CME 100 Vector Calculus for Engineers and CME 102 Ordinary Differential Equations for Engineers be taken rather than MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications and MATH 53 Ordinary Differential Equations with Linear Algebra. If you are taking the MATH 50 series, it is strongly recommended to take CME 192 Introduction to MATLAB. CME 106 Introduction to Probability and Statistics for Engineers utilizes MATLAB, a powerful technical computing program, and should be taken rather than STATS 110 Statistical Methods in Engineering and the Physical Sciences or STATS 141 Biostatistics. Although not required, CME 104 Linear Algebra and Partial Differential Equations for Engineers is recommended for some Bioengineering courses.

2 Science must include both Chemistry (CHEM 31A Chemical Principles I and CHEM 31B Chemical Principles II; or CHEM 31X Chemical Principles Accelerated) and calculus-based Physics (PHYSICS 41 Mechanics and PHYSICS 43 Electricity and Magnetism), with two quarters of course work in each, in addition to two courses of BIO core. CHEM 31A Chemical Principles I and CHEM 31B Chemical Principles II are considered one course even though given over two quarters.

3 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu). Students pursuing a premed program need to take additional courses; see the UGHB, BioE Premed 4-Year Plan.

Honors Program

The School of Engineering offers a program leading to a Bachelor of Science in Bioengineering with Honors (BIOE-BSH). This program provides the opportunity for qualified BioE majors to conduct independent research at an advanced level with a faculty research adviser and documented in an honors thesis.

In order to receive departmental honors, students admitted to the program must:

1. Declare the honors program in Axess (BIOE-BSH).
2. Maintain an overall grade point average (GPA) of at least 3.5 as calculated on the unofficial transcript.
3. Complete at least two quarters of research with a minimum of nine units of BIOE 191 Bioengineering Problems and Experimental Investigation or BIOE 191X Out-of-Department Advanced Research Laboratory in Bioengineering for a letter grade; up to three units may be used towards the bioengineering depth elective requirements.
4. Submit a completed thesis draft to the honors adviser and second reader by the third week of Spring Quarter. Further revisions and final endorsement are to be finished by the second Monday in May, when two signed bound copies plus one PC-compatible CD-ROM are to be submitted to the student services officer.
5. Attend the Bioengineering Honors Symposium at the end of Spring Quarter and give a poster or oral presentation, or present in another approved suitable forum.

For more information and application instructions, see the Bioengineering Honors Program (http://bioengineering.stanford.edu/academics/undergraduate-programs/bioengineering-honors-program) web site.

Biomechanical Engineering (BME)

Completion of the undergraduate program in Biomechanical Engineering leads to the conferral of the Bachelor of Science in Engineering. The subplan "Biomechanical Engineering" appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Biomechanical Engineering

The mission of the undergraduate program in Biomechanical Engineering is to help students address health science challenges by applying engineering mechanics and design to the fields of biology and medicine. The program is interdisciplinary in nature, integrating engineering course work with biology and clinical medicine. Research and teaching in this discipline focus primarily on neuromuscular, musculoskeletal, cardiovascular, and cell and tissue biomechanics. This major prepares students for graduate studies in bioengineering, biomechanics, medicine or related areas.

Requirements

	Units
Mathematics	21
21 units minimum; CME sequence is recommended, but MATH sequence is acceptable; see Basic Requirement 1 [1]	

CME 102/ ENGR 155A	Ordinary Differential Equations for Engineers	
or MATH 53	Ordinary Differential Equations with Linear Algebra	
Select one of the following:		
CME 106/ ENGR 155C	Introduction to Probability and Statistics for Engineers	
STATS 110	Statistical Methods in Engineering and the Physical Sciences	
STATS 116	Theory of Probability	
STATS 141	Biostatistics	
Science (22 units Minimum) [1]		
CHEM 31X	Chemical Principles Accelerated (or CHEM 31A+B)	5
PHYSICS 41	Mechanics	4
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
Biology or Human Biology A/B core courses [4]		8-10
BIO 45	Introduction to Laboratory Research in Cell and Molecular Biology (or BIO 44X if taken before 2016-17)	4
or BIOE 44	Fundamentals for Engineering Biology Lab	
Technology in Society		
One course required; course must be on School of Engineering Approved Courses list in the UGHB the year taken		3-5
Engineering Topics (Engineering Science and Design)		
Engineering Fundamentals (minimum two courses; see Basic Requirement 3):		
ENGR 14	Intro to Solid Mechanics	3
Pick one of the following:		
ENGR 25B	Biotechnology	3
ENGR 80	Introduction to Bioengineering (Engineering Living Matter)	
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis	
Engineering Depth		
ENGR 15	Dynamics	3
ME 30	Engineering Thermodynamics	3
ME 70	Introductory Fluids Engineering	3
ME 80	Mechanics of Materials	3
ME 112	Mechanical Systems Design [3]	3
ME 389	Biomechanical Research Symposium [2]	1
Mechanical Engineering/ Biomechanical Engineering Depth		
Students are encouraged to carefully select ME and BME depth courses that complement each other and form a cohesive plan of study.		
Options to complete the ME depth sequence (3 courses, minimum 9 units) and WIM: [3,5]		9
ENGR 105	Feedback Control Design	
ME 102	Foundations of Product Realization	
ME 131A	Heat Transfer	
ME 131B	Fluid Mechanics: Compressible Flow and Turbomachinery	
ME 133	Intermediate Fluid Mechanics (offered SPR AY 18-19; more information to come)	
ME 151	Introduction to Computational Mechanics (offered WIN AY 18-19; more information to come)	
ME 152	Material Behaviors and Failure Prediction	
ME 161	Dynamic Systems, Vibrations and Control	
Options to complete the BME depth sequence (3 courses, minimum 9 units) and WIM: [3,5]		9
BIOE 260	Tissue Engineering	
BIOE/ME 285	Computational Modeling in the Cardiovascular System	
ME 234	Introduction to Neuromechanics	
ME 281	Biomechanics of Movement	
ME 283	Introduction to Biomechanics and Mechanobiology	
ME 287	Mechanics of Biological Tissues	
ME 328	Medical Robotics (with permission of instructor)	
ME 337	Mechanics of Growth	
Total Units		85-89

1. Math: 21 units required and must include a course in differential equations (CME 102 or MATH 53; one of these required) and a course in calculus-based Statistics (CME 106 Introduction to Probability and Statistics for Engineers or STATS 110 Statistical Methods in Engineering and the Physical Sciences or STATS 116 Theory of Probability or STATS 141 Biostatistics).
2. If ME 389 is not offered, other options include BIOE 393, ME 571, or course by petition.
3. There are two options for fulfilling the WIM requirement. The first option is to complete ME 112. The second option is to perform engineering research over the summer or during the academic year and enroll in 3 units of ENGR 199W Writing of Original Research for Engineers, preferably during the time a student is performing research or the following quarter, to write a technical report on the research. This second option requires an agreement with the student's faculty research supervisor.
4. Students satisfy the Biology requirement by either:
    - taking two of the following: BIO 82 Genetics , BIO 83 Biochemistry & Molecular Biology, BIO 84 Physiologyor BIO 86 Cell Biology requires BIO 83); or
    - taking two of the following: HUMBIO 2A Genetics, Evolution, and Ecology, HUMBIO 3A Cell and Developmental Biology, or HUMBIO 4A The Human Organism
5. Courses may only be listed once on the program sheet i.e no double counting. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Honors Program

The School of Engineering offers a program leading to a Bachelor of Science in Engineering: Biomechanical Engineering with Honors. This program provides an opportunity for qualified BME majors to conduct independent study and research related to biomechanical engineering at an advanced level with a faculty mentor.

Honors Criteria:

- GPA of 3.5 or higher in the major
- Arrangement with an ME faculty member (or a faculty member from another department who is approved by the BME Undergraduate Program Director) who agrees to serve as the honors adviser, plus a second faculty member who reads and approves the thesis. The honors adviser must be a member of the Academic Council in the School of Engineering.
- Submit an application to the ME student services office no later than the second week of the term two quarters before anticipated conferral (e.g., Autumn for Spring conferral, Spring for Autumn conferral). An application consists of:

- A one page written statement describing the research topic, with signatures indicating approval of both the thesis adviser and thesis reader on a cover page
- An unofficial Stanford transcript;

- Applications are subject to the review and final approval by the BME Undergraduate Program Director. Applicants and thesis advisers receive written notification when a decision has been made.
- In order to graduate with honors:
  - Declare ENGR-BSH (honors) program in Axess
  - Maintain 3.5 GPA
  - Submit a completed thesis draft to the adviser by the 3rd week of the quarter the they intend to confer. Further revisions and final endorsement by the adviser and reader are to be finished by week 6, when two bound copies are to be submitted to the Mechanical Engineering student services office.
  - Present the thesis at the Mechanical Engineering Poster Session held in mid-April. If the poster session is not not offered or the student does not confer in the Spring, an alternative presentation will be approved on a case by case basis with advisor and BME Program Director approval.

Note: Students may not use work completed towards an honors degree to satisfy BME course requirements

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Biomedical Computation (BMC)

Completion of the undergraduate program in Biomedical Computation leads to the conferral of the Bachelor of Science in Engineering. The subplan "Biomedical Computation" appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Biomedical Computation

Quantitative and computational methods are central to the advancement of biology and medicine in the 21st century. These methods span the analysis of biomedical data, the construction of computational models for biological systems, and the design of computer systems that help biologists and physicians create and administer treatments to patients. The Biomedical Computation major prepares students to work at the cutting edge of this interface between computer science, biology, and medicine. Students begin their journey by acquiring foundational knowledge in the underlying biological and computational disciplines. They learn techniques in informatics and simulation and their numerous applications in understanding and analyzing biology at all levels, from individual molecules in cells to entire organs, organisms, and populations. Students then focus their efforts in a depth area of their choosing, and participate in a substantial research project with a Stanford faculty member. Upon graduation, students are prepared to enter a range of disciplines in either academia or industry.

Requirements

		Units
Mathematics		
21 unit minimum, see Basic Requirement 1		
MATH 19	Calculus (or AP Calculus)	3
MATH 20	Calculus (or AP Calculus)	3
MATH 21	Calculus (or AP Calculus)	4
CS 103	Mathematical Foundations of Computing	3-5
CS 109	Introduction to Probability for Computer Scientists	3-5
Science		
17 units minimum, see Basic Requirement 2		
PHYSICS 41	Mechanics	4
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
CHEM 31X	Chemical Principles Accelerated	5
CHEM 33	Structure and Reactivity of Organic Molecules	5
BIO 82	Genetics (or HUMBIO 2A)	4
BIO 83	Biochemistry & Molecular Biology (or BIO 84 or HUMBIO 3A)	4
BIO 86	Cell Biology (or HUMBIO 4A)	4
Engineering Fundamentals		
CS 106B	Programming Abstractions [4]	3-5
or CS 106X	Programming Abstractions (Accelerated)	
For the second required course, see concentrations [4]		
Technology in Society		
One course required, see Basic Requirement 4; course used must be on the School of Engineering Approved Courses list in the UGHB the year taken.		3-5
Engineering		
CS 107	Computer Organization and Systems	3-5
CS 161	Design and Analysis of Algorithms	3-5
Select one of the following:		3
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	
CS 273A	The Human Genome Source Code	
CS 274	Representations and Algorithms for Computational Molecular Biology	
CS 275	Translational Bioinformatics	
CS 279	Computational Biology: Structure and Organization of Biomolecules and Cells	
Research: 6 units of biomedical computation research in any department [2,3]		6
Engineering Depth Concentration (select one of the following concentrations): [7]		
Cellular/Molecular Concentration		
Mathematics: Select one of the following:		
CME 100	Vector Calculus for Engineers	
STATS 141	Biostatistics	
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
One additional Engineering Fundamental [4]		
BIO 104	Advance Molecular Biology: Epigenetics and Proteostasis	
CHEM 141	The Chemical Principles of Life I (or CHEM 171) [4]	
Cell/Mol Electives (two courses) [5,6]		
Informatics Electives (two courses) [5,6]		
Simulation Electives (two courses) [5, 6]		
Simulation, Informatics, or Cell/Mol Elective (one course) [5,6]		
Informatics Concentration		
Mathematics: Select one of the following:		
STATS 141	Biostatistics	
STATS 203	Introduction to Regression Models and Analysis of Variance	
STATS 205	Introduction to Nonparametric Statistics	
STATS 215	Statistical Models in Biology	
One additional Engineering Fundamental [4]		
Informatics Core (three courses):		
CS 145	Data Management and Data Systems	

or CS 147	Introduction to Human-Computer Interaction Design	
CS 221	Artificial Intelligence: Principles and Techniques	
or CS 228	Probabilistic Graphical Models: Principles and Techniques	
or CS 229	Machine Learning	
One additional course from the previous two lines		
Informatics Electives (three courses) [5,6]		
Cellular Electives (two courses) [5,6]		
Organs Electives (two courses) [5,6]		6-10
Organs/Organisms Concentration		
Mathematics (select one of the following):		
CME 100	Vector Calculus for Engineers	
STATS 141	Biostatistics	
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
One additional Engineering Fundamental [4]		
Biology (two courses):		
BIO 112	Human Physiology	
CHEM 141	The Chemical Principles of Life I (or BIOE 220)	
Two additional Organs Electives [5,6]		
Simulation Electives (two courses) [5,6]		
Informatics Electives (two courses) [5,6]		
Simulation, Informatics, or Organs Elective (one course) [5,6]		
Simulation Concentration		
Mathematics:		
CME 100	Vector Calculus for Engineers	
or MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
ME 30	Engineering Thermodynamics (Fulfills 2nd Engineering Fundamental)	3
Simulation Core:		
CME 102	Ordinary Differential Equations for Engineers	5
or MATH 53	Ordinary Differential Equations with Linear Algebra	
ENGR 80	Introduction to Bioengineering (Engineering Living Matter)	4
BIOE 101	Systems Biology	3
BIOE 103	Systems Physiology and Design	4
Simulation Electives (two courses) [5, 6]		
Cellular Elective (one course) [5,6]		
Organs Elective (one course) [5,6]		
Simulation, Cellular, or Organs Elective (two courses) [5,6]		
Total Units		88-104

1. Acceptable substitutes for CS 109 are STATS 116 Theory of Probability, MS&E 120 Probabilistic Analysis, MS&E 220 Probabilistic Analysis, EE 178 Probabilistic Systems Analysis, and CME 106 Introduction to Probability and Statistics for Engineers .
2. Research projects require pre-approval of BMC Coordinators
3. Research units taken as CS 191W Writing Intensive Senior Project or in conjunction with ENGR 199W Writing of Original Research for Engineers fulfill the Writing in the Major (WIM) requirement. CS 272 Introduction to Biomedical Informatics Research Methodology, which does not have to be taken in conjunction with research, also fulfills the WIM requirement.
4. One 3-5 unit course required; CS 106A Programming Methodology may not be used. See Engineering Fundamentals list in Handbook for Undergraduate Engineering Programs or on Approved Courses page at ughb.stanford.edu.
5. The list of electives is continually updated to include all applicable courses. For the current list of electives, see http://bmc.stanford.edu.
6. A course may only be counted towards one elective or core requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.
7. A total of 40 Engineering Fundamentals and Core/Depth units must be taken. The core classes only provide 27 Engineering units, so the remaining units must be taken from within the electives.

Honors Program

The Biomedical Computation program offers an honors option for qualified students, resulting in a B.S. with Honors degree in Engineering (ENGR-BSH, Biomedical Computation). An honors project is meant to be a substantial research project during the later part of a student's undergraduate career, culminating in a final written and oral presentation describing the student's project and its significance. There is no limit to the number of majors who can graduate with honors; any BMC major who is interested and meets the qualifications is considered.

1. Students apply by submitting a 1-2 page proposal describing the problem the student has chosen to investigate, its significance, and the student's research plan. This plan must be endorsed by the student's research and academic advisers, one of whom must be a member of the Academic Council. In making its decision, the department evaluates the overall scope and significance of the student's proposed work.
2. Students must maintain a 3.5 GPA.
3. Students must complete three quarters of research. All three quarters must be on the same project with the same adviser. A Summer Quarter counts as one quarter of research.
    - Ideally, funding should not be obtained through summer research college sources, but rather through the UAR's Student Grants Program (http://exploredegrees.stanford.edu/schoolofengineering/%20http://studentgrants.stanford.edu). In no case can the same work be double-paid by two sources.
4. Students must complete a substantial write-up of the research in the format of a publishable research paper. This research paper is expected to be approximately 15-20 pages and must be approved by the student's research adviser and by a second reader.
5. As the culmination of the honors project, each student presents the results in a public forum. This can either be in the honors presentation venue of the home department of the student's adviser, or in a suitable alternate venue.

For additional information and sample programs, see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Chemical Engineering

Completion of the undergraduate program in Chemical Engineering leads to the conferral of the Bachelor of Science in Chemical Engineering.

Mission of the Undergraduate Program in Chemical Engineering

Chemical engineers are responsible for the conception and design of processes for the purpose of production, transformation, and transportation of materials. This activity begins with experimentation in the laboratory and is followed by implementation of the technology in full-scale production. The mission of the undergraduate program in Chemical Engineering is to develop students' understanding of the core scientific, mathematical, and engineering principles that serve as the foundation underlying these technological processes. The program's core mission is reflected in its curriculum which is built on a foundation in the sciences of chemistry, physics, and biology. Course work includes the study of applied mathematics, material and energy balances, thermodynamics, fluid mechanics, energy and mass transfer, separations technologies, chemical reaction kinetics and reactor design, and process design. The program provides students with excellent preparation for careers in the corporate sector and government, or for graduate study.

Requirements*

		Units
Mathematics [1]		10
The following sequence or approved AP credit		
MATH 19	Calculus	
MATH 20	Calculus	
MATH 21	Calculus	
Select one of the following:		5-10
CME 100	Vector Calculus for Engineers	
MATH 51 & MATH 52	Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables	
Select one of the following:		5
CME 102	Ordinary Differential Equations for Engineers	
or MATH 53	Ordinary Differential Equations with Linear Algebra	
Select one of the following:		4-5
CME 104	Linear Algebra and Partial Differential Equations for Engineers	
or CME 106	Introduction to Probability and Statistics for Engineers	
Science [1]		
CHEM 31X	Chemical Principles Accelerated	5
CHEM 33	Structure and Reactivity of Organic Molecules	5
CHEM 35	Organic Chemistry of Bioactive Molecules	5
PHYSICS 41	Mechanics	4
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
PHYSICS 43	Electricity and Magnetism	4
CHEM 131	Organic Polyfunctional Compounds	3
Technology in Society		
One course required, see Basic Requirement 4; course chosen must be on the SoE-Approved Courses list at <ughb.stanford.edu> the year taken.		3-5
Engineering Fundamentals		
Three courses minimum; see Basic Requirement 3		
CHEMENG/ENGR 20	Introduction to Chemical Engineering	4
Fundamentals Elective from another School of Engineering department		3-5
See the UGHB for a list of courses.		
Select one of the following:		3
ENGR 25B	Biotechnology (same as CHEMENG 25B)	
ENGR 25E	Energy: Chemical Transformations for Production, Storage, and Use (same as CHEMENG 25E)	
Chemical Engineering Depth		
Minimum 68 Engineering Science and Design units; see Basic Requirement 5		
CHEMENG 10	The Chemical Engineering Profession	1
CHEMENG 100	Chemical Process Modeling, Dynamics, and Control	3
CHEMENG 110	Equilibrium Thermodynamics	3
CHEMENG 120A	Fluid Mechanics	4
CHEMENG 120B	Energy and Mass Transport	4
CHEMENG 130	Separation Processes	3
CHEMENG 150	Biochemical Engineering	3
CHEMENG 170	Kinetics and Reactor Design	3
CHEMENG 180	Chemical Engineering Plant Design	4
CHEMENG 181	Biochemistry I	4
CHEMENG 185A	Chemical Engineering Laboratory A (WIM)	4
CHEMENG 185B	Chemical Engineering Laboratory B	4
CHEM 171	Physical Chemistry I	4
CHEM 173	Physical Chemistry II	3
CHEM 175	Physical Chemistry III	3
Select four of the following: [2,3]		12
CHEMENG 140	Micro and Nanoscale Fabrication Engineering	
CHEMENG 142	Basic Principles of Heterogeneous Catalysis with Applications in Energy Transformations	
CHEMENG 160	Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life	
CHEMENG 162	Polymers for Clean Energy and Water	
CHEMENG 174	Environmental Microbiology I	
CHEMENG 183	Biochemistry II	
CHEMENG 196	Creating New Ventures in Engineering and Science-based Industries	
Total Units		125-135

1 Unit count is higher if program includes one or more of the following: MATH 51 and MATH 52 in lieu of CME 100; or CHEM 31A and CHEM 31B in lieu of CHEM 31X.

2 Any two acceptable except combining 160 and 162.

3 Students may substitute two of the depth electives with two other science and engineering 3-unit lecture courses. See Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu) for additional details.

4 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

* For additional information and sample programs, see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu)

Civil Engineering (CE)

Completion of the undergraduate program in Civil Engineering leads to the conferral of the Bachelor of Science in Civil Engineering.

Mission of the Undergraduate Program in Civil Engineering

The mission of the undergraduate program in Civil Engineering is to provide students with the principles of engineering and the methodologies necessary for civil engineering practice. This pre-professional program balances the fundamentals common to many specialties in civil engineering and allows for concentration in structures and construction or environmental and water studies. Students in the major learn to apply knowledge of mathematics, science, and civil engineering to conduct experiments, design structures and systems to creatively solve engineering problems, and communicate their ideas effectively. The curriculum includes course work in structural, construction, and environmental engineering. The major prepares students for careers in consulting, industry and government, as well as for graduate studies in engineering.

Requirements

		Units
Mathematics and Science		45
45 units minimum; see Basic Requirements 1 and 2 [1]		
Technology in Society		
One course; course chosen must be on the SoE Approved Courses list at <ughb.stanford.edu> the year taken; see Basic Requirement 4 [2]		3-5
Engineering Fundamentals		
Two courses required		
ENGR 14	Intro to Solid Mechanics	3
ENGR 90/CEE 70	Environmental Science and Technology	3
Engineering Depth		
Minimum of 68 Engineering Fundamentals plus Engineering Depth; see Basic Requirement 5		
CEE 100	Managing Sustainable Building Projects [3]	4
CEE 101A	Mechanics of Materials	4
CEE 101B	Mechanics of Fluids	4
CEE 101C	Geotechnical Engineering	4
CEE 146S	Engineering Economics and Sustainability	3
Specialty courses in either:		39-42
Environmental and Water Studies (see below)		
Structures and Construction (see below)		
Other School of Engineering Electives		3-0
Total Units		115-117

1 Mathematics must include CME 100 Vector Calculus for Engineers and CME 102 Ordinary Differential Equations for Engineers (or Math 51 Linear Algebra and Differential Calculus of Several Variables and MATH 53 Ordinary Differential Equations with Linear Algebra) and a Statistics course. Science must include Physics 41 Mechanics; either ENGR 31 Chemical Principles with Application to Nanoscale Science and Technology, CHEM31A Chemical Principles I or CHEM 31X Chemical Principles; two additional quarters in either chemistry or physics, and GEOLSCI 1 Introduction to Geology; for students in the Environmental and Water Studies track, the additional chemistry or physics must include CHEM 33; for students in the Structures and Construction track, it must include PHYSICS 43 or 45. Please note that the only quarter GEOLSCI 1 is offered for AY 2018-19 is Spring Quarter.

2 Chosen TiS class must specifically include an ethics component, as indicated in Figure 3-3 in the Engineering Undergraduate Handbook (http://web.stanford.edu/group/ughb/cgi-bin/handbook/index.php/Handbooks)

3 CEE 100 meets the Writing in the Major (WIM) requirement

4 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Environmental and Water Studies Focus

		Units
ME 30	Engineering Thermodynamics	3
CEE 101D	Computations in Civil and Environmental Engineering (or CEE 101S) [2]	3
CEE 102	Legal and Ethical Principles in Design, Construction, and Project Delivery (or CEE 175A (alt years) or CEE 171 (no longer offered))	3
CEE 162E	Rivers, Streams, and Canals	3
CEE 166A	Watersheds and Wetlands	4
CEE 166B	Floods and Droughts, Dams and Aqueducts	4
CEE 172	Air Quality Management	3
CEE 177	Aquatic Chemistry and Biology	4
CEE 179A	Water Chemistry Laboratory	3
CEE 179C	Environmental Engineering Design	5
(or CEE 169) Capstone design experience course		
Remaining specialty units from:		
CEE 63	Weather and Storms [2]	3
CEE 64	Air Pollution and Global Warming: History, Science, and Solutions [2]	3
CEE 107A	Understanding Energy	3-5
CEE 155	Introduction to Sensing Networks for CEE	4
CEE 161C		3
CEE 161I	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation	3
CEE 162D	Introduction to Physical Oceanography	4
CEE 162F	Coastal Processes	3
CEE 162I	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation	3
CEE 165C	Water Resources Management	3
CEE 166D		2
CEE 174A	Providing Safe Water for the Developing and Developed World	3
CEE 174B	Wastewater Treatment: From Disposal to Resource Recovery	3
CEE 176A	Energy Efficient Buildings	3-4
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	3-4
CEE 178	Introduction to Human Exposure Analysis	3
CEE 199	Undergraduate Research in Civil and Environmental Engineering	1-4

Structures and Construction Focus

		Units
CEE 102	Legal and Ethical Principles in Design, Construction, and Project Delivery	3
CEE 120A	Building Information Modeling Workshop (or CEE 120S)	3
CEE 156	Building Systems	4
CEE 180	Structural Analysis	4
CEE 181	Design of Steel Structures	4
CEE 182	Design of Reinforced Concrete Structures	4
CEE 183	Integrated Civil Engineering Design Project	4
Select one of the following (beyond the 2 required Engineering Fundamentals):		4
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis	
ENGR 50E	Introduction to Materials Science, Energy Emphasis	
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis	
Remaining specialty units from:		
ENGR 15	Dynamics	3

CME 104	Linear Algebra and Partial Differential Equations for Engineers	5
CEE 101D	Computations in Civil and Environmental Engineering (or CEE 101S)	3
CEE 112A	Industry Applications of Virtual Design & Construction	2-4
CEE 112B	Industry Applications of Virtual Design & Construction	2-4
CEE 122A	Computer Integrated Architecture/ Engineering/Construction	2
CEE 122B	Computer Integrated A/E/C	2
CEE 131A	Professional Practice: Mixed-Use Design in an Urban Setting (not offered AY 18-19)	4
CEE 131B	Financial Management of Sustainable Urban Systems	3
CEE 141A	Infrastructure Project Development	3
CEE 141B	Infrastructure Project Delivery	3
CEE 151	Negotiation	3
CEE 155	Introduction to Sensing Networks for CEE	4
CEE 161C		3
CEE 162E	Rivers, Streams, and Canals	3-4
CEE 171	Environmental Planning Methods (no longer offered)	3
CEE 176A	Energy Efficient Buildings	3-4
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	3-4
CEE 199	Undergraduate Research in Civil and Environmental Engineering	1-4
CEE 203	Probabilistic Models in Civil Engineering	3-4
One of the following can also count as remaining specialty units.		3-4
CEE 120B	Building Information Modeling Workshop	2-4
CEE 130	Architectural Design: 3-D Modeling, Methodology, and Process	
CEE 134B	Intermediate Arch Studio	

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Computer Science (CS)

Completion of the undergraduate program in Computer Science leads to the conferral of the Bachelor of Science in Computer Science.

Mission of the Undergraduate Program in Computer Science

The mission of the undergraduate program in Computer Science is to develop students' breadth of knowledge across the subject areas of computer science, including their ability to apply the defining processes of computer science theory, abstraction, design, and implementation to solve problems in the discipline. Students take a set of core courses. After learning the essential programming techniques and the mathematical foundations of computer science, students take courses in areas such as programming techniques, automata and complexity theory, systems programming, computer architecture, analysis of algorithms, artificial intelligence, and applications. The program prepares students for careers in government, law, the corporate sector, and for graduate study.

Requirements

Mathematics (26 units minimum)—

		Units
CS 103	Mathematical Foundations of Computing	5
CS 109	Introduction to Probability for Computer Scientists	5
MATH 19	Calculus [1]	3
MATH 20	Calculus [1]	3
MATH 21	Calculus [1]	4
Plus two electives [2]		

Science (11 units minimum)—

		Units
PHYSICS 41	Mechanics	4
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
PHYSICS 43	Electricity and Magnetism	4
Science elective [3]		3

Technology in Society (3-5 units)—

One course; course chosen must be on the SoE Approved Courses list at <ughb.stanford.edu> the year taken; see Basic Requirements 4 in the School of Engineering section

Engineering Fundamentals (13 units minimum; see Basic Requirement 3 in the School of Engineering section)—

		Units
CS 106B	Programming Abstractions	5
or CS 106X	Programming Abstractions (Accelerated)	
ENGR 40M	An Intro to Making: What is EE (or ENGR 40A and ENGR 40B)	3-5
Fundamentals Elective (May be an ENGR fundamentals or an additional CS Depth course. See Fig. 3-4 in the UGHB for approved ENGR fundamentals list. May not be any CS 106)		3-5
*Students who take ENGR 40A or 40M for fewer than 5 units are required to take 1-2 additional units of ENGR Fundamentals (13 units minimum), or 1-2 additional units of Depth.		

Writing in the Major—

		Units
Select one of the following:		
CS 181W	Computers, Ethics, and Public Policy	
CS 191W	Writing Intensive Senior Project	
CS 194W	Software Project	
CS 210B	Software Project Experience with Corporate Partners	
CS 294W	Writing Intensive Research Project in Computer Science	

Computer Science Core (15 units)—

		Units
CS 107	Computer Organization and Systems	5
or CS 107E	Computer Systems from the Ground Up	
CS 110	Principles of Computer Systems	5
CS 161	Design and Analysis of Algorithms	5

Senior Project (3 units)—

		Units
CS 191	Senior Project	
CS 191W	Writing Intensive Senior Project	
CS 194	Software Project	
CS 194H	User Interface Design Project	

CS 194W	Software Project	
CS 210B	Software Project Experience with Corporate Partners	
CS 294	[6]	
or CS 294W	Writing Intensive Research Project in Computer Science	

Computer Science Depth B.S.

Choose one of the following ten CS degree tracks (a track must consist of at least 25 units and 7 classes):

Artificial Intelligence Track—

		Units
CS 221	Artificial Intelligence: Principles and Techniques	4
Select two courses, each from a different area:		
Area I, AI Methods:		
CS 228	Probabilistic Graphical Models: Principles and Techniques	
CS 229	Machine Learning	
CS 234	Reinforcement Learning	
CS 238	Decision Making under Uncertainty	
Area II, Natural Language Processing:		
CS 124	From Languages to Information	
CS 224N	Natural Language Processing with Deep Learning	
CS 224S	Spoken Language Processing	
CS 224U	Natural Language Understanding	
Area III, Vision:		
CS 131	Computer Vision: Foundations and Applications	
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	
CS 231N	Convolutional Neural Networks for Visual Recognition	
Area IV, Robotics:		
CS 223A	Introduction to Robotics	
Select one additional course from the Areas above or from the following:		
AI Methods:		
CS 157	Computational Logic	
CS 205L	Continuous Mathematical Methods with an Emphasis on Machine Learning	
CS 230	Deep Learning	
CS 236	Deep Generative Models	
STATS 315A	Modern Applied Statistics: Learning	
STATS 315B	Modern Applied Statistics: Data Mining	
Vision:		
CS 231B		
CS 231M		
CS 331A		
Comp Bio:		
CS 262		
CS 279	Computational Biology: Structure and Organization of Biomolecules and Cells	
CS 371	Computational Biology in Four Dimensions	
CS 374		
Information and the Web:		
CS 276	Information Retrieval and Web Search	
CS 224W	Analysis of Networks	
Other:		
CS 151	Logic Programming	
CS 227B	General Game Playing	
CS 277		
CS 379	Interdisciplinary Topics	
Robotics and Control:		
CS 327A	Advanced Robotic Manipulation	
CS 329	Topics in Artificial Intelligence (with advisor approval)	
ENGR 205	Introduction to Control Design Techniques	
EE 209		
MS&E 251	Introduction to Stochastic Control with Applications	
MS&E 351	Dynamic Programming and Stochastic Control	
Track Electives: at least three additional courses selected from the Areas and lists above, general CS electives, or the following: [4]		
CS 238	Decision Making under Uncertainty	
CS 257	Logic and Artificial Intelligence	
CS 275	Translational Bioinformatics	
CS 326	Topics in Advanced Robotic Manipulation	
CS 334A	Convex Optimization I	
or EE 364A	Convex Optimization I	
CS 428	Computation and Cognition: The Probabilistic Approach	
EE 278	Introduction to Statistical Signal Processing	
EE 364B	Convex Optimization II	
ECON 286	Game Theory and Economic Applications	
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	
MS&E 352	Decision Analysis II: Professional Decision Analysis	
MS&E 355	Influence Diagrams and Probabilistics Networks	
PHIL 152	Computability and Logic	
PSYCH 204A	Human Neuroimaging Methods	
PSYCH 204B	Computational Neuroimaging	
PSYCH 209	Neural Network Models of Cognition	
STATS 200	Introduction to Statistical Inference	
STATS 202	Data Mining and Analysis	
STATS 205	Introduction to Nonparametric Statistics	

Biocomputation Track—

		Units
The Mathematics, Science, and Engineering Fundamentals requirements are non-standard for this track. See Handbook for Undergraduate Engineering Programs for details.		
Select one of the following:		3-4
CS 221	Artificial Intelligence: Principles and Techniques	
CS 228	Probabilistic Graphical Models: Principles and Techniques	
CS 229	Machine Learning	
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	
Select one of the following:		

CS 262		
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	
CS 273A	The Human Genome Source Code	
CS 274	Representations and Algorithms for Computational Molecular Biology	
CS 275	Translational Bioinformatics	
CS 279	Computational Biology: Structure and Organization of Biomolecules and Cells	
One additional course from the lists above or the following:		3-4
CS 124	From Languages to Information	
CS 145	Data Management and Data Systems	
CS 147	Introduction to Human-Computer Interaction Design	
CS 148	Introduction to Computer Graphics and Imaging	
CS 248	Interactive Computer Graphics	
One course selected from the following:		3-4
CS 108	Object-Oriented Systems Design	3-4
CS 124	From Languages to Information	3-4
CS 131	Computer Vision: Foundations and Applications	3-4
CS 140	Operating Systems and Systems Programming	3-4
or CS 140E	Operating systems design and implementation	
CS 141	Introduction to Computer Sound	3
CS 142	Web Applications	3
CS 143	Compilers	3-4
CS 144	Introduction to Computer Networking	3-4
CS 145	Data Management and Data Systems	3-4
CS 146	Introduction to Game Design and Development	3
CS 147	Introduction to Human-Computer Interaction Design	3-5
CS 148	Introduction to Computer Graphics and Imaging	3-4
CS 149	Parallel Computing	3-4
CS 151	Logic Programming	3
CS 154	Introduction to Automata and Complexity Theory	3-4
CS 155	Computer and Network Security	3
CS 157	Computational Logic	3
or PHIL 151	Metalogic	
CS 164		
CS 166	Data Structures	3-4
CS 167		
CS 168	The Modern Algorithmic Toolbox	3-4
CS 190	Software Design Studio	3
CS 195	Supervised Undergraduate Research (4 units max)	3-4
CS 205L	Continuous Mathematical Methods with an Emphasis on Machine Learning	3
CS 205B		3
CS 210A	Software Project Experience with Corporate Partners	3-4
CS 217	Hardware Accelerators for Machine Learning	3-4
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 223A	Introduction to Robotics	3
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 224S	Spoken Language Processing	2-4
CS 224U	Natural Language Understanding	3-4
CS 224W	Analysis of Networks	3-4
CS 225A	Experimental Robotics	3
CS 227B	General Game Playing	3
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
CS 229T	Statistical Learning Theory	3
CS 230	Deep Learning	3-4
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	3-4
CS 231B		
CS 231M		
CS 231N	Convolutional Neural Networks for Visual Recognition	3-4
CS 232	Digital Image Processing	3
CS 233	Geometric and Topological Data Analysis	3
CS 234	Reinforcement Learning	3
CS 236	Deep Generative Models	3
CS 238	Decision Making under Uncertainty	3-4
CS 240	Advanced Topics in Operating Systems	3
CS 242	Programming Languages	3
CS 243	Program Analysis and Optimizations	3-4
CS 244	Advanced Topics in Networking	3-4
CS 244B	Distributed Systems	3
CS 245	Principles of Data-Intensive Systems	3
CS 246	Mining Massive Data Sets	3-4
CS 247	Human-Computer Interaction Design Studio	3-4
CS 248	Interactive Computer Graphics	3-4
CS 251	Cryptocurrencies and blockchain technologies	3
CS 252	Analysis of Boolean Functions	3
CS 254	Computational Complexity	3
CS 255	Introduction to Cryptography	3
CS 261	Optimization and Algorithmic Paradigms	3
CS 262		
CS 263	Algorithms for Modern Data Models	3
CS 264	Beyond Worst-Case Analysis	3
CS 265	Randomized Algorithms and Probabilistic Analysis	3
CS 266		
CS 267		3
CS 269I	Incentives in Computer Science	3
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	3
CS 272	Introduction to Biomedical Informatics Research Methodology	3-5
CS 273A	The Human Genome Source Code	3
CS 273B	Deep Learning in Genomics and Biomedicine	3
CS 274	Representations and Algorithms for Computational Molecular Biology	3-4
CS 275	Translational Bioinformatics	4

CS 276	Information Retrieval and Web Search	3
CS 278	Social Computing	3
CS 279	Computational Biology: Structure and Organization of Biomolecules and Cells	3
CS 348B	Computer Graphics: Image Synthesis Techniques	3-4
CS 348C	Computer Graphics: Animation and Simulation	3
CS 348K	Visual Computing Systems	3-4
CS 371	Computational Biology in Four Dimensions	3
CS 374		
CME 108	Introduction to Scientific Computing	3
EE 180	Digital Systems Architecture	4
EE 263	Introduction to Linear Dynamical Systems	3
EE 282	Computer Systems Architecture	3
EE 364A	Convex Optimization I	3
BIOE 101	Systems Biology	3
MS&E 152	Introduction to Decision Analysis	3-4
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	3-4
STATS 206	Applied Multivariate Analysis	3
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3
GENE 211	Genomics	3
One course from the following:		3-5
CS 145	Data Management and Data Systems	3-4
CS 147	Introduction to Human-Computer Interaction Design	3-5
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 228	Probabilistic Graphical Models: Principles and Techniques	3-4
CS 229	Machine Learning	3-4
CS 262		
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	3
CS 273A	The Human Genome Source Code	3
CS 273B	Deep Learning in Genomics and Biomedicine	3
CS 274	Representations and Algorithms for Computational Molecular Biology	3-4
CS 275	Translational Bioinformatics	4
CS 279	Computational Biology: Structure and Organization of Biomolecules and Cells	3
CS 371	Computational Biology in Four Dimensions	3
CS 373	Statistical and Machine Learning Methods for Genomics	3
CS 374		
EE 263	Introduction to Linear Dynamical Systems	3
EE 364A	Convex Optimization I	3
MS&E 152	Introduction to Decision Analysis	3-4
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	3-4
STATS 206	Applied Multivariate Analysis	3
STATS 315A	Modern Applied Statistics: Learning	2-3
STATS 315B	Modern Applied Statistics: Data Mining	2-3
GENE 211	Genomics	3
One course selected from the list above or the following:		
CHEMENG 150	Biochemical Engineering	3
CHEMENG 174	Environmental Microbiology I	3
APPPHYS 294	Cellular Biophysics	3
BIO 104	Advance Molecular Biology: Epigenetics and Proteostasis	5
BIO 118		4
BIO 188		
BIO 189		
BIO 214	Advanced Cell Biology	4
BIO 217		
BIO 230	Molecular and Cellular Immunology	4
CHEM 141	The Chemical Principles of Life I	4
CHEM 171	Physical Chemistry I	4
BIOC 218		
BIOC 241	Biological Macromolecules	3-5
One course from the following:		
BIOE 220	Introduction to Imaging and Image-based Human Anatomy	3
CHEMENG 150	Biochemical Engineering	3
CHEMENG 174	Environmental Microbiology I	3
CS 262		
CS 274	Representations and Algorithms for Computational Molecular Biology	3-4
CS 279	Computational Biology: Structure and Organization of Biomolecules and Cells	3
CS 371	Computational Biology in Four Dimensions	3
CS 374		
ME 281	Biomechanics of Movement	3
APPHYS 294		
BIO 104	Advance Molecular Biology: Epigenetics and Proteostasis	5
BIO 112	Human Physiology	4
BIO 118		4
BIO 158	Developmental Neurobiology	4
BIO 183	Theoretical Population Genetics	3
BIO 188		
BIO 189		
BIO 214	Advanced Cell Biology	4
BIO 217		
BIO 230	Molecular and Cellular Immunology	4
CHEM 171	Physical Chemistry I	4
BIOC 218		
BIOC 241	Biological Macromolecules	3-5
DBIO 210	Developmental Biology	4
GENE 211	Genomics	3
SURG 101	Regional Study of Human Structure	5

Computer Engineering Track—

		Units
For this track there is a 10 unit minimum for ENGR Fundamentals and a 29 unit minimum for Depth (for track and elective courses)		
EE 108 & EE 180	Digital System Design and Digital Systems Architecture	6-8
Select two of the following:		8
EE 101A	Circuits I	
EE 101B	Circuits II	
EE 102A	Signal Processing and Linear Systems I	
EE 102B	Signal Processing and Linear Systems II	
Satisfy the requirements of one of the following concentrations:		

1) Digital Systems Concentration		
CS 140	Operating Systems and Systems Programming	
or CS 140E or CS		
EE 109	Digital Systems Design Lab	
EE 271	Introduction to VLSI Systems	
Plus two of the following (6-8 units):		
CS 140	Operating Systems and Systems Programming (if not counted above)	
or CS 140E or CS		
CS 144	Introduction to Computer Networking	
CS 149	Parallel Computing	
CS 190	Software Design Studio	
CS 217	Hardware Accelerators for Machine Learning	
CS 240E		
CS 244	Advanced Topics in Networking	
EE 273	Digital Systems Engineering	
EE 282	Computer Systems Architecture	
2) Robotics and Mechatronics Concentration		
CS 205L	Continuous Mathematical Methods with an Emphasis on Machine Learning	
CS 223A	Introduction to Robotics	
ME 210	Introduction to Mechatronics	
ENGR 105	Feedback Control Design	
Plus one of the following (3-4 units):		
CS 225A	Experimental Robotics	
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	
ENGR 205	Introduction to Control Design Techniques	
ENGR 207B	Linear Control Systems II	
3) Networking Concentration		
CS 140 & CS 144	Operating Systems and Systems Programming and Introduction to Computer Networking (CS 140E can substitute for CS 140)	
Plus three of the following (9-11 units):		
CS 240	Advanced Topics in Operating Systems	
CS 241	Embedded Systems Workshop	
CS 244	Advanced Topics in Networking	
CS 244B	Distributed Systems	
EE 179	Analog and Digital Communication Systems	

Graphics Track—

		Units
CS 148 & CS 248	Introduction to Computer Graphics and Imaging and Interactive Computer Graphics	8
Select one of the following: [5]		3-5
CS 205L	Continuous Mathematical Methods with an Emphasis on Machine Learning	
CME 104	Linear Algebra and Partial Differential Equations for Engineers (Note: students taking CME 104 are also required to take its prerequisite course, CME 102)	
CME 108	Introduction to Scientific Computing	
MATH 52	Integral Calculus of Several Variables	
MATH 113	Linear Algebra and Matrix Theory	
Select two of the following:		6-8
CS 146	Introduction to Game Design and Development	
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	
or CS 131	Computer Vision: Foundations and Applications	
CS 233	Geometric and Topological Data Analysis	
CS 268	Geometric Algorithms	
CS 348A	Computer Graphics: Geometric Modeling & Processing	
CS 348B	Computer Graphics: Image Synthesis Techniques	
CS 348C	Computer Graphics: Animation and Simulation	
CS 348K	Visual Computing Systems	
CS 448	Topics in Computer Graphics	
Track Electives: at least two additional courses from the lists above, the general CS electives list, or the following: [4]		6-8
ARTSTUDI 160	Intro to Digital / Physical Design	
ARTSTUDI 170	Photography I: Black and White	
ARTSTUDI 179	Digital Art I	
CME 302	Numerical Linear Algebra	
CME 306	Numerical Solution of Partial Differential Equations	
EE 168	Introduction to Digital Image Processing	
EE 262	Two-Dimensional Imaging	
EE 264	Digital Signal Processing	
EE 278	Introduction to Statistical Signal Processing	
EE 368	Digital Image Processing	
ME 101	Visual Thinking	
PSYCH 30	Introduction to Perception	
PSYCH 221	Image Systems Engineering	

Human-Computer Interaction Track—

		Units
CS 147	Introduction to Human-Computer Interaction Design	4
CS 247	Human-Computer Interaction Design Studio	4
Any three of the following:		
CS 142	Web Applications	
CS 146	Introduction to Game Design and Development	
CS 148	Introduction to Computer Graphics and Imaging	
CS 194H	User Interface Design Project	
CS 206	Exploring Computational Journalism	
CS 210A	Software Project Experience with Corporate Partners	
CS 278	Social Computing	
CS 376	Human-Computer Interaction Research	
Any CS 377 'Topics in HCI' of three or more units		
CS 448B	Data Visualization	
ME 216M	Introduction to the Design of Smart Products	
At least two additional courses from above list, the general CS electives list, or the following: [4]		3-6
Any d.school class of 3 or more units		

Any class of 3 or more units at hci.stanford.edu under the 'courses' link	
Communication-	
COMM 121	Behavior and Social Media
COMM 124	Lies, Trust, and Tech
or COMM 224	Lies, Trust, and Tech
COMM 140	
or COMM 240	
COMM 154	The Politics of Algorithms
COMM 166	Virtual People
COMM 169	
or COMM 269	
COMM 172	Media Psychology
or COMM 272	Media Psychology
COMM 182	
COMM 254	The Politics of Algorithms
COMM 324	Language and Technology
Art Studio-	
ARTSTUDI 160	Intro to Digital / Physical Design
ARTSTUDI 162	Embodied Interfaces
ARTSTUDI 163	Drawing with Code
ARTSTUDI 164	DESIGN IN PUBLIC SPACES
ARTSTUDI 165	Social Media and Performative Practices
ARTSTUDI 168	Data as Material
ARTSTUDI 264	Advanced Interaction Design
ARTSTUDI 266	Sculptural Screens / Malleable Media
ARTSTUDI 267	Emerging Technology Studio
Sym Sys-	
SYMSYS 245	Cognition in Interaction Design
Psychology-	
PSYCH 30	Introduction to Perception
PSYCH 35	Minds and Machines
PSYCH 45	Introduction to Learning and Memory
PSYCH 50	Introduction to Cognitive Neuroscience
PSYCH 60	Introduction to Developmental Psychology
PSYCH 70	Self and Society: Introduction to Social Psychology
PSYCH 75	Introduction to Cultural Psychology
PSYCH 80	Introduction to Personality and Affective Science
PSYCH 90	Introduction to Clinical Psychology
PSYCH 95	Introduction to Abnormal Psychology
PSYCH 131	
PSYCH 154	Judgment and Decision-Making
Empirical Methods-	
COMM 314	Ethnographic Methods
MS&E 125	Introduction to Applied Statistics
PSYCH 251	Experimental Methods
PSYCH 252	Statistical Methods for Behavioral and Social Sciences
PSYCH 253	High-Dimensional Methods for Behavioral and Neural Data
STATS 203	Introduction to Regression Models and Analysis of Variance
EDUC 191	Introduction to Survey Research
HUMBIO 82A	Qualitative Research Methodology
ME Design-	
ME 101	Visual Thinking
ME 115A	Introduction to Human Values in Design
ME 203	Design and Manufacturing
ME 210	Introduction to Mechatronics
ME 216A	Advanced Product Design: Needfinding
Learning Design + Tech-	
EDUC 236	Beyond Bits and Atoms: Designing Technological Tools
EDUC 281	Technology for Learners
EDUC 239	Educating Young STEM Thinkers
EDUC 338	Innovations in Education
EDUC 342	Child Development and New Technologies
MS&E-	
MS&E 185	Global Work
MS&E 331	
Computer Music-	
MUSIC 220A	Fundamentals of Computer-Generated Sound
MUSIC 220B	Compositional Algorithms, Psychoacoustics, and Computational Music
MUSIC 220C	Research Seminar in Computer-Generated Music
MUSIC 250A	Physical Interaction Design for Music
MUSIC 256A	Music, Computing, Design I: The Art of Design
Optional Elective [4]	

Information Track—

		Units
CS 124	From Languages to Information	4
CS 145	Data Management and Data Systems	4
Two courses, from different areas:		6-9
1) Information-based AI applications		
CS 224N	Natural Language Processing with Deep Learning	
CS 224S	Spoken Language Processing	
CS 229	Machine Learning	
CS 233	Geometric and Topological Data Analysis	
CS 234	Reinforcement Learning	
2) Database and Information Systems		
CS 140	Operating Systems and Systems Programming	
or CS 140E	Operating systems design and implementation	
CS 142	Web Applications	
CS 151	Logic Programming	
CS 245	Principles of Data-Intensive Systems	
CS 246	Mining Massive Data Sets	
CS 341	Project in Mining Massive Data Sets	
CS 345	(Offered occasionally)	
3) Information Systems in Biology		
CS 262		
CS 270	Modeling Biomedical Systems: Ontology, Terminology, Problem Solving	
CS 274	Representations and Algorithms for Computational Molecular Biology	
4) Information Systems on the Web		
CS 224W	Analysis of Networks	
CS 276	Information Retrieval and Web Search	

At least three additional courses from the above areas or the general CS electives list. [4]

Systems Track—

		Units
CS 140	Operating Systems and Systems Programming	4
or CS 140E	Operating systems design and implementation	
Select one of the following:		3-4
CS 143	Compilers	
EE 180	Digital Systems Architecture	
Two additional courses from the list above or the following:		6-8
CS 144	Introduction to Computer Networking	
CS 145	Data Management and Data Systems	
CS 149	Parallel Computing	
CS 155	Computer and Network Security	
CS 190	Software Design Studio	
CS 217	Hardware Accelerators for Machine Learning	
CS 240	Advanced Topics in Operating Systems	
CS 242	Programming Languages	
CS 243	Program Analysis and Optimizations	
CS 244	Advanced Topics in Networking	
CS 245	Principles of Data-Intensive Systems	
EE 271	Introduction to VLSI Systems	
EE 282	Computer Systems Architecture	
Track Electives: at least three additional courses selected from the list above, the general CS electives list, or the following: [4]		9-12
CS 241	Embedded Systems Workshop	
CS 316	Advanced Multi-Core Systems	
CS 341	Project in Mining Massive Data Sets	
CS 343	(Not given this year)	
CS 344	Topics in Computer Networks (3 or more units, any suffix)	
CS 345	(Advanced Topics in Database Systems - 3 or more units, any suffix)	
CS 349	Topics in Programming Systems (with permission of undergraduate advisor)	
CS 448	Topics in Computer Graphics	
EE 108	Digital System Design	
EE 382C	Interconnection Networks	
EE 384A	Internet Routing Protocols and Standards	
EE 384B		
EE 384C	Wireless Local and Wide Area Networks	
EE 384S	Performance Engineering of Computer Systems & Networks	

Theory Track—

		Units
CS 154	Introduction to Automata and Complexity Theory	4
Select one of the following:		3
CS 168	The Modern Algorithmic Toolbox	
CS 255	Introduction to Cryptography	
CS 261	Optimization and Algorithmic Paradigms	
CS 264	Beyond Worst-Case Analysis	
CS 265	Randomized Algorithms and Probabilistic Analysis	
CS 268	Geometric Algorithms	
Two additional courses from the list above or the following:		6-8
CS 143	Compilers	
CS 151	Logic Programming	
CS 155	Computer and Network Security	
CS 157	Computational Logic	
or PHIL 151	Metalogic	
CS 166	Data Structures	
CS 205L	Continuous Mathematical Methods with an Emphasis on Machine Learning	
CS 228	Probabilistic Graphical Models: Principles and Techniques	
CS 233	Geometric and Topological Data Analysis	
CS 236	Deep Generative Models	
CS 242	Programming Languages	
CS 250	Algebraic Error Correcting Codes	
CS 251	Cryptocurrencies and blockchain technologies	
CS 252	Analysis of Boolean Functions	
CS 254	Computational Complexity	
CS 259	(with permission of undergraduate advisor)	
CS 262		
CS 263	Algorithms for Modern Data Models	
CS 266		
CS 267		
CS 269I	Incentives in Computer Science	
CS 352	Pseudo-Randomness	
CS 354	Topics in Intractability: Unfulfilled Algorithmic Fantasies (Not given this year)	
CS 355	Advanced Topics in Cryptography (Not given this year)	
CS 357	(Not given this year)	
CS 358	Topics in Programming Language Theory	
CS 359	Topics in the Theory of Computation (with permission of undergraduate advisor)	
CS 364A		
CS 369	Topics in Analysis of Algorithms (with permission of undergraduate advisor)	
CS 374		
MS&E 310	Linear Programming	
Track Electives: at least three additional courses from the lists above, the general CS electives list, or the following: [4]		9-12
CS 269G	Almost Linear Time Graph Algorithms	
CME 302	Numerical Linear Algebra	
CME 305	Discrete Mathematics and Algorithms	
PHIL 152	Computability and Logic	

Unspecialized Track—

		Units
CS 154	Introduction to Automata and Complexity Theory	4
Select one of the following:		4
CS 140	Operating Systems and Systems Programming	
or CS 140E	Operating systems design and implementation	
CS 143	Compilers	
One additional course from the list above or the following:		3-4
CS 144	Introduction to Computer Networking	

CS 155	Computer and Network Security	
CS 190	Software Design Studio	
CS 242	Programming Languages	
CS 244	Advanced Topics in Networking	
EE 180	Digital Systems Architecture	
Select one of the following:		3-4
CS 221	Artificial Intelligence: Principles and Techniques	
CS 223A	Introduction to Robotics	
CS 228	Probabilistic Graphical Models: Principles and Techniques	
CS 229	Machine Learning	
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	
Select one of the following:		3-4
CS 145	Data Management and Data Systems	
CS 147	Introduction to Human-Computer Interaction Design	
CS 148	Introduction to Computer Graphics and Imaging	
CS 248	Interactive Computer Graphics	
CS 262		
At least two courses from the general CS electives list [4]		

Individually Designed Track—

Students may propose an individually designed track. Proposals should include a minimum of 25 units and seven courses, at least four of which must be CS courses numbered 100 or above. See Handbook for Undergraduate Engineering Programs for further information.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu)

1 MATH 19, MATH 20, and MATH 21 OR MATH 41 and MATH 42 OR AP Calculus Credit may be used as long as at least 26 MATH units are taken. AP Calculus Credit must be approved by the School of Engineering.

2 The math electives list consists of: MATH 51, Math 52, Math 53, MATH 104, MATH 108, MATH 109, MATH 110, MATH 113; CS 157, CS 205L; PHIL 151; CME 100, CME 102, CME 103 (or EE103), CME 104. Restrictions: CS 157 and PHIL 151 may not be used in combination to satisfy the math electives requirement. Students who have taken both MATH 51 and MATH 52 may not count CME 100 as an elective. Courses counted as math electives cannot also count as CS electives, and vice versa.

3 The science elective may be any course of 3 or more units from the School of Engineering Science list (Fig. 4-2 in the UGHB), PSYCH 30, or AP Chemistry Credit. Either of the PHYSICS sequences 61/63 or 21/23 may be substituted for 41/43 as long as at least 11 science units are taken. AP Chemistry Credit and AP Physics Credit must be approved by the School of Engineering.

4 General CS Electives: CS 108,CS 124, CS 131, CS 140 (or CS 140E), CS 141, CS 142, CS 143 CS 144, CS 145, CS 146, CS 147, CS 148, CS 149, CS 154, CS 155, CS 157(or PHIL 151), CS 166, CS 168, CS 190, CS 195 (4 units max), CS 205L, CS 205B, CS 210A, CS 217, CS 223A, CS 224N, CS 224S, CS 224U, CS 224W, CS 225A, CS 227B, CS 228, CS 229, CS 229T, CS 231A, CS 231B, CS 231M, CS 231N, CS 232, CS 233, CS 234, CS 238, CS 240, CS 242, CS 243, CS 244, CS 244B, CS 245, CS 246, CS 247, CS 248, CS 251, CS 252, CS 254, CS 255, CS 261, CS 262, CS 263, CS 264, CS 265, CS 266, CS 267, CS 269I, CS 270, CS 272, CS 273A, CS 273B, CS 274, CS 276, CS 278, CS 279, CS 348B, CS 348C, CS 348K, CS 352, CS 369L; CME 108; EE 180, EE 282, EE 364A.

5 CS 205L is strongly recommended in this list for the Graphics track. Students taking CME 104 Linear Algebra and Partial Differential Equations for Engineers are also required to take its prerequisite, CME 102 Ordinary Differential Equations for Engineers.

6 Independent study projects (CS 191 Senior Project or CS 191W Writing Intensive Senior Project) require faculty sponsorship and must be approved by the adviser, faculty sponsor, and the CS senior project adviser (P. Young). A signed approval form, along with a brief description of the proposed project, should be filed the quarter before work on the project is begun. Further details can be found in the *Handbook for Undergraduate Engineering Programs (UGHB)* (http://ughb.stanford.edu).

7 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Honors Program in Computer Science

The Department of Computer Science (CS) offers an honors program for undergraduates whose academic records and personal initiative indicate that they have the necessary skills to undertake high-quality research in computer science. Admission to the program is by application only. To apply for the honors program, students must be majoring in Computer Science, have a grade point average (GPA) of at least 3.6 in courses that count toward the major, and achieve senior standing (135 or more units) by the end of the academic year in which they apply. Coterminal master's students are eligible to apply as long as they have not already received their undergraduate degree. Beyond these requirements, students who apply for the honors program must find a Computer Science faculty member who agrees to serve as the thesis adviser for the project. Thesis advisers must be members of Stanford's Academic Council.

Students who meet the eligibility requirements and wish to be considered for the honors program must submit a written application to the CS undergraduate program office by May 1 of the year preceding the honors work. The application must include a letter describing the research project, a letter of endorsement from the faculty sponsor, and a transcript of courses taken at Stanford. Each year, a faculty review committee selects the successful candidates for honors from the pool of qualified applicants.

In order to receive departmental honors, students admitted to the honors program must, in addition to satisfying the standard requirements for the undergraduate degree, do the following:

1. Complete at least 9 units of CS 191 or CS 191W under the direction of their project sponsor.
2. Attend a weekly honors seminar Winter and Spring quarters.
3. Complete an honors thesis deemed acceptable by the thesis adviser and at least one additional faculty member.
4. Present the thesis at a public colloquium sponsored by the department.
5. Maintain the 3.6 GPA required for admission to the honors program.

Electrical Engineering (EE)

Completion of the undergraduate program in Electrical Engineering leads to the conferral of the Bachelor of Science in Electrical Engineering.

Mission of the Undergraduate Program in Electrical Engineering

The mission of the undergraduate program of the Department of Electrical Engineering is to augment the liberal education expected of all Stanford undergraduates, to impart basic understanding of electrical engineering and to develop skills in the design and building of systems that directly impact societal needs.

The program includes a balanced foundation in the physical sciences, mathematics and computing; core courses in electronics, information systems and digital systems; and develops specific skills in the analysis and design of systems. Students in the major have broad flexibility to select from disciplinary areas beyond the core, including hardware and software, information systems and science, and physical technology and science, as well as electives in multidisciplinary areas, including bio-electronics and bio-imaging, energy and environment and music.

The program prepares students for a broad range of careers—both industrial and government—as well as for professional and academic graduate education.

Requirements

		Units
Mathematics [1]		
Select one sequence: May also be satisfied with AP Calculus.		10
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	
Select one 2-course sequence:		10
CME 100 & CME 102	Vector Calculus for Engineers and Ordinary Differential Equations for Engineers (Same as ENGR 154 and ENGR 155A)	
MATH 51 & MATH 53	Linear Algebra, Multivariable Calculus, and Modern Applications and Ordinary Differential Equations with Linear Algebra [2]	
EE Math. One additional 100-level course. Select one:		3
EE 103	Introduction to Matrix Methods (Preferred) [1]	
MATH 113	Linear Algebra and Matrix Theory	
CS 103	Mathematical Foundations of Computing	
Statistics/Probability. Select one:		3-4
EE 178	Probabilistic Systems Analysis (Preferred)	
CS 109	Introduction to Probability for Computer Scientists	
Science [1]		
Minimum 12 units		
Select one sequence:		12
PHYSICS 41 & EE 42	Mechanics and Introduction to Electromagnetics and Its Applications [3]	
PHYSICS 41 & PHYSICS 43	Mechanics and Electricity and Magnetism [3]	
PHYSICS 61 & PHYSICS 63	Mechanics and Special Relativity and Electricity, Magnetism, and Waves	
Science elective. One additional 4-5 unit course from approved list in Undergraduate Handbook, Figure 4-2.		4-5
Technology in Society		
One course, see Basic Requirement 4 in the School of Engineering section. The course taken must be on the School of Engineering Approved Courses list, Fig 4-3, the year it is taken.		3-5
Engineering Topics		
Minimum 60 units comprised of: Engineering Fundamentals (minimum 10 units), Core Electrical Engineering Courses (minimum 16 units) Disciplinary Area (minimum 17 units), Electives (maximum 17 units, restrictions apply).		
Engineering Fundamentals		
2 courses required; minimum 10 units		
Select one:		
CS 106B/ENGR 70B	Programming Abstractions	5
or CS 106X/ ENGR 70X	Programming Abstractions (Accelerated)	
Choose one Fundamental from the Approved List; Recommended: ENGR 40A and ENGR 40B or ENGR 40M (recommended before taking EE 101A); taking CS 106A or a second ENGR 40-series course not allowed for the Fundamentals elective. Choose from table in Undergraduate Handbook, Approved List.		5
Core Electrical Engineering Courses		
EE 100	The Electrical Engineering Profession [4]	
EE 101A	Circuits I	
EE 102A	Signal Processing and Linear Systems I	
EE 108	Digital System Design	
Physics of Electrical Engineering.		4
EE 65	Modern Physics for Engineers [5]	
Disciplinary Area		17
Minimum 17 units, 5 courses: 1-2 Required, 1 WIM/Design and 2-3 disciplinary area electives.		
Writing in the Major (WIM)		3-5
Select one. A single course can concurrently meet the WIM and Design Requirements.		
EE 109	Digital Systems Design Lab (WIM/Design)	
EE 133	Analog Communications Design Laboratory (WIM/Design)	
EE 134	Introduction to Photonics (WIM/Design)	
EE 153	Power Electronics (WIM/Design)	
EE 155	Green Electronics (WIM/Design)	
EE 168	Introduction to Digital Image Processing (WIM/Design)	
EE 191W	Special Studies and Reports in Electrical Engineering (WIM; Department approval required) [6]	
EE 264W	Digital Signal Processing (WIM/Design)	
EE 267W	Virtual Reality (WIM/Design)	
CS 194W	Software Project (WIM/Design)	
Design Course		3-5
Select one. Students may select their Design course from any Disciplinary Area.		
EE 109	Digital Systems Design Lab (WIM/Design)	
EE 133	Analog Communications Design Laboratory (WIM/Design)	
EE 134	Introduction to Photonics (WIM/Design)	
EE 153	Power Electronics (WIM/Design)	
EE 155	Green Electronics (WIM/Design)	
EE 168	Introduction to Digital Image Processing (WIM/Design)	
EE 262	Two-Dimensional Imaging (Design)	
EE 264	Digital Signal Processing (Design) [7]	
EE 264W	Digital Signal Processing (WIM/Design)	
EE 267	Virtual Reality (Design) [7]	
EE 267W	Virtual Reality (WIM/Design)	
CS 194	Software Project (Design)	
CS 194W	Software Project (WIM/Design)	
Electives		17

Minimum 17 units. The elective units should be sufficient to meet the 60 unit total for the major, over and above the 40 units of Math and Science. Depending on units completed in the Diciplincary Area, elective units will be in the range of 17 units or less. Students may select electives from the disciplinary areas; from the multidisciplinary elective areas; or any combination of disciplinary and multidisciplinary areas. May include up to two additional Engineering Fundamentals, any CS 193 course and any letter graded EE courses (minus any previously noted restrictions). Freshman and Sophmore seminars, EE 191 and CS 106A do not count toward the 60 units. Students may have fewer elective units if they have more units in their disciplinary area.

[1] Math 41 and Math 42 are no longer offered and have been replaced by MATH 19, MATH 20, and MATH 21. If used for math, EE 103 may not be used as an EE disciplinary elective. PHYSICS 41E may be used in place of PHYSICS 41.

[2] MATH 52 may be taken in place of MATH 51. CME 102 can be taken in place of MATH 53.

[3] EE 42 may be used in place of PHYSICS 43 (if not used in EE electives area). The EE introductory class ENGR 40A and ENGR 40B or ENGR 40M may be taken concurrently with either EE 42 or PHYSICS 43. There are no prerequisites for ENGR 40A and ENGR 40B or ENGR 40M.

[4] For upper division students, a 200-level seminar in their disciplinary area will be accepted, on petition.

[5] Students may petition to have either PHYSICS 65 or the combination of PHYSICS 45 and PHYSICS 70 count as an alternative to EE 65.

[6] EE 191W may satisfy WIM only if it is a follow-up to an REU, independent study project or as part of an honors thesis project where a faculty agrees to provide supervision of writing a technical paper and with suitable support from the Writing Center.

[7] To satisfy Design, must take EE 264 or EE 267 for 4 units and complete the laboratory project.

[8] A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Disciplinary Areas

		Units
Hardware and Software		
EE 103	Introduction to Matrix Methods	3-5
EE 104	Introduction to Machine Learning	3-5
EE 180	Digital Systems Architecture (Required)	4
EE 107	Embedded Networked Systems	3
EE 109	Digital Systems Design Lab (WIM/Design)	4
EE 118	Introduction to Mechatronics	4
EE 155	Green Electronics (Design)	4
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
EE 267	Virtual Reality (Design)	3-4
EE 267W	Virtual Reality (WIM/Design)	5
EE 271	Introduction to VLSI Systems	3
EE 272	Design Projects in VLSI Systems	3-4
EE 273	Digital Systems Engineering	3
EE 282	Computer Systems Architecture	3
EE 285	Embedded Systems Workshop	2
CS 107	Computer Organization and Systems (Required prerequisite for EE 180; CS 107E preferred)	3-5
or CS 107E	Computer Systems from the Ground Up	
CS 108	Object-Oriented Systems Design	3-4
CS 110	Principles of Computer Systems	3-5
CS 131	Computer Vision: Foundations and Applications	3-4
CS 140	Operating Systems and Systems Programming	3-4
CS 143	Compilers	3-4
CS 144	Introduction to Computer Networking	3-4
CS 145	Data Management and Data Systems	3-4
CS 148	Introduction to Computer Graphics and Imaging	3-4
CS 149	Parallel Computing	3-4
CS 155	Computer and Network Security	3
CS 194W	Software Project (WIM/Design)	3
CS 221	Artificial Intelligence: Principles and Techniques	3-4
CS 223A	Introduction to Robotics	3
CS 224N	Natural Language Processing with Deep Learning	3-4
CS 225A	Experimental Robotics	3
CS 229	Machine Learning	3-4
CS 231A	Computer Vision: From 3D Reconstruction to Recognition	3-4
CS 231N	Convolutional Neural Networks for Visual Recognition	3-4
CS 241	Embedded Systems Workshop	2
CS 244	Advanced Topics in Networking	3-4
Information Systems and Science		
EE 102B	Signal Processing and Linear Systems II (Required)	4
EE 103	Introduction to Matrix Methods	3-5
EE 104	Introduction to Machine Learning	3-5
EE 107	Embedded Networked Systems	3
EE 118	Introduction to Mechatronics	4
EE 124	Introduction to Neuroelectrical Engineering	3
EE 133	Analog Communications Design Laboratory (WIM/Design)	3-4
EE 155	Green Electronics (WIM/Design)	4
EE 168	Introduction to Digital Image Processing (WIM/Design)	3-4
EE 169	Introduction to Bioimaging	3
EE 179	Analog and Digital Communication Systems	3
EE 261	The Fourier Transform and Its Applications	3
EE 262	Two-Dimensional Imaging (Design)	3
EE 263	Introduction to Linear Dynamical Systems	3
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
EE 267	Virtual Reality (Design)	3-4
EE 267W	Virtual Reality (WIM/Design)	5
EE 278	Introduction to Statistical Signal Processing	3
EE 279	Introduction to Digital Communication	3
CS 107	Computer Organization and Systems	3-5
CS 229	Machine Learning	3-4
ENGR 105	Feedback Control Design	3
ENGR 205	Introduction to Control Design Techniques	3
Physical Technology and Science		

EE 101B	Circuits II (Required)	4
EE 103	Introduction to Matrix Methods	3-5
EE 107	Embedded Networked Systems	3
EE 114	Fundamentals of Analog Integrated Circuit Design	3-4
EE 116	Semiconductor Devices for Energy and Electronics	3
EE 118	Introduction to Mechatronics	4
EE 124	Introduction to Neuroelectrical Engineering	3
EE 133	Analog Communications Design Laboratory (WIM/Design)	3-4
EE 134	Introduction to Photonics (WIM/Design)	4
EE 142	Engineering Electromagnetics	3
EE 153	Power Electronics (WIM/Design)	3-4
EE 155	Green Electronics (WIM/Design)	4
EE 212	Integrated Circuit Fabrication Processes	3
EE 214B	Advanced Integrated Circuit Design	3
EE 216	Principles and Models of Semiconductor Devices	3
EE 222	Applied Quantum Mechanics I	3
EE 223	Applied Quantum Mechanics II	3
EE 228	Basic Physics for Solid State Electronics	3
EE 236A	Modern Optics	3
EE 236B	Guided Waves	3
EE 242	Electromagnetic Waves	3
EE 247	Introduction to Optical Fiber Communications	3
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
EE 267	Virtual Reality (Design)	3-4
EE 267W	Virtual Reality (WIM/Design)	5
EE 271	Introduction to VLSI Systems	3
EE 272	Design Projects in VLSI Systems	3-4
EE 273	Digital Systems Engineering	3
EE 282	Computer Systems Architecture	3
CS 107	Computer Organization and Systems	3-5
ENGR 105	Feedback Control Design	3

Multidisciplinary Area Electives

Bio-electronics and Bio-imaging		
EE 101B	Circuits II	4
EE 102B	Signal Processing and Linear Systems II	4
EE 107	Embedded Networked Systems	3
EE 124	Introduction to Neuroelectrical Engineering	3
EE 134	Introduction to Photonics (WIM/Design)	4
EE 168	Introduction to Digital Image Processing (WIM/Design)	4
EE 169	Introduction to Bioimaging	3
EE 225	Biochips and Medical Imaging	3
BIOE 248	Neuroengineering Laboratory	3
BIOE 131	Ethics in Bioengineering	3
MED 275B	Biodesign Fundamentals	4
Energy and Environment		
EE 101B	Circuits II	4
EE 103	Introduction to Matrix Methods	3-5
EE 116	Semiconductor Devices for Energy and Electronics	3
EE 134	Introduction to Photonics (WIM/Design)	4
EE 151	Sustainable Energy Systems	3
EE 153	Power Electronics (WIM/Design)	3-4
EE 155	Green Electronics (WIM/Design)	4
EE 168	Introduction to Digital Image Processing (WIM/Design)	3-4
EE 180	Digital Systems Architecture	4
EE 263	Introduction to Linear Dynamical Systems	3
EE 293	Energy storage and conversion: Solar Cells, Fuel Cells, Batteries and Supercapacitors	3-4
EE 293B	Fundamentals of Energy Processes	3
CEE 107A	Understanding Energy (Formerly CEE 173A)	3-5
CEE 155	Introduction to Sensing Networks for CEE	3-4
CEE 176A	Energy Efficient Buildings	3-4
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	3-4
ENGR 105	Feedback Control Design	3
ENGR 205	Introduction to Control Design Techniques	3
MATSCI 142	Quantum Mechanics of Nanoscale Materials (Formerly MATSCI 157)	4
MATSCI 152	Electronic Materials Engineering	4
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	3-4
ME 185	Electric Vehicle Design	3
ME 227	Vehicle Dynamics and Control	3
ME 271E	Aerial Robot Design	4
Music		
EE 102B	Signal Processing and Linear Systems II	4
EE 109	Digital Systems Design Lab (WIM/Design)	4
EE 264	Digital Signal Processing (Design)	3-4
EE 264W	Digital Signal Processing (WIM/Design)	5
MUSIC 250A	Physical Interaction Design for Music	3-4
MUSIC 256A	Music, Computing, Design I: The Art of Design	3-4
MUSIC 256B	Music, Computing, Design II: Virtual and Augmented Reality for Music	3-4
MUSIC 257	Neuroplasticity and Musical Gaming	3-5
MUSIC 320	Introduction to Audio Signal Processing	2-4
MUSIC 420A	Signal Processing Models in Musical Acoustics [1]	3-4
MUSIC 421A	Time-Frequency Audio Signal Processing [1]	3-4
MUSIC 422	Perceptual Audio Coding [1]	3
MUSIC 424	Signal Processing Techniques for Digital Audio Effects [1]	3-4

1 Best taken as a coterm student.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Honors Program in Electrical Engineering

The Department of Electrical Engineering offers a program leading to a Bachelor of Science in Electrical Engineering with Honors. This program offers a unique opportunity for qualified undergraduate majors to conduct independent study and research at an advanced level with a faculty mentor, graduate students, and fellow undergraduates.

Admission to the honors program is by application. Declared EE majors with a grade point average (GPA) of at least 3.5 in Electrical Engineering are eligible to submit an application. Applications must be submitted by Autumn quarter of the senior year, be signed by the thesis adviser and second reader (one must be a member of the EE Faculty), and include an honors proposal. Students need to declare honors on Axess.

In order to receive departmental honors, students admitted to the honors program must:

1. Submit an application, including the thesis proposal, by autumn quarter of senior year signed by the thesis advisor and second reader (one must be a member of the Electrical Engineering faculty).
2. Declare the EE Honors major in Axess before the end of autumn quarter of senior year.
3. Maintain a grade point average of at least 3.5 in Electrical Engineering courses.
4. Complete at least 10 units of EE 191 or EE 191W with thesis advisor for a letter grade. EE 191 units do not count toward the required 60 units, with the exception of EE 191W if approved to satisfy WIM.
5. Submit one final copy of the honors thesis approved by the advisor and second reader to the EE Degree Progress Officer by May 15.
6. Attend poster and oral presentation held at the end of spring quarter or present in another suitable forum approved by the faculty adviser.

Engineering Physics (EPHYS)

Completion of the undergraduate program in Engineering Physics leads to the conferral of the Bachelor of Science in Engineering. The subplan "Engineering Physics" appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Engineering Physics

The mission of the undergraduate program in Engineering Physics is to provide students with a strong foundation in physics and mathematics, together with engineering and problem-solving skills. All majors take high-level math and physics courses as well as engineering courses. This background prepares them to tackle complex problems in multidisciplinary areas that are at the forefront of 21st-century technology such as aerospace physics, biophysics, computational science, quantum science & engineering, materials science, nanotechnology, electromechanical systems, energy systems, renewable energy, and any other engineering field that requires a solid background in physics. Because the program emphasizes science, mathematics, and engineering, students are well prepared to pursue graduate work in engineering, physics, or applied physics.

Requirements

		Units
Mathematics		
Select one of the following sequences:		10
MATH 51 & MATH 52	Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables	
CME 100 & CME 104	Vector Calculus for Engineers and Linear Algebra and Partial Differential Equations for Engineers	
MATH 53	Ordinary Differential Equations with Linear Algebra	5
or CME 102	Ordinary Differential Equations for Engineers	
MATH 131P	Partial Differential Equations (or CME 204 or MATH 173 or MATH 220 or PHYSICS 111)	3
Science		
PHYSICS 41	Mechanics (or PHYSICS 61)	4
PHYSICS 42	Classical Mechanics Laboratory (or PHYSICS 62)	1
PHYSICS 43	Electricity and Magnetism (or PHYSICS 63)	4
PHYSICS 67	Introduction to Laboratory Physics [1]	2
PHYSICS 45	Light and Heat (or PHYSICS 65)	4
PHYSICS 46	Light and Heat Laboratory (or PHYSICS 67)	1
PHYSICS 70	Foundations of Modern Physics (if taking the 40 series)	4
Technology in Society		
One course required; course must be on the School of Engineering Approved List, Fig 4-3 in the UGHB, the year it is taken. See Basic Requirement 4.		3-5
Engineering Fundamentals		
Two courses minimum (CS 106A or X recommended) [2]		6-10
Engineering Physics Depth (core)		
Advanced Mathematics:		
One advanced math elective such as		3-5
EE 261	The Fourier Transform and Its Applications	
PHYSICS 112	Mathematical Methods for Physics	
CS 109	Introduction to Probability for Computer Scientists	
CME 106	Introduction to Probability and Statistics for Engineers	
Also qualified are EE 263, any Math or Statistics course numbered 100 or above, and any CME course numbered 200 or above, except CME 206.		
Advanced Mechanics:		3-4
AA 242A	Classical Dynamics (or ME 333 or PHYSICS 110)	3
Intermediate Electricity and Magnetism		6-8
Select one of the following sequences:		
PHYSICS 120 & PHYSICS 121	Intermediate Electricity and Magnetism I and Intermediate Electricity and Magnetism II	
EE 142 & EE 242	Engineering Electromagnetics and Electromagnetic Waves	
Numerical Methods		
Select one of the following:		3-4
APPPHYS 215	Numerical Methods for Physicists and Engineers	
CME 108	Introduction to Scientific Computing	
CME 206/ ME 300C	Introduction to Numerical Methods for Engineering	
PHYSICS 113	Computational Physics	
Electronics Lab		
Select one of the following:		3-5
ENGR 40A & ENGR 40B	Introductory Electronics and Introductory Electronics Part II (ENGR 40A alone is not allowed)	
EE 101B	Circuits II	
EE 122A		
PHYSICS 105	Intermediate Physics Laboratory I: Analog Electronics	
APPPHYS 207	Laboratory Electronics	
Writing in the Major (WIM)		
Select one of the following:		4-5
AA 190	Directed Research and Writing in Aero/Astro (for Aerospace specialty only)	
ENGR 199W	Writing of Original Research for Engineers (for students pursuing an independent research project)	
BIOE 131	Ethics in Bioengineering (for Biophysics specialty only)	
CS 181W	Computers, Ethics, and Public Policy (for Computational Science specialty only)	

EE 134	Introduction to Photonics (for Photonics specialty only)	
EE 155	Green Electronics (for Renewable Energy specialty only)	
ME 112	Mechanical Systems Design (for Electromechanical System Design specialty only)	
ME 131A & ME 140	Heat Transfer and Advanced Thermal Systems (for Energy Systems specialty only)	
MATSCI 161	Energy Materials Laboratory (Okay for Materials Science and Renewable Energy specialties)	
MATSCI 164	Electronic and Photonic Materials and Devices Laboratory (Okay for Materials Science and Renewable Energy specialties)	
PHYSICS 107	Intermediate Physics Laboratory II: Experimental Techniques and Data Analysis (for Photonics or other specialty)	
Quantum Mechanics		
Select one of the following sequences:		6-8
EE 222 & EE 223	Applied Quantum Mechanics I and Applied Quantum Mechanics II	
PHYSICS 130 & PHYSICS 131	Quantum Mechanics I and Quantum Mechanics II	
Thermodynamics and Statistical Mechanics		
PHYSICS 170 & PHYSICS 171	Thermodynamics, Kinetic Theory, and Statistical Mechanics I and Thermodynamics, Kinetic Theory, and Statistical Mechanics II	3-8
or ME 346A	Introduction to Statistical Mechanics	
Design Course		
Select one of the following:		3-4
AA 236A	Spacecraft Design	
CS 108	Object-Oriented Systems Design	
EE 133	Analog Communications Design Laboratory	
ME 203	Design and Manufacturing	
ME 210	Introduction to Mechatronics	
PHYSICS 108	Advanced Physics Laboratory: Project	
Specialty Tracks		
See Undergraduate Engineering Handbook for important details. Select three courses from one specialty area:		9-12
Aerospace Physics:		
AA 203	Optimal and Learning-based Control	
AA 244A	Introduction to Plasma Physics and Engineering	
AA 251	Introduction to the Space Environment	
AA 279A	Space Mechanics	
ME 161	Dynamic Systems, Vibrations and Control	
Materials Science:		
Any MATSCI courses numbered 151 to 199 (except 159Q) or PHYSICS 172		
Electromechanical System Design:		
ME 80	Mechanics of Materials	
ME 112	Mechanical Systems Design	
ME 210	Introduction to Mechatronics	
or EE 118	Introduction to Mechatronics	
Energy Systems:		
ME 131A	Heat Transfer	
ME 131B	Fluid Mechanics: Compressible Flow and Turbomachinery	
ME 140	Advanced Thermal Systems	
Renewable Energy:		
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	
EE 153	Power Electronics	
EE 155	Green Electronics	
EE 293A		
EE 293B	Fundamentals of Energy Processes	
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	
MATSCI 302	Solar Cells	
MATSCI 316	Nanoscale Science, Engineering, and Technology	
ME 260	Fuel Cell Science and Technology	
Biophysics:		
APPPHYS 205	Introduction to Biophysics	
BIO 132	Advanced Imaging Lab in Biophysics	
BIOE 41		
BIOE 42	Physical Biology	
BIOE 44	Fundamentals for Engineering Biology Lab	
BIOE 101	Systems Biology	
BIOE 103	Systems Physiology and Design	
BIOE 123	Biomedical System Prototyping Lab	
BIOE 211	Biophysics of Multi-cellular Systems and Amorphous Computing	
BIOE 214	Representations and Algorithms for Computational Molecular Biology	
EE 169	Introduction to Bioimaging	
or EE 369A	Medical Imaging Systems I	
Computational Science:		
CME 212	Advanced Software Development for Scientists and Engineers	
CME 215A	Advanced Computational Fluid Dynamics	
CME 215B	Advanced Computational Fluid Dynamics	
Any CME course with course number greater than 300 and less than 390		
CS 103	Mathematical Foundations of Computing	
CS 154	Introduction to Automata and Complexity Theory	
CS 161	Design and Analysis of Algorithms	
CS 205A		
CS 205B		
CS 221	Artificial Intelligence: Principles and Techniques	
CS 228	Probabilistic Graphical Models: Principles and Techniques	
CS 229	Machine Learning	
STATS 202	Data Mining and Analysis	
STATS 213	Introduction to Graphical Models	
Quantum Science & Engineering		
APPPHYS 203	Atoms, Fields and Photons	
APPPHYS 225	Probability and Quantum Mechanics	
APPPHYS 383		
CS 254	Computational Complexity	
EE 234	Photonics Laboratory	
EE 236C	Lasers	

EE 243	Semiconductor Optoelectronic Devices	
EE 340	Optical Micro- and Nano-Cavities	
PHYSICS 134	Advanced Topics in Quantum Mechanics	
PHYSICS 230	Graduate Quantum Mechanics I	
PHYSICS 231	Graduate Quantum Mechanics II	
PHYSICS 282	Introduction to Modern Atomic Physics and Quantum Optics	
Total Units		93-119

1 PHYSICS 67 Introduction to Laboratory Physics (2 units), recommended in place of PHYSICS 44 Electricity and Magnetism Lab

2 The Engineering Fundamental courses are to be selected from the Basic Requirements 3 list. Fundamentals courses acceptable for the core program may also be used to satisfy the fundamentals requirement as long as 45 unduplicated units of Engineering are taken.

3 Although not required, PHYSICS 59 (https://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&catalog=&academicYear=&q=physics59&collapse=) (Frontiers in Physics Research, 1 unit) and PHYSICS 91SI (https://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&catalog=&academicYear=&q=physics91si&collapse=) (Practical Computing for Scientists, 2 units) are highly recommended.

4 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Honors Program

The School of Engineering offers a program leading to a Bachelor of Science in Engineering: Engineering Physics with Honors.

Honors Criteria

1. Minimum overall GPA of 3.5.
2. Independent research conducted at an advanced level with a faculty research adviser and documented in an honors thesis. The honors candidate must identify a faculty member who will serve as his or her honors research adviser and a second reader who will be asked to read the thesis and give feedback before endorsing the thesis. One of the two must be a member of the Academic Council and in the School of Engineering.

Application: The deadline to apply is October 15 in Autumn Quarter of the senior year. The application documents should be submitted to the Student Services Officer. Applications are reviewed by a subcommittee of the faculty advisers for Engineering Physics majors. Applicants and thesis advisers receive written notification when the application is approved. An application consists of three items:

1. One-page description of the research topic
2. Application form (http://www.stanford.edu/group/ughb/2011-12/2012-13/EPhysHonorsReq_App_2012.doc) signed by the honors thesis adviser
3. Unofficial Stanford transcript

Requirements and Timeline for Honors in Engineering Physics:

1. Declare the honors program in Axess (ENGR-BSH, Subplan: Engineering Physics)
2. Obtain application form from the student services officer.
3. Apply to honors program by October 15 in the Autumn Quarter of the senior year.
4. Maintain an overall GPA of at least 3.5.
5. Optional: Under direction of the thesis adviser, students may enroll for research units in ENGR 199(W) or in departmental courses such as AA 190 or ME 191(H).
6. Submit a completed thesis draft to the research adviser and second reader by April 15.
7. Present the thesis work in an oral presentation or poster session in an appropriate forum (e.g., an event that showcases undergraduate research and is organized by the department of the adviser, the school of the adviser, or the University).
8. Incorporate feedback, which the adviser and second reader should provide by April 30, and obtain final endorsement signatures from the thesis adviser and second reader by May 15.
9. Submit one signed, single-sided copy to the student services officer by May 15. Students are sent email instructions on how to archive a permanent electronic copy in Terman Engineering library.

Environmental Systems Engineering (EnvSE)

Completion of the undergraduate program in Environmental Systems Engineering leads to the conferral of the Bachelor of Science in Environmental Systems Engineering.

Mission of the Undergraduate Program in Environmental Systems Engineering

The mission of the undergraduate program in Environmental Systems Engineering is to prepare students for incorporating environmentally sustainable design, strategies and practices into natural and built systems and infrastructure involving buildings, water supply, and coastal regions. Courses in the program are multidisciplinary in nature, combining math/science/engineering fundamentals, and tools and skills considered essential for an engineer, along with a choice of one of three focus areas for more in-depth study: coastal environments, freshwater environments, or urban environments. This major offers the opportunity for a more focused curriculum than the Environmental and Water Studies concentration in the Civil Engineering degree program. The program of study, which includes a capstone experience, aims to equip engineering students to take on the complex challenges of the twenty-first century involving natural and built environments, in consulting and industry as well as in graduate school.

Requirements

Mathematics and Science		
See Basic Requirement 1 and 2 [1]		36
Technology in Society (TiS)		
One 3-5 unit course required, course chosen must be on the SoE Approved Courses list at <ughb.stanford.edu> the year taken; see Basic Requirement 4		3-5
Engineering Fundamentals		
Two courses minimum (see Basic Requirement 3), including:		
ENGR 70A	Programming Methodology	5
(or ENGR 70X)		
ENGR 14	Intro to Solid Mechanics	3
Fundamental Tools/Skills [2]		9
in visual, oral/written communication, and modeling/analysis		
Specialty Courses, in either		40
Coastal environments (see below)		
or freshwater environments (see below)		

or urban environments (see below)		
Total Units		96-98

1 Math must include CME 100 Vector Calculus for Engineers (or MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications), and either a Probability/Statistics course or CME 102 Ordinary Differential Equations for Engineers (or MATH 53 Ordinary Differential Equations with Linear Algebra). Science must include PHYSICS 41 Mechanics; and either CHEM 31B Chemical Principles II or CHEM 31X Chemical Principles Accelerated (or PHYSICS 43 Electricity and Magnetism, for Urban focus area only).

2 Fundamental tools/skills must include:

1. CEE 1 Introduction to Environmental Systems Engineering ;
2. at least one visual communication class from CEE 31 Accessing Architecture Through Drawing / CEE 31Q Accessing Architecture Through Drawing, CEE 133H Drawing in the Urban Environment, ME 101 Visual Thinking, ME 110 Design Sketching, ARTSTUDI 160 Intro to Digital / Physical Design, or OSPPARIS 44 EAP: Analytical Drawing and Graphic Art;
3. at least one oral/written communication class from ENGR 103 Public Speaking, ENGR 102W Technical and Professional Communication, ENGR 202W Technical Communication, CEE 151 Negotiation, CEE 175P , EARTHSYS 191 Concepts in Environmental Communication or EARTHSYS 200 Environmental Communication in Action: The SAGE Project;
4. at least one modeling/analysis class from CEE 101D Computations in Civil and Environmental Engineering(or CEE 101S) if not counted as Math, CEE 120A Building Information Modeling Workshop (or CEE 120S Building Information Modeling Special Study), CEE 146S Engineering Economics and Sustainability, CEE 155 Introduction to Sensing Networks for CEE, CEE 226 Life Cycle Assessment for Complex Systems,CEE 228 Methods in Urban Systems, CME 211 Software Development for Scientists and Engineers, CS 102 Big Data - Tools and Techniques, EARTHSYS 142 Remote Sensing of Land, EARTHSYS 144 Fundamentals of Geographic Information Science (GIS), ENGR 150 Data Challenge Lab, ESS 214 Introduction to geostatistics and modeling of spatial uncertainty, or OSPCPTWN 13 Technological Risks (Win 18-19 only)

3 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Urban Environments Focus Area (37 units)

Required		
CEE 100	Managing Sustainable Building Projects	4
CEE 101B	Mechanics of Fluids	4
CEE 146S	Engineering Economics and Sustainability	3
CEE 176A	Energy Efficient Buildings	3-4
Electives (at least two of the 4 areas below must be included)		
Building Systems		
CEE 102	Legal and Ethical Principles in Design, Construction, and Project Delivery	3
CEE 120B	Building Information Modeling Workshop	2-4
CEE 130	Architectural Design: 3-D Modeling, Methodology, and Process	5
CEE 156	Building Systems	4
Energy Systems		
CEE 107A	Understanding Energy	4-5
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	3-4
ENERGY 104	Sustainable Energy for 9 Billion	3
CEE 173S	Electricity Economics	3
or		
ENERGY 171	Energy Infrastructure, Technology and Economics	3
Water Systems		
CEE 165C	Water Resources Management	3
or		
OSPSANTG 76	Urban Water (Spr 18-19 only)	4
CEE 166A	Watersheds and Wetlands	4
CEE 166B	Floods and Droughts, Dams and Aqueducts	4
CEE 174A	Providing Safe Water for the Developing and Developed World	3
CEE 174B	Wastewater Treatment: From Disposal to Resource Recovery	3
Urban Planning, Design, Analysis		
CEE 6	Physics of Cities	3
CEE 230	Urban Development and Governance	3
or		
CEE 265E	Adaptation to Sea Level Rise and Extreme Weather Events	3
or		
EARTHSYS 238	Land Use Law	3
CEE 177L	Smart Cities & Communities	3
URBANST 113	Introduction to Urban Design: Contemporary Urban Design in Theory and Practice	5
or		
URBANST 164	Sustainable Cities	4-5
or		
URBANST 165	Sustainable Urban and Regional Transportation Planning	4-5
or		
URBANST 174	Defining Smart Cities: Visions of Urbanism for the 21st Century	3-4
Capstone (one class required)		
CEE 112A	Industry Applications of Virtual Design & Construction	3-4
CEE 122A	Computer Integrated Architecture/ Engineering/Construction	2
and		
CEE 122B	Computer Integrated A/E/C	2
CEE 131D	Urban Design Studio	5
CEE 141A	Infrastructure Project Development	3
CEE 141B	Infrastructure Project Delivery	3
CEE 224X	Sustainable Urban Systems Fundamentals	3-5
CEE 224Y	Sustainable Urban Systems Project	3-5
CEE 224Z	Sustainable Urban Systems Project	3-5
CEE 226E	Advanced Topics in Integrated, Energy-Efficient Building Design	3
CEE 235		5
CEE 243	Intro to Urban Sys Engrg	3
CEE 199	Undergraduate Research in Civil and Environmental Engineering	3-4

Freshwater Environments Focus Area (37 units)

Required		
CEE 70	Environmental Science and Technology	3
CEE 101B	Mechanics of Fluids	4
CEE 177	Aquatic Chemistry and Biology	4
CEE 166A	Watersheds and Wetlands	4
or		
CEE 174A	Providing Safe Water for the Developing and Developed World	3
Electives		
CEE 162E	Rivers, Streams, and Canals	3

CEE 165C	Water Resources Management	3
CEE 166A	Watersheds and Wetlands (if not counted as a req'd course)	4
CEE 166B	Floods and Droughts, Dams and Aqueducts	4
CEE 166D		2
CEE 230	Urban Development and Governance	3
or		
EARTHSYS 238	Land Use Law	3
or		
CEE 273B	The Business of Water	2
CEE 174A	Providing Safe Water for the Developing and Developed World	3
CEE 174B	Wastewater Treatment: From Disposal to Resource Recovery	3
CEE 179A	Water Chemistry Laboratory	3
CEE 265A	Sustainable Water Resources Development (offered occasionally)	3
CEE 265D	Water and Sanitation in Developing Countries	3
BIOHOPK 150H	Ecological Mechanics	3
ESS 224	Remote Sensing of Hydrology	3
OSPAUSTL 25	Freshwater Systems	3
OSPSANTG 76	Urban Water (Spr 18-19 only)	4
Capstone (1 class required)		
CEE 141A	Infrastructure Project Development	3
CEE 179C	Environmental Engineering Design	5
CEE 224X	Sustainable Urban Systems Fundamentals	1-5
CEE 224Y	Sustainable Urban Systems Project	3-5
CEE 224Z	Sustainable Urban Systems Project	3-5
CEE 235		5
CEE 199	Undergraduate Research in Civil and Environmental Engineering	3-4

Coastal Environments Focus Area (37 units)

Required		
CEE 70	Environmental Science and Technology	3
CEE 101B	Mechanics of Fluids	4
CEE 162F	Coastal Processes	3
CEE 175A	California Coast: Science, Policy, and Law	3-4
or		
CEE 162I	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation	3
Electives		
CEE 162I	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation	3
CEE 166A	Watersheds and Wetlands	4
CEE 166B	Floods and Droughts, Dams and Aqueducts	4
CEE 230	Urban Development and Governance	3
or		
EARTHSYS 238	Land Use Law	3
CEE 174A	Providing Safe Water for the Developing and Developed World	3
CEE 174B	Wastewater Treatment: From Disposal to Resource Recovery	3
CEE 175A	California Coast: Science, Policy, and Law	3-4
CEE 177	Aquatic Chemistry and Biology	4
CEE 230	Urban Development and Governance	3
CEE 265E	Adaptation to Sea Level Rise and Extreme Weather Events	3
CEE 272	Coastal Contaminants	3-4
BIOHOPK 150H	Ecological Mechanics	3
BIOHOPK 163H	Oceanic Biology	4
BIO 30	Ecology for Everyone	4
or		
BIO 81	Introduction to Ecology	4
or		
BIOHOPK 81	Introduction to Ecology	4
or		
BIOHOPK 172H	Marine Ecology: From Organisms to Ecosystems	5
or		
EARTHSYS 116	Ecology of the Hawaiian Islands	4
or		
OSPAUSTL 10	Coral Reef Ecosystems	3
ESS 8	The Oceans: An Introduction to the Marine Environment	4
or		
BIOHOPK 182H	Stanford at Sea (Oceanography portion)	4 (only 4 units allowed to count)
EARTHSYS 141	Remote Sensing of the Oceans	3-4
EARTHSYS 151	Biological Oceanography	3-4
to be taken concurrently with		
EARTHSYS 152	Marine Chemistry	3-4
OSPSANTG 76	Urban Water (Spr 18-19 only)	4
Capstone (1 class required)		
CEE 126	International Urbanization Seminar: Cross-Cultural Collaboration for Sustainable Urban Development	4-5
CEE 141A	Infrastructure Project Development	3
CEE 179C	Environmental Engineering Design	5
CEE 224X	Sustainable Urban Systems Fundamentals	3-5
CEE 224Y	Sustainable Urban Systems Project	3-5
CEE 224Z	Sustainable Urban Systems Project	3-5
CEE 235		5
CEE 199	Undergraduate Research in Civil and Environmental Engineering	3-4

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Individually Designed Majors in Engineering (IDMENS)

Completion of the undergraduate program in Individually Designed Majors in Engineering (IDMEN) leads to the conferral of the Bachelor of Science in an Individually Designed Major: (approved title). The approved title of the IDMEN also appears on the transcript.

Mission of the Undergraduate Program in Individually Designed Majors in Engineering

The mission of the undergraduate program in Individually Designed Majors in Engineering (IDMEN) is to provide students with an understanding of engineering principles and the analytical and problem solving, design, and communication skills necessary to be successful in the field. The B.S. for IDMENs is intended for undergraduates interested in pursuing engineering programs that, by virtue of their focus and intellectual content, cannot be accommodated by existing departmental majors or the pre-approved School of Engineering majors. Core courses in the curriculum include engineering fundamentals, mathematics, technology in society, and the sciences. Students then take additional courses pertinent to their IDMEN major. The program prepares students for careers in government and the corporate sector, and for graduate study.

B.S. in Individually Designed Majors in Engineering

The B.S. degree for IDMENs is intended for undergraduates interested in pursuing engineering programs that, by virtue of their focus and intellectual content, cannot be accommodated by existing departmental majors or the pre-approved School of Engineering majors. IDMEN curricula are designed by students with the assistance of two faculty advisers of their choice and are submitted to the Undergraduate Council's Subcommittee on Individually Designed Majors. The degree conferred is "Bachelor of Science in Individually Designed Major in Engineering: (approved title)."

Students must submit written proposals to the IDMEN subcommittee detailing their course of study. Programs must meet the following requirements: mathematics (21 units minimum, see Basic Requirement 1 in right sidebar); science (17 units minimum, see Basic Requirement 2); a Technology in Society (one course from School of Engineering Approved Courses list; the course must be on the list the year it is taken; see Basic Requirement 4); at least two Engineering Fundamentals courses, see Basic Requirement 3 for a list of courses; a minimum of 34 units of engineering depth courses, including a capstone depth course with content relevant to proposed goals; and sufficient relevant additional course work to bring the total number of units to at least 90 and at most 107. Introductory Seminar courses (IntroSems) may not count toward the major. Students may take additional courses pertinent to their IDMEN major, but the IDMEN proposal itself may not exceed 107 units. Students are responsible for completing the prerequisites for all courses included in their majors.

Each proposal should begin with a statement describing the proposed major. In the statement, the student should make clear the motivation for and goal of the major, and indicate how it relates to her or his projected career plans. The statement should specify how the courses to be taken relate to and move the student toward realizing the major's goal. A proposed title for the major should be included. The title approved by the IDMEN Subcommittee is listed on the student's official University transcript and on the diploma in this form: "Individually Designed Major in Subplan", where "Subplan" is the title approved by the IDMEN Subcommittee.

The proposal statement should be followed by a completed Program Sheet listing all the courses comprising the student's IDMEN curriculum, organized by the five categories printed on the sheet (mathematics, science, technology in society, engineering fundamentals, and engineering depth). Normally, the courses selected should comprise a well-coordinated sequence or sequences that provide mastery of important principles and techniques in a well-defined field. In some circumstances, especially if the proposal indicates that the goal of the major is to prepare the student for graduate work outside of engineering, a more general engineering program may be appropriate. A four-year study plan, showing courses to be taken each quarter, should also be included in the student's IDMEN proposal.

The proposal must be signed by two faculty members who certify that they endorse the major as described in the proposal and that they agree to serve as the student's permanent advisers. One of the faculty members, who must be a member of the School of Engineering and of the Academic Council, acts as the student's primary adviser. The proposal must be accompanied by a statement from that person giving an appraisal of the academic value and viability of the proposed major.

Students proposing IDMENs must have at least four quarters of undergraduate work remaining at Stanford after the quarter in which their proposals are first submitted. Any changes in a previously approved major must be endorsed by the advisers and re-approved by the IDMEN subcommittee. A request by a student to make changes in her or his approved curriculum must be made sufficiently far in advance so that, should the request be denied, adequate time remains to complete the original, approved curriculum. Proposals are reviewed and acted upon once a quarter. Planning forms may be obtained from the Handbook for Undergraduate Engineering Programs at http://ughb.stanford.edu. Completed proposals should be submitted to Darlene Lazar in the Office of Student Affairs, Huang Engineering Center, Suite 135. An IDMEN cannot be a student's secondary major.

Honors in Individually Designed Major in Engineering

Qualified IDMEN students may pursue a Bachelor's degree with Honors (IDMEN-BSH) following the general guidelines outlined below, and consulting with advisers to set a topic and any further parameters regarding directed reading or research, special honors seminars, and the format of the honors work. The honors thesis, and any course work associated with the honors degree, is above and beyond the scope of the major itself and cannot be counted as part of the basic IDMEN-BS requirements.

1. The student must submit a letter applying for the honors option endorsed by the student' primary adviser and honors adviser; the letter should be submitted to the Office of Student Affairs in 135 Huang no later than mid-October of the senior year.
2. The IDMEN honors adviser may require course work beyond what is required for the BS without honors.
3. The student must maintain a GPA of at least 3.5.
4. The student must complete an honors thesis or project. The manner of evaluating the work will be set by the honors adviser and a second reader, one of whom must be a member of the Academic Council in the School of Engineering. The deadline to submit the thesis or project will be decided by the honors or program adviser but should be set by mid-May at latest.
5. The student must present the work in an appropriate forum, e.g., in the same session as honors theses are presented in the department of the adviser.
6. A copy of the signed (approved) thesis or project must be submitted to the Office of Student Affairs by the end of the second week of May.

Management Science and Engineering (MS&E)

Completion of the undergraduate program in Management Science and Engineering leads to the conferral of the Bachelor of Science in Management Science and Engineering.

Requirements

		Units
Mathematics and Science		
All required; see SoE Basic Requirements 1 and 2 [1]		23
CME 100	Vector Calculus for Engineers	
or MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
CME 103	Introduction to Matrix Methods	
MS&E 120	Probabilistic Analysis	
MS&E 121	Introduction to Stochastic Modeling	
MS&E 125	Introduction to Applied Statistics	
Select two of the following options:		8-10
CHEM 31B	Chemical Principles II	
or CHEM 31X	Chemical Principles Accelerated	

CHEM 33	Structure and Reactivity of Organic Molecules	
PHYSICS 41	Mechanics	
or PHYSICS 21	Mechanics, Fluids, and Heat	
PHYSICS 43	Electricity and Magnetism	
or PHYSICS 23	Electricity, Magnetism, and Optics	
BIO 81	Introduction to Ecology	
BIO 82	Genetics	
BIO 83	Biochemistry & Molecular Biology	
BIO 84	Physiology	
BIO 85	Evolution	
BIO 86	Cell Biology	
Math, Science, or Statistics Elective from SoE approved lists. [1]		3
Up to ten units of AP/IB Calculus, MATH 19, 20, 21, 41, or 42.		10
Technology in Society		
Select one of the following; see SoE Basic Requirement 4		3-5
AA 252	Techniques of Failure Analysis	
COMM 120W	Digital Media in Society	
BIOE 131	Ethics in Bioengineering	
CS 181	Computers, Ethics, and Public Policy	
ENGR 117	Expanding Engineering Limits: Culture, Diversity, and Equity	
ENGR 131	Ethical Issues in Engineering [4]	
ME 267	Ethics and Equity in Transportation Systems	
MS&E 193	Technology and National Security [4]	
POLISCI 114S	International Security in a Changing World	
STS 1	The Public Life of Science and Technology	
Engineering Fundamentals [2]		
Two courses; see SoE Basic Requirement 3		8-10
CS 106A	Programming Methodology [3]	
Select one of the following:		
ENGR 10	Introduction to Engineering Analysis	
ENGR 14	Intro to Solid Mechanics	
ENGR 15	Dynamics	
ENGR 20	Introduction to Chemical Engineering	
ENGR 21	Engineering of Systems	
ENGR 25B	Biotechnology	
ENGR 25E	Energy: Chemical Transformations for Production, Storage, and Use	
ENGR 40A	Introductory Electronics	
ENGR 40M	An Intro to Making: What is EE	
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis	
ENGR 50E	Introduction to Materials Science, Energy Emphasis	
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis	
ENGR 80	Introduction to Bioengineering (Engineering Living Matter)	
ENGR 90	Environmental Science and Technology	
Engineering Depth [2]		
Core Courses (all six required)		25-27
CS 106B	Programming Abstractions [4]	
or CS 106X	Programming Abstractions (Accelerated)	
ECON 50	Economic Analysis I	
MS&E 108	Senior Project (WIM)	
MS&E 111	Introduction to Optimization [4]	
or MS&E 111X	Introduction to Optimization (Accelerated)	
MS&E 140	Accounting for Managers and Entrepreneurs	
or MS&E 140X	Financial Accounting Concepts and Analysis	
MS&E 180	Organizations: Theory and Management	
Area Courses (see below)		27
Choose four or five courses (minimum 15 units) from a primary area and two courses (minimum 6 units) from each of the other two areas.		

Depth Areas

		Units
Finance and Decision Area		6-15
Students choosing F&D as their primary area must take at least two of ECON 51, MS&E 145 (or 245A), and MS&E 152 (or 252), as part of their 15 units		
Introductory (no prerequisites)		
MS&E 147	Finance and Society for non-MBAs	
MS&E 152	Introduction to Decision Analysis	
Intermediate (has prerequisites and/or appropriate for juniors and seniors)		
MS&E 145	Introduction to Investment Science	
MS&E 146	Corporate Financial Management	
MS&E 252	Decision Analysis I: Foundations of Decision Analysis	
Advanced (intended primarily for graduate students, but may be taken by advanced undergraduates)		
MS&E 245A	Investment Science	
MS&E 245B	Advanced Investment Science	
MS&E 246	Financial Risk Analytics	
MS&E 250A	Engineering Risk Analysis	
MS&E 250B	Project Course in Engineering Risk Analysis	
Operations and Analytics Area		6-15
Students choosing O&A as their primary area may also include CS 161, CS 229, and STATS 202 in their selections [4]		
Methods		
MS&E 112	Mathematical Programming and Combinatorial Optimization	
MS&E 135	Networks	
MS&E 213	Introduction to Optimization Theory	
MS&E 223	Simulation	
MS&E 226	"Small" Data: Prediction, Inference, Causality	
MS&E 231	Introduction to Computational Social Science	
MS&E 251	Introduction to Stochastic Control with Applications	
Applications		
MS&E 130	Information Networks and Services	
MS&E 234	Data Privacy and Ethics	
MS&E 235	Network Analytics	
MS&E 260	Introduction to Operations Management	
MS&E 263	Healthcare Operations Management	
MS&E 267	Service Operations and the Design of Marketplaces	
MS&E 330	Law, Bias, & Algorithms	
Organizations, Technology, and Policy Area		6-15
Students choosing OT&P as their primary area must take at least two of ENGR 145, MS&E 175, MS&E 182, MS&E 184, and MS&E 185 as part of their 15 units		

Introductory (no prerequisites)		
ENGR 131	Ethical Issues in Engineering [4]	
MS&E 190	Methods and Models for Policy and Strategy Analysis	
MS&E 193	Technology and National Security [4]	
Advanced (has prerequisites and/or appropriate for juniors and seniors)		
ENGR 145	Technology Entrepreneurship	
MS&E 175	Innovation, Creativity, and Change	
or MS&E 177	Creativity Rules	
MS&E 182	Leading Organizational Change	
MS&E 183		
MS&E 184	Future of Work: Issues in Organizational Learning and Design	
MS&E 185	Global Work	
MS&E 188	Organizing for Good	
MS&E 243	Energy and Environmental Policy Analysis	
MS&E 292	Health Policy Modeling	
MS&E 294		
MS&E 295		

1. Math and Science must total a minimum of 44 units. Electives must come from the School of Engineering approved list or PSYCH 50 Introduction to Cognitive Neuroscience, and may not repeat material from any other requirement. AP/IB credit for Chemistry and Physics may be used.
2. Engineering fundamentals plus engineering depth must total a minimum of 60 units. Recommended engineering fundamentals are E25B, E25E, E40A, E40M, and E80.
3. Students may petition to place out of CS 106A Programming Methodology.
4. A course may only be counted towards one requirement; it may not be double-counted. For example, MS&E 193 may not count towards both TiS and towards the OTP depth area, and MS&E 111/ENGR 62 may not count towards both an engineering fundamental and towards the MS&E core depth.
5. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

Materials Science and Engineering (MSE/ MATSCI)

Completion of the undergraduate program in Materials Science and Engineering leads to the conferral of the Bachelor of Science in Materials Science and Engineering.

Mission of the Undergraduate Program in Materials Science and Engineering

The mission of the undergraduate program in Materials Science and Engineering is to provide students with a strong foundation in materials science and engineering with emphasis on the fundamental scientific and engineering principles which underlie the knowledge and implementation of material structure, processing, properties, and performance of all classes of materials used in engineering systems. Courses in the program develop students' knowledge of modern materials science and engineering, teach them to apply this knowledge analytically to create effective and novel solutions to practical problems, and develop their communication skills and ability to work collaboratively. The program prepares students for careers in industry and for further study in graduate school.

The B.S. in Materials Science and Engineering provides training for the materials engineer and also preparatory training for graduate work in materials science. Capable undergraduates are encouraged to take at least one year of graduate study to extend their course work through the coterminal degree program which leads to an M.S. in Materials Science and Engineering. Coterminal degree programs are encouraged both for undergraduate majors in Materials Science and Engineering and for undergraduate majors in related disciplines.

Requirements

		Units
Mathematics		
20 units minimum		
Select one of the following:		5
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
CME 100/ ENGR 154	Vector Calculus for Engineers	
Select one of the following:		5
MATH 52	Integral Calculus of Several Variables	
CME 104/ ENGR 155B	Linear Algebra and Partial Differential Equations for Engineers	
Select one of the following:		5
MATH 53	Ordinary Differential Equations with Linear Algebra	
CME 102/ ENGR 155A	Ordinary Differential Equations for Engineers	
One additional course [1]		5
Science		
20 units minimum		
Must include a full year (15 units) of calculus-based physics or chemistry, with one quarter of study (5 units) in the other subject. [2]		20
Technology in Society		
One course minimum [3]		3-5
Engineering Fundamentals		
Two courses minimum		
Select one of the following:		4
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis [4]	
ENGR 50E	Introduction to Materials Science, Energy Emphasis [4]	
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis [4]	
At least one additional courses [4]		3-5
Department Requirements: MSE Fundamentals, Depth & Focus Areas		
Materials Science Fundamentals: All of the following courses:		16
MATSCI 142	Quantum Mechanics of Nanoscale Materials	
MATSCI 143	Materials Structure and Characterization	
MATSCI 144	Thermodynamic Evaluation of Green Energy Technologies	
MATSCI 145	Kinetics of Materials Synthesis	
Two of the following courses:		8
MATSCI 151	Microstructure and Mechanical Properties	
MATSCI 152	Electronic Materials Engineering	

MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	
MATSCI 158	Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life	
MATSCI 190	Organic and Biological Materials	
MATSCI 192	Materials Chemistry	
MATSCI 193	Atomic Arrangements in Solids	
MATSCI 194	Thermodynamics and Phase Equilibria	
MATSCI 195	Waves and Diffraction in Solids	
MATSCI 196	Defects in Crystalline Solids	
MATSCI 197	Rate Processes in Materials	
MATSCI 198	Mechanical Properties of Materials	
MATSCI 199	Electronic and Optical Properties of Solids	
Materials Science & Engineering Depth		16
Four laboratory courses for Sixteen units; Four units must be WIM		
MATSCI 161	Energy Materials Laboratory (WIM)	
MATSCI 164	Electronic and Photonic Materials and Devices Laboratory (WIM)	
MATSCI 160	Nanomaterials Laboratory	
MATSCI 162	X-Ray Diffraction Laboratory	
MATSCI 163	Mechanical Behavior Laboratory	
MATSCI 165	Nanoscale Materials Physics Computation Laboratory	
Focus Area Options [5, 6]		13
Total Units		103-107

1. See a list of approved math courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses). AP/IB Credit (https://ughb.stanford.edu/petitions/ap-credit) may also be used to meet the 20 units minimum, but cannot replace the three required courses.
2. See a list of approved science courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses). AP/IB Credit (https://ughb.stanford.edu/petitions/ap-credit)may also be used to meet the 20 units minimum in some cases; see the AP chart in the Bulletin or check with the School of Engineering in 135 Huang Engineering Center.
3. See a list of approved Technology in Society courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses). Course chosen must be on the approved list the year taken.
4. See a list of approved Engineering Fundamentals Courses at ughb.stanford.edu (https://ughb.stanford.edu/courses-and-planning/approved-courses). If two of ENGR 50, ENGR 50E or ENGR 50M are taken, one may be used for the Engineering Fundamentals requirement and the other for the Materials Science Fundamentals requirement.
5. Focus Area Options: 13 units from one of the following Focus Area Options below. If the focus area contains only 12 units, but the combined unit total in major (SoE Fundamentals, MSE Fundamentals, MSE Depth and the Focus Area) is at 60 or more, it will be allowed and no petition is necessary.
6. The self-defined focus area option requires additional approval; program deviation forms for this option can be found on the MSE website (https://mse.stanford.edu/student-resources/forms/undergraduate).
7. A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

Focus Area Options (Four courses for a minimum of 13 units; select from one of the ten Focus Areas.)

Bioengineering	
BIOE 80	Introduction to Bioengineering (Engineering Living Matter)
BIOE 220	Introduction to Imaging and Image-based Human Anatomy
BIOE 260	Tissue Engineering
BIOE 281	Biomechanics of Movement
BIOE 381	Orthopaedic Bioengineering
MATSCI 158	Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life
MATSCI 190	Organic and Biological Materials
MATSCI 380	Nano-Biotechnology
MATSCI 381	Biomaterials in Regenerative Medicine
MATSCI 382	Biochips and Medical Imaging
Chemical Engineering	
CHEM 171	Physical Chemistry I
CHEMENG 130	Separation Processes
CHEMENG 140	Micro and Nanoscale Fabrication Engineering
CHEMENG 150	Biochemical Engineering
MATSCI 158	Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life
Chemistry	
CHEM 151	Inorganic Chemistry I
CHEM 153	Inorganic Chemistry II
CHEM 171	Physical Chemistry I
CHEM 173	Physical Chemistry II
CHEM 175	Physical Chemistry III
CHEM 181	Biochemistry I
CHEM 183	Biochemistry II
CHEM 185	Biophysical Chemistry
Electronics & Photonics	
EE 101A	Circuits I
EE 101B	Circuits II
EE 102A	Signal Processing and Linear Systems I
EE 102B	Signal Processing and Linear Systems II
EE 116	Semiconductor Devices for Energy and Electronics
EE 134	Introduction to Photonics
EE 142	Engineering Electromagnetics (Formerly EE 141)
EE 155	Green Electronics
ME 210	Introduction to Mechatronics
MATSCI 343	Organic Semiconductors for Electronics and Photonics
MATSCI 346	Nanophotonics
Energy Technology	
EE 293B	Fundamentals of Energy Processes
EE 155	Green Electronics
CEE 107A	Understanding Energy
EE 293B	Fundamentals of Energy Processes
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution
MATSCI 302	Solar Cells
MATSCI 303	Principles, Materials and Devices of Batteries

ME 260	Fuel Cell Science and Technology
ME 262	Physics of Wind Energy
Materials Characterization Techniques	
MATSCI 320	Nanocharacterization of Materials
MATSCI 321	Transmission Electron Microscopy
MATSCI 322	Transmission Electron Microscopy Laboratory
MATSCI 323	Thin Film and Interface Microanalysis
MATSCI 326	X-Ray Science and Techniques
CHEMENG 345	Fundamentals and Applications of Spectroscopy
BIO 232	Advanced Imaging Lab in Biophysics
APPPHYS 201	Electrons and Photons (PHOTON 201)
Mechanical Behavior & Design	
AA 240	Analysis of Structures
AA 256	Mechanics of Composites
MATSCI 198	Mechanical Properties of Materials
MATSCI 241	Mechanical Behavior of Nanomaterials
MATSCI 358	Fracture and Fatigue of Materials and Thin Film Structures
ME 80	Mechanics of Materials
or CEE 101A	Mechanics of Materials
ME 203	Design and Manufacturing
Nanoscience	
ENGR 240	Introduction to Micro and Nano Electromechanical Systems
MATSCI 241	Mechanical Behavior of Nanomaterials
MATSCI 316	Nanoscale Science, Engineering, and Technology
MATSCI 320	Nanocharacterization of Materials
MATSCI 346	Nanophotonics
MATSCI 347	Magnetic materials in nanotechnology, sensing, and energy
MATSCI 380	Nano-Biotechnology
Physics	
PHYSICS 70	Foundations of Modern Physics
PHYSICS 110	Advanced Mechanics
PHYSICS 120	Intermediate Electricity and Magnetism I
PHYSICS 121	Intermediate Electricity and Magnetism II
PHYSICS 130	Quantum Mechanics I
PHYSICS 131	Quantum Mechanics II
PHYSICS 134	Advanced Topics in Quantum Mechanics
PHYSICS 170	Thermodynamics, Kinetic Theory, and Statistical Mechanics I
PHYSICS 171	Thermodynamics, Kinetic Theory, and Statistical Mechanics II
PHYSICS 172	Solid State Physics
Self-Defined Option	
Petition for a self-defined cohesive program. [7]	

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (http://ughb.stanford.edu).

Honors Program

The Materials Science and Engineering honors program offers an opportunity for undergraduate Materials Science and Engineering majors with a GPA of 3.5 or higher to pursue independent research at an advanced level, supported by a faculty advisor and graduate student mentors. The main requirements are as follows:

1. Application to the honors program (must be pre-approved by faculty advisor)
2. Enrollment in MATSCI 150 and participation in an independent research project over three sequential full quarters
3. Completion of a faculty-approved thesis
4. Participation in either the yearly Materials Science and Engineering Research Symposium OR an alternate, approved public oral/poster presentation

Since this requires three full quarters of research in addition to a final written thesis and presentation following completion of the work, students must apply to the program no less than four quarters prior to their planned graduation date. Materials Science and Engineering majors pursuing a typical four-year graduation timeline should meet with student services no later than the Winter quarter of their junior year to receive information on the application process.

All requirements for the honors program are in addition to the normal undergraduate program requirements.

To apply to the MATSCI Honors program:

- Have an overall GPA of 3.5 or higher (as calculated on the unofficial transcript) prior to application.
- Seek out a MATSCI faculty advisor and agree on a proposed research topic. Primary honors advisor must be a member of the School of Engineering academic council.
- Compose a brief (less than 1 page) summary of proposed research, including a proposed title, and submit along with unofficial transcript and signed faculty endorsement.
- Submit application at least four quarters prior to planned graduation.

To complete the MATSCI Honors program:

- Overall GPA of 3.5 or higher (as calculated on the unofficial transcript) at graduation
- Complete at least three quarters of research with a minimum of 9 units of MATSCI 150 for a letter grade (students may petition out of unit requirement with faculty advisor approval). All quarters must focus on the same topic. Maintain the same faculty advisor throughout, if possible.
- Present either a poster or oral presentation of thesis work in the Materials Science and Engineering Research Symposium held during Spring Quarter or, at the faculty advisor's discretion, in a comparable public event.
- Submit final drafts of an Honors Thesis to Dr. Ryan Brock and to the faculty advisor at least one quarter prior to graduation. Both must approve the thesis by completing a Signature Page and returning it to student services.
- Submit to MATSCI student services one copy of the honors thesis in electronic form at the same time as the final hard copy. Submit one copy of the thesis, with the signature page indicating approval of both readers (primary advisor and Dr. Brock), to the School of Engineering's Office of Student Affairs in 135 Huang.

Mechanical Engineering (ME)

Completion of the undergraduate program in Mechanical Engineering leads to the conferral of the Bachelor of Science in Mechanical Engineering.

Mission of the Undergraduate Program in Mechanical Engineering

The mission of the undergraduate program in Mechanical Engineering is to provide students with a balance of theoretical and practical experiences that enable them to address a variety of societal needs. The curriculum encompasses elements from a wide range of disciplines built around the themes of biomedicine, computational engineering, design, energy, and multiscale engineering. Course work may include mechatronics, computational simulation, solid and fluid dynamics, microelectromechanical systems, biomechanical engineering, energy science and technology, propulsion, sensing and control, nano- and micro- mechanics, and design. The program prepares students for entry-level work as mechanical engineers and for graduate studies in either an engineering discipline or other fields where a broad engineering background is useful.

Core Requirements

		Units
Mathematics		
24 units minimum; see Basic Requirement 1 [1]		
CME 102/ENGR 155A	Ordinary Differential Equations for Engineers	5
or MATH 53	Ordinary Differential Equations with Linear Algebra	
Select one of the following:		3-5
CME 106/ ENGR 155C	Introduction to Probability and Statistics for Engineers	
STATS 110	Statistical Methods in Engineering and the Physical Sciences	
STATS 116	Theory of Probability	
Plus additional courses to total min. 24		
Science		
20 units minimum; see Basic Requirement 2 [1]		
CHEM 31X	Chemical Principles Accelerated	5
Plus addtional required courses [1]		
Technology in Society		
One course required; TIS courses should be selected from AA 252, BIOE 131, CS 181, ENGR 131 or ME 267		3-5
Engineering Fundamentals		
Two courses minimum; see Basic Requirement 3		
ENGR 14	Intro to Solid Mechanics	3
ENGR 70A	Programming Methodology (same as CS 106A)	5
Engineering Core		
Minimum of 68 Engineering Science and Design ABET units; see Basic Requirement 5		
ME 1	Introduction to Mechanical Engineering	3
ENGR 15	Dynamics	3
ME 80	Mechanics of Materials	3
ME 30	Engineering Thermodynamics	3
ME 70	Introductory Fluids Engineering	3
ME 131A	Heat Transfer	3
ME 102	Foundations of Product Realization	3
ME 103	Product Realization: Design and Making	3
ME 112	Mechanical Systems Design [2]	3
ME 123	Computational Engineering	4
ME 170A	Mechanical Engineering Design- Integrating Context with Engineering [3]	4
ME 170B	Mechanical Engineering Design: Integrating Context with Engineering [3]	4

Core Concentrations and Concentration Electives

In addition to completing core requirements, students must choose one of the concentrations paths below. In addition to their concentration specific 3-courses, students select 2-3 additional courses such that the combination adds up to a minimum of 18 units. One of these additional courses must be from technical electives associated with the student's selected concentration. The other 1-2 courses could come from either technical electives from the student's selected concentration or any other concentration and its associated technical electives.

		Units
Dynamic Systems and Controls Concentration		
ME 161	Dynamic Systems, Vibrations and Control	3
ENGR 105	Feedback Control Design	3
Pick one of:		
ME 227	Vehicle Dynamics and Control	3
ME 327	Design and Control of Haptic Systems	3
Dynamic Systems and Controls Electives		
ME 171E	Aerial Robot Design	4
ENGR 205	Introduction to Control Design Techniques	3
ME 210	Introduction to Mechatronics	4
ME 220	Introduction to Sensors	3-4
ME 331A	Advanced Dynamics & Computation	3
ME 485	Modeling and Simulation of Human Movement	3
Pick one, if not used in concentration already:		
ME 227	Vehicle Dynamics and Control	3
ME 327	Design and Control of Haptic Systems	3

		Units
Materials and Structures Concentration		
ME 149	Mechanical Measurements	3
ME 151	Introduction to Computational Mechanics	3
ME 152	Material Behaviors and Failure Prediction	3
Materials and Structures Electives		
ME 234	Introduction to Neuromechanics	3
ME 241	Mechanical Behavior of Nanomaterials	3
ME 281	Biomechanics of Movement	3
ME 283	Introduction to Biomechanics and Mechanobiology	3
ME 287	Mechanics of Biological Tissues	4
ME 331A	Advanced Dynamics & Computation	3
ME 335A	Finite Element Analysis	3
ME 338	Continuum Mechanics	3
ME 339	Introduction to parallel computing using MPI, openMP, and CUDA	3
ME 345	Fatigue Design and Analysis	3
ME 348	Experimental Stress Analysis	3

		Units
Product Realization Concentration		
ME 127	Design for Additive Manufacturing	3
ME 128	Computer-Aided Product Realization	3
ME 129	(offered AY 19-20)	
Product Realization Electives		
ENGR 110	Perspectives in Assistive Technology (ENGR 110)	3
ENGR 240	Introduction to Micro and Nano Electromechanical Systems	3

ME 181	Deliverables: A Mechanical Engineering Design Practicum	3
CME 106	Introduction to Probability and Statistics for Engineers	4
ME 210	Introduction to Mechatronics	4
ME 263	The Chair	3-4
or ME 298	Silversmithing and Design	
ME 309	Finite Element Analysis in Mechanical Design	3
ME 324	Precision Engineering	4

		Units
Thermo, Fluids, and Heat Transfer Concentration		
ME 132	Intermediate Thermodynamics	4
ME 133	Intermediate Fluid Mechanics	3
ME 149	Mechanical Measurements	3
Thermo, Fluids, and Heat Transfer Electives		
ME 250	Internal Combustion Engines	1-5
ME 257	Gas-Turbine Design Analysis	3
ME 351A	Fluid Mechanics	3
ME 351B	Fluid Mechanics	3
ME 352A	Radiative Heat Transfer	3
ME 352B	Fundamentals of Heat Conduction	3
ME 352C	Convective Heat Transfer	3
ME 362A	Physical Gas Dynamics	3
ME 370A	Energy Systems I: Thermodynamics	3
ME 370B	Energy Systems II: Modeling and Advanced Concepts	4
ME 371	Combustion Fundamentals	3
AA 283	Aircraft and Rocket Propulsion	3

1 Math and science must total 45 units.
- Math: 24 units required and must include a course in differential equations (CME 102 Ordinary Differential Equations for Engineers or MATH 53 Ordinary Differential Equations with Linear Algebra; one of these required) and calculus-based Statistics (CME 106 Introduction to Probability and Statistics for Engineers or STATS 110 Statistical Methods in Engineering and the Physical Sciences or STATS 116 is required.
- Science: 20 units minimum and requires courses in calculus-based Physics and Chemistry, with at least a full year (3 courses) in one or the other. CHEM 31A Chemical Principles I/CHEM 31B Chemical Principles II are considered one course because they cover the same material as CHEM 31X Chemical Principles Accelerated but at a slower pace. CHEM 31X Chemical Principles Accelerated is recommended.

2 ME 112 fulfills the WIM requirement.

3 ME 170A and ME 170B are a two quarter Capstone Design Sequence and must be taken in consecutive quarters.

4 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

5 ME 129 will be offered Winter Quarter of AY 2019-20. Product realization students should take one of their concentration electives, or ME 219, in AY 2018-19.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

BSME 1.0 Student Notes

Those students (primarily juniors and seniors) who are completing BSME 1.0 from prior years should refer to bulletins from the academic year that corresponds with their program sheet.

The following exception will be made for BSME 1.0 students in the AY 2018-19 year:

- ME 131B or ME 133 may be taken to fulfill that course requirement

Honors Program in Mechanical Engineering

The Department of Mechanical Engineering offers a program leading to a B.S. in Mechanical Engineering with honors. This program offers a unique opportunity for qualified undergraduate engineering majors to conduct independent study and research at an advanced level with a faculty mentor.

Mechanical Engineering majors who have a grade point average (GPA) of 3.5 or higher in the major may apply for the honors program. Students who meet the eligibility requirement and wish to be considered for the honors program must submit a written application to the Mechanical Engineering student services office no later than the second week of Autumn Quarter in the senior year. The application to enter the program can be obtained from the ME student services office, and must contain a one-page statement describing the research topic and include an unofficial Stanford transcript. In addition, the application must be approved by a Mechanical Engineering faculty member who agrees to serve as the thesis adviser for the project. Thesis advisers must be members of Stanford's Academic Council.

In order to receive departmental honors, students admitted to the program must:

1. Maintain the 3.5 GPA required for admission to the honors program.
2. Submit a completed thesis draft to the adviser by the 3rd week of the quarter the they intend to confer. Further revisions and final endorsement by the adviser are to be finished by week 6, when two bound copies are to be submitted to the Mechanical Engineering student services office.
3. Present the thesis at the Mechanical Engineering Poster Session held in mid-April. If the poster session is not offered or the student does not confer in the spring, an alternative presentation will be approved on a case by case basis with advisor and UGCC chair approval.

Note: Students may not use work completed towards an honors degree to satisfy the B.S. in ME course requirements.

Product Design (PD)

Completion of the undergraduate program in Product Design leads to the conferral of the Bachelor of Science in Engineering. The subplan Product Design appears on the transcript and on the diploma.

Mission of the Undergraduate Program in Product Design

The mission of the undergraduate program in Product Design is to graduate designers who can synthesize technology, human factors, and business factors in the service of human need. The program teaches a design process that encourages creativity, craftsmanship, aesthetics, and personal expression, and emphasizes brainstorming and need finding. The course work provides students with the skills necessary to carry projects from initial concept to completion of working prototypes. Students studying product design follow the basic Mechanical Engineering curriculum and are expected to meet the University requirements for a Bachelor of Science degree. The program prepares students for careers in industry and for graduate study.

Requirements

	Units
Mathematics and Science	36 units minimum

Mathematics [1,2]		20 units minimum
Recommended: one course in Statistics [1]		
Science [2]		16 units minimum
16 units minimum : Minimum of 9 units of SoE approved science and 8 units of Behavioral Science [2,3]		
PHYSICS 41	Mechanics	4-5
or PHYSICS 41E	Mechanics, Concepts, Calculations, and Context	
PSYCH 1	Introduction to Psychology	5
PSYCH or HUMBIO elective [1]		3-5
Technology in Society		3-5 units
One course required; must be on the SoE approved TiS courses list at <ughb.stanford.edu> the year it is taken..		
Engineering Fundamentals		8 units minimum
ENGR 70A	Programming Methodology	5
ENGR 40M	An Intro to Making: What is EE	3-5
or ENGR 40A	Introductory Electronics	
Product Design Engineering Depth		54 units minimum
Two Art Studio or Computer Science courses, 100 series or higher		8
ENGR 14	Intro to Solid Mechanics	3
ME 80	Mechanics of Materials	3
ME 101	Visual Thinking	4
ME 102	Foundations of Product Realization	3
ME 103	Product Realization: Design and Making	3
ME 110	Design Sketching	2
ME 112	Mechanical Systems Design [4]	3
ME 115A	Introduction to Human Values in Design	3
ME 115B	Product Design Methods	4
ME 120	History and Philosophy of Design	3
ME 215C	Analytical Product Design [5]	4
ME 216A	Advanced Product Design: Needfinding	4
ME 216B	Advanced Product Design: Implementation 1 [6]	4
ME 216C	Advanced Product Design: Implementation 2 [6]	4

1. Math requirements can be met with the Math 19-21 series, the MATH 50's series, and/or the CME 100 series; STATS 60 is recommended
2. AP units can be applied; have these approved by SoE Dean's Office before final quarter.
3. School of Engineering approved science list available at http://ughb.stanford.edu. PSYCH electives numbered 30-200 or HUMBIO 82A or HUMBIO 160 are pre-approved.
4. ME 112 meets the Writing in the Major (WIM) requirement for Product Design.
5. ME 215C is the only course that can be waived if a student takes a quarter overseas or at one of the BOSP campuses in New York or Washington DC. Students should plan their overseas quarter to take place in sophomore year, or Spring Quarter of the junior year only. If the student elects to go overseas junior year, the total depth units are reduced by 4; this is approved without petition.
6. You may substitute ME 216B and ME 216C with ME 206A and ME 206B Design for Extreme Affordability.

A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Topics (Engineering Fundamentals and Depth courses) is 2.0.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

The joint major program (JMP), was authorized by the Academic Senate for a pilot period of six years beginning in 2014-15, permitting students to major in both Computer Science and one of 14 Humanities majors. Based upon continuing assessment, including feedback from students and faculty, the pilot will be discontinued at the end of the academic year 2018-19.

All students with declared joint majors will be permitted to complete their degree; faculty and departments are committed to providing the necessary advising support. Students wishing to declare a joint major may do so until June 18, 2019. After that date, no new joint major declarations will be approved.

See the "Joint Major Program (http://exploredegrees.stanford.edu/undergraduatedegreesandprograms/#jointmajortext)" section of this bulletin for a description of University requirements for the JMP. See also the Undergraduate Advising and Research JMP (https://majors.stanford.edu/more-ways-explore/joint-majors-csx) web site and its associated FAQs.

Students completing the JMP receive a B.A.S. (Bachelor of Arts and Science).

Mission

The Joint Major provides a unique opportunity to gain mastery in two disciplines: Computer Science and a selected humanities field. Unlike the double major or dual major, the Joint Major emphasizes integration of the two fields through a cohesive, transdisciplinary course of study and integrated capstone experience. The Joint Major not only blends the intellectual traditions of two Stanford departments-it does so in a way that reduces the total unit requirement for each major.

Computer Science Major Requirements in the Joint Major Program

(See the respective humanities department Joint Major Program section of this bulletin for details on humanities major requirements.)

The CS requirements for the Joint Major follow the CS requirements for the CS-BS degree with the following exceptions:

1. Two of the depth electives are waived. The waived depth electives are listed below for each CS track.
2. The Senior Project is fulfilled with a joint capstone project. The student enrolls in CS191 or 191W (3 units) during the senior year. Depending on the X department, enrollment in an additional Humanities capstone course may also be required. But, at a minimum, 3 units of CS191 or 191W must be completed.
3. There is no double-counting of units between majors. If a course is required for both the CS and Humanities majors, the student will work with one of the departments to identify an additional course - one which will benefit the academic plan - to apply to that major's total units requirement.
4. For CS, WIM can be satisfied with CS181W or CS191W.

Depth Electives for CS Tracks for students completing a Joint Major:

Artificial Intelligence Track:

One Track Elective (rather than three).

Biocomputation Track:

One course from Note 3 of the Department Program Sheet, plus one course from Note 4 of the Program Sheet..

Computer Engineering Track:

- EE 108A and 108B
- One of the following: EE 101A, 101B, 102A, 102B
- Satisfy the requirements of one of the following concentrations:

1. Digital Systems Concentration: CS 140 or 143; EE 109, 271; plus one of CS 140 or 143 (if not counted above), 144, 149, 240E, 244: EE 273, 282
2. Robotics and Mechatronics Concentration: CS 205A, 223A; ME 210; ENGR 105
3. Networking Concentration: CS 140, 144; plus two of the following, CS 240, 240E, 244, 244B, 244E, 249A, 249B, EE 179, EE 276

Graphics Track:

No Track Electives required (rather than two)

HCI Track:

No Interdisciplinary HCI Electives required

Information Track:

One Track Elective (rather than three)

Systems Track:

One Track Elective (rather than three)

Theory Track:

One Track Elective (rather than three)

Unspecialized Track:

No Track Electives required (rather than two)

Individually Designed Track:

Proposals should include a minimum of five (rather than seven) courses, at least four of which must be CS courses numbered 100 or above.

Declaring a Joint Major Program

To declare the joint major, students must first declare each major through Axess, and then submit the Declaration or Change of Undergraduate Major, Minor, Honors, or Degree Program. (https://stanford.box.com/change-UG-program) The Major-Minor and Multiple Major Course Approval Form (https://stanford.box.com/MajMin-MultMaj) is required for graduation for students with a joint major.

Dropping a Joint Major Program

To drop the joint major, students must submit the Declaration or Change of Undergraduate Major, Minor, Honors, or Degree Program (https://stanford.box.com/change-UG-program). Students may also consult the Student Services Center (http://studentservicescenter.stanford.edu) with questions concerning dropping the joint major.

Transcript and Diploma

Students completing a joint major graduate with a B.A.S. degree. The two majors are identified on one diploma separated by a hyphen. There will be a notation indicating that the student has completed a "Joint Major." The two majors are identified on the transcript with a notation indicating that the student has completed a "Joint Major."

See the "Undergraduate Majors and Minors (http://exploredegrees.stanford.edu/soe-ug-majors)" menu item on the left side of this page for program-by-program descriptions of minor requirements. All programs are listed below to facilitate export as a pdf; use the Print option in the right hand menu of this page to create such a pdf for all the tabs in the School of Engineering.

Minor in the School of Engineering

An undergraduate minors in some Engineering programs may be pursued by interested students; see the Handbook for Undergraduate Engineering Programs, or consult with a department's undergraduate program representative or the Office of Student Affairs, Huang Engineering Center, Suite 135.

Minors are offered in the following programs:

- Aeronautics and Astronautics (AA) Minor (http://exploredegrees.stanford.edu/schoolofengineering/aeronauticsandastronautics/#minortext)
- Chemical Engineering Minor (http://exploredegrees.stanford.edu/schoolofengineering/chemicalengineering/#minortext)
- Civil Engineering (CE) Minor (http://exploredegrees.stanford.edu/schoolofengineering/civilandenvironmentalengineering/#minortext)
- Computer Science (CS) Minor (http://exploredegrees.stanford.edu/schoolofengineering/computerscience/#minortext)
- Electrical Engineering (EE) Minor (http://exploredegrees.stanford.edu/schoolofengineering/electricalengineering/#minortext)
- Environmental Systems Engineering (EnvSE) Minor (http://exploredegrees.stanford.edu/schoolofengineering/civilandenvironmentalengineering/#minortext)
- Management Science and Engineering (MS&E) Minor (http://exploredegrees.stanford.edu/schoolofengineering/managementscienceandengineering/#minortext)
- Materials Science and Engineering (MATSCI) Minor (http://exploredegrees.stanford.edu/schoolofengineering/materialsscienceandengineering/#minortext)
- Mechanical Engineering (ME) Minor (http://exploredegrees.stanford.edu/schoolofengineering/mechanicalengineering/#minortext)

General requirements and policies for a minor in the School of Engineering are:

1. A set of courses totaling not less than 20 and not more than 36 units, with a minimum of six courses of at least 3 units each. These courses must be taken for a letter grade except where letter grades are not offered, and a minimum GPA of 2.0 within the minor course list must be maintained (departments may require a higher GPA if they choose).
2. The set of courses should be sufficiently coherent as to present a body of knowledge within a discipline or subdiscipline.
3. Prerequisite mathematics, statistics, or science courses, such as those normally used to satisfy the school's requirements for a department major, may not be used to satisfy the requirements of the minor; conversely, engineering courses that serve as prerequisites for subsequent courses must be included in the unit total of the minor program.
4. Courses used for the major and/or minor core must not be duplicated within any other of the student's degree programs; that is, students may not overlap (double-count) courses for completing core major and minor requirements.

Departmentally based minor programs are structured at the discretion of the sponsoring department, subject only to requirements 1, 2, 3, and 4 above. Interdisciplinary minor programs may be submitted to the Undergraduate Council for approval and sponsorship. A general Engineering minor is not offered.

Aeronautics and Astronautics (AA) Minor

The Aero/Astro minor introduces undergraduates to the key elements of modern aerospace systems. Within the minor, students may focus on aircraft, spacecraft, or disciplines relevant to both. The course requirements for the minor are described in detail below. If any core classes (aside from ENGR 21; see footnote) are part of student's major or other degree program, the Aero/Astro adviser can help select substitute courses to fulfill the Aero/Astro minor requirements; no double counting allowed. All courses taken for the minor must be taken for a letter grade if that option is offered by the instructor. Minimum GPA for all minor courses combined is 2.0.

The following core courses fulfill the minor requirements:

AA Core		
12 Core Units, 24 Total Program Units		
ENGR 21	Engineering of Systems [2]	3
AA 100	Introduction to Aeronautics and Astronautics	3
AA 131	Space Flight	3
AA 141	Atmospheric Flight	3
AA Electives		
Choose 4 courses		
AA 101 Introduction to Aero Fluid Mechanics [1]		
AA 102	Introduction to Applied Aerodynamics	3
AA 103	Air and Space Propulsion	3
AA 111 Introduction to Aerospace Computational Engineering [1]		
AA 135 Introduction to Space Policy [1]		
AA 151	Lightweight Structures	3
AA 156	Mechanics of Composite Materials	3
AA 171 Autonomous Systems [1]		
AA 173 Flight Mechanics and Controls [1]		
AA 175 Embedded Programming [1]		
AA 272C	Global Positioning Systems	3
AA 279A	Space Mechanics	3
ENGR 105	Feedback Control Design	3

1. This course will be offered in the future. Please see our website for future course offerings (https://aa.stanford.edu/academics/undergraduate-program). For courses yet not offered please contact the Aero/Astro Student Services Office (https://aa.stanford.edu/academics/student-services-office) for a list of approved replacement courses.
2. ENGR 21 is waived as minor requirement if already taken as part of the major program.

Chemical Engineering Minor

The following core courses fulfill the minor requirements:

		Units
ENGR 20	Introduction to Chemical Engineering	4
CHEMENG 100	Chemical Process Modeling, Dynamics, and Control	3
CHEMENG 110	Equilibrium Thermodynamics	3
CHEMENG 120A	Fluid Mechanics	4
CHEMENG 120B	Energy and Mass Transport	4
CHEMENG 170	Kinetics and Reactor Design	3
CHEMENG 185A	Chemical Engineering Laboratory A	4
CHEM 171	Physical Chemistry I	4
CHEMENG 180	Chemical Engineering Plant Design	4
Select one of the following:		3
CHEMENG 140	Micro and Nanoscale Fabrication Engineering	
CHEMENG 142	Basic Principles of Heterogeneous Catalysis with Applications in Energy Transformations	
CHEMENG 160	Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life	
CHEMENG 162	Polymers for Clean Energy and Water	
CHEMENG 174	Environmental Microbiology I	
CHEMENG 181	Biochemistry I	
Total Units		36

Civil Engineering (CE) Minor

The civil engineering minor is intended to give students a focused introduction to one or more areas of civil engineering. Departmental expertise and undergraduate course offerings are available in the areas of Architectural Design, Construction Engineering and Management, and Structural and Geotechnical Engineering. Students interested in Environmental and Water Studies should refer to the Environmental Systems Engineering minor.

The minimum prerequisite for a civil engineering minor is MATH 19 Calculus (or MATH 20 Calculus or MATH 21 Calculus); however, many courses of interest require PHYSICS 41 Mechanics and/or MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications as prerequisites. The minimum prerequisite for a Civil Engineering minor focusing on architectural design is MATH 19 Calculus (or MATH 20 Calculus or MATH 21 Calculus). Students should recognize that a minor in civil engineering is not an ABET-accredited degree program.

Since undergraduates having widely varying backgrounds may be interested in obtaining a civil engineering minor, and the field itself is so broad, no single set of course requirements will be appropriate for all students. Instead, interested students are encouraged to propose their own set of courses within the guidelines listed below. Additional information, including example minor programs, are provided on the CEE web site (http://cee.stanford.edu/prospective/undergrad/minor_overview.html) and in Chapter 6 of the Handbook for Undergraduate Engineering Programs (http://ughb.stanford.edu).

General guidelines are:

1. A civil engineering minor must contain at least 24 units of course work not taken for the major, and must consist of at least six classes of at least 3 units each of letter-graded work, except where letter grades are not offered.
2. The list of courses must represent a coherent body of knowledge in a focused area, and should include classes that build upon one another. Example programs are given on the CEE webpage.

Professor Anne Kiremidjian (kiremidjian@stanford.edu) is the CEE undergraduate minor adviser in Structural Engineering and Construction Engineering and Management. John Barton (jhbarton@stanford.edu (http://www.stanford.edu/dept/registrar/bulletin/jhbarton@stanford.edu)), Program Director for Architectural Design, is the undergraduate minor adviser in Architectural Design. Students must consult the appropriate adviser when developing their minor program, and obtain approval of the finalized study list from them.

Computer Science (CS) Minor

The following core courses fulfill the minor requirements. Prerequisites include the standard mathematics sequence through MATH 51 (or CME 100).

		Units
Introductory Programming (AP Credit may be used to fulfill this requirement):		
CS 106B	Programming Abstractions	5
or CS 106X	Programming Abstractions (Accelerated)	
Core:		
CS 103	Mathematical Foundations of Computing	5
CS 107	Computer Organization and Systems	5
or CS 107E	Computer Systems from the Ground Up	
CS 109	Introduction to Probability for Computer Scientists	5
Electives (choose two courses from different areas):		
Artificial Intelligence—		
CS 124	From Languages to Information	4
CS 221	Artificial Intelligence: Principles and Techniques	4
CS 229	Machine Learning	3-4
Human-Computer Interaction—		
CS 147	Introduction to Human-Computer Interaction Design	4
Software—		
CS 108	Object-Oriented Systems Design	4
CS 110	Principles of Computer Systems	5
Systems—		
CS 140	Operating Systems and Systems Programming	4
or CS 140E	Operating systems design and implementation	
CS 143	Compilers	4
CS 144	Introduction to Computer Networking	4
CS 145	Data Management and Data Systems	4
CS 148	Introduction to Computer Graphics and Imaging	4
Theory—		
CS 154	Introduction to Automata and Complexity Theory	4
CS 157	Computational Logic	3
CS 161	Design and Analysis of Algorithms	5

Note: for students with no programming background and who begin with CS 106A, the minor consists of seven courses.

Electrical Engineering (EE) Minor

The options for completing a minor in EE are outlined below. Students must complete a minimum of 23-25 units, as follows:

		Units
Select one:		5
EE 42	Introduction to Electromagnetics and Its Applications	
EE 65	Modern Physics for Engineers	
ENGR 40A & ENGR 40B	Introductory Electronics and Introductory Electronics Part II	
ENGR 40M	An Intro to Making: What is EE	
Select one:		8
Option I:		
EE 101A	Circuits I	
EE 101B	Circuits II	
Option II:		
EE 102A	Signal Processing and Linear Systems I	
EE 102B	Signal Processing and Linear Systems II	
Option III:		
EE 102A	Signal Processing and Linear Systems I	
EE 103	Introduction to Matrix Methods	
Option IV:		
EE 108	Digital System Design	
EE 180	Digital Systems Architecture	
In addition, four letter-graded EE courses at the 100-level or higher must be taken (12 units minimum). CS 107 is required as a prerequisite for EE 180, but can count as one of the four classes.		12

Environmental Systems Engineering (EnvSE) Minor

The Environmental Systems Engineering minor is intended to give students a focused introduction to one or more areas of Environmental Systems Engineering. Departmental expertise and undergraduate course offerings are available in the areas of environmental engineering and science, environmental fluid mechanics and hydrology, and atmosphere/energy. The minimum prerequisite for an Environmental Systems Engineering minor is MATH 19 Calculus (or MATH 20 Calculus or MATH 21 Calculus); additionally, many courses of interest require PHYSICS 41 Mechanics and/or MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications as prerequisites. Students should recognize that a minor in Environmental Systems Engineering is not an ABET-accredited degree program.

Since undergraduates having widely varying backgrounds may be interested in obtaining an Environmental Systems Engineering minor, no single set of course requirements is appropriate for all students. Instead, interested students are encouraged to propose their own set of courses within the guidelines listed below. Additional information on preparing a minor program is available in the Undergraduate Engineering Handbook (http://web.stanford.edu/group/ughb/cgi-bin/handbook/index.php/Handbooks).

General guidelines are—

- An Environmental Systems Engineering minor must contain at least 24 units of course work not taken for the major, and must consist of at least six classes of at least 3 units each of letter-graded work, except where letter grades are not offered.
- The list of courses must represent a coherent body of knowledge in a focused area, and should include classes that build upon one another. Example programs are available on the CEE web site (https://cee.stanford.edu/academics/undergraduate-programs/minor).

Professor Nicholas Ouellette (nto@stanford.edu) is the CEE undergraduate minor adviser in Environmental Systems Engineering. Students must consult with Professor Ouellette (https://cee.stanford.edu/people/nicholas-t-ouellette) in developing their minor program, and obtain approval of the finalized study list from him.

Management Science and Engineering (MS&E) Minor

The following courses are required to fulfill the minor requirements:

		Units
Background requirements (two courses; letter-graded or CR/NC)		
CME 100	Vector Calculus for Engineers	5
or MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
CS 106A	Programming Methodology	5
Minor requirements (seven courses; all letter-graded)		
MS&E 111	Introduction to Optimization	3-4
or MS&E 111X	Introduction to Optimization (Accelerated)	
MS&E 120	Probabilistic Analysis [1]	5
MS&E 121	Introduction to Stochastic Modeling	4
MS&E 125	Introduction to Applied Statistics	4
MS&E 180	Organizations: Theory and Management	4
Electives (select any two 100- or 200-level MS&E courses)		6
Recommended courses		
In addition to the required background and minor courses, it is recommended that students also take the following courses.		
ECON 50	Economic Analysis I	5
MS&E 140	Accounting for Managers and Entrepreneurs (may be used as one of the required electives above)	2-4
or MS&E 140X	Financial Accounting Concepts and Analysis	

1 Students completing a calculus-based probability course such as CS 109 or STATS 116 for their major, may substitute another MS&E course for MS&E 120.

Materials Science and Engineering (MATSCI) Minor

A minor in Materials Science and Engineering allows interested students to explore the role of materials in modern technology and to gain an understanding of the fundamental processes that govern materials behavior.

The following courses fulfill the minor requirements:

		Units
Engineering Fundamentals		
Select one of the following:		4
ENGR 50	Introduction to Materials Science, Nanotechnology Emphasis	
ENGR 50E	Introduction to Materials Science, Energy Emphasis	
ENGR 50M	Introduction to Materials Science, Biomaterials Emphasis	
Materials Science Fundamentals and Engineering Depth		
Select six of the following:		24
MATSCI 142	Quantum Mechanics of Nanoscale Materials	
MATSCI 143	Materials Structure and Characterization	
MATSCI 144	Thermodynamic Evaluation of Green Energy Technologies	
MATSCI 145	Kinetics of Materials Synthesis	
MATSCI 151	Microstructure and Mechanical Properties	
MATSCI 152	Electronic Materials Engineering	
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	
MATSCI 158	Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life	
MATSCI 160	Nanomaterials Laboratory	
MATSCI 161	Energy Materials Laboratory	
MATSCI 162	X-Ray Diffraction Laboratory	
MATSCI 163	Mechanical Behavior Laboratory	
MATSCI 164	Electronic and Photonic Materials and Devices Laboratory	
MATSCI 165	Nanoscale Materials Physics Computation Laboratory	
MATSCI 190	Organic and Biological Materials	
MATSCI 192	Materials Chemistry	
MATSCI 193	Atomic Arrangements in Solids	
MATSCI 194	Thermodynamics and Phase Equilibria	
MATSCI 195	Waves and Diffraction in Solids	
MATSCI 196	Defects in Crystalline Solids	
MATSCI 197	Rate Processes in Materials	
MATSCI 198	Mechanical Properties of Materials	
MATSCI 199	Electronic and Optical Properties of Solids	
Total Units		28

Mechanical Engineering (ME) Minor

The following courses fulfill the minor requirements:

		Units
General Minor *		
ENGR 14	Intro to Solid Mechanics	3
ENGR 15	Dynamics	3
ME 1	Introduction to Mechanical Engineering	3
ME 30	Engineering Thermodynamics	3
ME 70	Introductory Fluids Engineering	3
Plus two of the following:		
ME 80	Mechanics of Materials	3
ME 103	Product Realization: Design and Making	3
ME 131A	Heat Transfer	3
ME 161	Dynamic Systems, Vibrations and Control	3
Total Units: 21		
Thermosciences Minor **		
ENGR 14	Intro to Solid Mechanics	3
ME 30	Engineering Thermodynamics	3
ME 70	Introductory Fluids Engineering	3
ME 131A	Heat Transfer	3
ME 149	Mechanical Measurements	3
ME 132	Intermediate Thermodynamics	4
ME 133	Intermediate Fluid Mechanics (offered SPR 18-19; more information to come)	3
Total units: 22		
Mechanical Design Minor ***		
ENGR 14	Intro to Solid Mechanics	3
ENGR 15	Dynamics	3
ME 80	Mechanics of Materials	3
ME 1	Introduction to Mechanical Engineering	3
ME 102	Foundations of Product Realization	3
ME 103	Product Realization: Design and Making	3
ME 112	Mechanical Systems Design	3
Plus one of the following:		
ME 113	Mechanical Engineering Design	4
ME 210	Introduction to Mechatronics	4

ME 220	Introduction to Sensors	3-4
Total units: 24-25		

* This minor aims to expose students to the breadth of ME in terms of topics and analytic and design activities. Prerequisites: MATH 19 Calculus, MATH 20 Calculus, MATH 21 Calculus, and PHYSICS 41 Mechanics or PHYSICS 41E Mechanics, Concepts, Calculations, and Context.

** Prerequisites: MATH 19 Calculus, MATH 20 Calculus, MATH 21 Calculus , MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications (or CME 100 Vector Calculus for Engineers) and PHYSICS 41 Mechanics or PHYSICS 41E Mechanics, Concepts, Calculations, and Context.

*** This minor aims to expose students to design activities supported by analysis. Prerequisites: MATH 19 Calculus, MATH 20 Calculus, MATH 21 Calculus,PHYSICS 42 Classical Mechanics Laboratory, and PHYSICS 41 Mechanics or PHYSICS 41E Mechanics, Concepts, Calculations, and Context.

Master of Science in the School of Engineering

The M.S. degree is conferred on graduate students in engineering according to the University regulations stated in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin, and is described in the various department listings. A minimum of 45 units is usually required in M.S. programs in the School of Engineering. The presentation of a thesis is not a school requirement. Further information is found in departmental listings.

Master of Science in Engineering

The M.S. in Engineering is available to students who wish to follow an interdisciplinary program of study that does not conform to a normal graduate program in a department.

Each student's program is administered by the particular department in which it is lodged and must meet the standard of quality of that department. Transfer into this program is possible from any graduate program by application through the appropriate department; the department then recommends approval to the Office of Student Affairs in the School of Engineering. The application should be submitted before completing 18 units of the proposed program; it should include a statement describing the objectives of the program, the coherence of the proposed course work, and why this course of study cannot conform to existing graduate programs. Normally, it would include the approval of at least one faculty member willing to serve as adviser. (A co-advising team may be appropriate for interdisciplinary programs.) Each student's program is administered by the particular department in which it is lodged and must meet the standard of quality of that department. The actual transfer is accomplished through the Graduate Authorization Petition process.

There are three school requirements for the M.S. degree in Engineering:

1. The student's program must be a coherent one with a well-defined objective and must be approved by a department within the school which has experience with graduate-level teaching and advising in the program area.
2. The student's program must include at least 21 units of courses within the School of Engineering with catalog numbers of 200 or above in which the student receives letter grades.
3. The program must include a total of at least 45 units.

Departments may have additional requirements or expectations for programs of study which they would recommend for this degree; further information may be found in departmental listings or handbooks.

The M.S. in Engineering is rarely pursued as a coterminal program, and potential coterms are encouraged to explore the range of master's options in the departments and interdisciplinary programs. In the unusual circumstance of a coterminal application to the M.S. in Engineering, the application process should be the same as described above, using either the Graduate Authorization Petition in Axess (for coterminal students who want to transfer between MS programs) or the the Application for Admission to Coterminal Masters' Program (http://registrar.stanford.edu/pdf/CotermApplic.pdf) (for students who have not yet been admitted to a master's program). The policy for transferring courses taken as an undergraduate prior to coterm admission to the M.S. in Engineering corresponds to the policy of the particular department in which the student's program is lodged and administered. A clear statement of the department's coterminal policy, and how it applies to the applicant within the Master of Science in Engineering program, should be added to the application materials.

Honors Cooperative Program

Industrial firms, government laboratories, and other organizations may participate in the Honors Cooperative Program (HCP), a program that permits qualified engineers, scientists, and technology professionals admitted to Stanford graduate degree programs to register for Stanford courses and obtain the degree on a part-time basis. In many areas of concentration, the master's degree can be obtained entirely online.

Through this program, many graduate courses offered by the School of Engineering on campus are made available through the Stanford Center for Professional Development (SCPD). SCPD delivers more than 250 courses a year online. For HCP employees who are not part of a graduate degree program at Stanford, courses and certificates are also available through a non-degree option (NDO) and a non-credit professional education program. Non-credit short courses may be customized to meet a company's needs. For a full description of educational services provided by SCPD, see the SCPD website (http://scpd.stanford.edu); call (650) 204-3984; fax (650) 725-2868; or email scpd-gradstudents@stanford.edu.

Engineer Degree in the School of Engineering

The degree of Engineer is intended for students who want additional graduate training beyond that offered in an M.S. program. The program of study must satisfy the student's department and must include at least 90 units beyond the B.S. degree. The presentation of a thesis is required. The University regulations for the Engineer degree are stated in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin, and further information is available in the individual departmental sections of this bulletin.

Doctor of Philosophy in the School of Engineering

Programs leading to the Ph.D. degree are offered in each of the departments of the school. University regulations for the Ph.D. are given in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin. Further information is found in departmental listings.

Dean: Jennifer Widom

Senior Associate Deans: Stacey Bent (Faculty and Academic Affairs), Laura L. Breyfogle (External Relations), Scott Calvert (Administration), Thomas Kenny (Student Affairs)

Associate Dean: Kirsti Copeland (Student Affairs)

Assistant Dean: Sally Gressens (Graduate Student Affairs)

Faculty Teaching General Engineering Courses

Professors: Juan Alonso, Mark Cappelli, Ashish Goel, Chaitan Khosla, Chris Gerdes, Mark Horowitz, Roger Howe, Ellen Kuhl, Allison Okamura, Peter Pinsky, Jim Plummer, Stephen M. Rock, Bernard Roth, Sheri Sheppard, Robert Sinclair, Simon Wong, Yinyu Ye

Associate Professors: Eric Darve, Chuck Eesley, Sarah Heilshorn, W. Matthias Ihme, Michael Lepech, Jan Liphardt, Nick Melosh, Amin Saberi, Thomas Jaramillo,

Assistant Professors: Sindy Tang

Professors (Teaching): Thomas H. Byers, Robert McGinn, Mehran Sahami

Senior Lecturers: Vadim Khayms

Lecturers: Jeff Epstein, Christopher Gregg, Kelly Harrison, David Jaffe, Victoria Kirst, Royal Kopperud, Hung Le, Cynthia Bailey Lee, Mary McDevitt, Chris Piech, Marty Stepp, Matt Vassar

Professor of the Practice: Tina Seelig

Overseas Studies Courses in Engineering

The Bing Overseas Studies Program (http://bosp.stanford.edu) manages Stanford study abroad programs for Stanford undergraduates. Students should consult their department or program's student services office for applicability of Overseas Studies courses to a major or minor program.

The Bing Overseas Studies course search site (https://undergrad.stanford.edu/programs/bosp/explore/search-courses) displays courses, locations, and quarters relevant to specific majors.

For course descriptions and additional offerings, see the listings in the Stanford Bulletin's ExploreCourses (http://explorecourses.stanford.edu) or Bing Overseas Studies (http://bosp.stanford.edu).

		Units
OSPBER 40M	An Intro to Making: What is EE	5
OSPBER 50M	Introductory Science of Materials	4
OSPFLOR 50M	Introductory Science of Materials	4
OSPKYOTO 40M	An Intro to Making: What is EE	5
OSPPARIS 40M	An Intro to Making: What is EE	5
OSPPARIS 50M	Introductory Science of Materials	4