CIVIL AND ENVIRONMENTAL ENGINEERING

Courses offered by the Department of Civil and Environmental Engineering are listed under the subject code CEE (https://explorecourses.stanford.edu/search?/search?view=catalog&academicYear=&q=CEE&filter-departmentcode-CEE=on&filter-coursestatus-Active=on&filter-term-Autumn=on&filter-term-Winter=on&filter-term-Spring=on&filter-term-Summer=on&page=0) on the *Stanford Bulletin's* ExploreCourses (https://explorecourses.stanford.edu) web site.

The Department of Civil and Environmental Engineering (CEE) at Stanford conducts fundamental and applied research to advance the civil and environmental engineering professions, educate future academic and industry leaders, and prepare students for careers in professional practice. Civil and environmental engineers work to protect and sustain the natural environment while creating and maintaining a resilient, sustainable built environment. Civil and environmental engineers are essential to providing the necessities of human life, including water, air, shelter, the infrastructure, and energy, in increasingly more efficient and renewable ways.

Research and teaching in the department focus on the theme of engineering for sustainability, including three core areas: built environment, environmental and water studies, and atmosphere/energy. In the area of sustainable built environments, the focus is on processes, techniques, materials, and monitoring technologies for planning, design, construction and operation of environmentally sensitive, economically efficient, performance-based buildings and infrastructure, and managing associated risks from natural and man-made hazards. In the area of environmental and water studies, the focus is on creating plans, policies, science-based assessment models and engineered systems to manage water in ways that protect human health, promote human welfare, and provide freshwater and coastal ecosystem services. In the atmosphere/energy area, research and teaching focus on fundamental energy and atmospheric engineering and science, assessment of energy-use effects on atmospheric processes and air quality, and analysis and design energy-efficient generation and use systems with minimal environmental impact.

The department oversees undergraduate programs in Civil Engineering and in Environmental Systems Engineering. The department also hosts the School of Engineering undergraduate major in Architectural Design and the undergraduate major in Atmosphere/Energy - both of which lead to a B.S. in Engineering.

Mission of the Undergraduate Program in Civil Engineering

The mission of the undergraduate program in Civil Engineering is to equip students with the knowledge and skills needed for world-class civil engineering practice. This pre-professional program balances the fundamentals common to many specialties in civil engineering while allowing for concentration in structures and construction or in 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 science and 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, and engineering fundamentals, and tools and skills considered essential for an engineer. Students can choose from one of three focus areas for more in-depth study: coastal environments, freshwater environments, or urban environments. The 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 21^{st} century involving natural and built environments, in consulting and industry as well as in graduate school.

Learning Outcomes (Undergraduate)

Undergraduates in the Civil Engineering and the Environmental Systems Engineering programs are expected to achieve the following learning outcomes through their major. These learning outcomes are used both in evaluating students and the department's undergraduate programs. Students are expected to demonstrate the ability to:

1. apply knowledge of mathematics, science, and engineering.
2. design and conduct experiments, as well as analyze and interpret data.
3. design a system, component, or process to meet desired needs.
4. function on multidisciplinary teams.
5. identify, formulate, and solve engineering problems.
6. understand professional and ethical responsibility.
7. communicate effectively.
8. obtain the broad education necessary to understand the impact of engineering solutions in a global and societal context.
9. recognize the need for and engage in life-long learning.
10. gain knowledge of contemporary issues.
11. apply the techniques, skills, and modern engineering tools necessary for engineering practice.

Learning Outcomes (Graduate)

The purpose of the master's program is to equip students with the knowledge and skills necessary for a successful professional career or for the pursuit of doctoral studies. Students are prepared through course work that is organized into three broad areas including the built environment, atmosphere and energy, and environmental engineering. Graduate students must master the analytical, quantitative, and interpretive skills necessary for successful leadership in their chosen field.

The Ph.D. is conferred upon candidates who have demonstrated substantial original scholarship and the ability to conduct independent research. The Ph.D. program prepares students to make original contributions to the theory and practice of Civil and Environmental Engineering and related fields.

Graduate Programs in Civil and Environmental Engineering

The Department of Civil and Environmental Engineering (CEE) offers graduate degrees structured in three areas of study.

- The Atmosphere/Energy Program offers degrees with the designation of Atmosphere/Energy.
- The Sustainable Built Environment Program offers degrees with two designations:
  - Structural Engineering and Geomechanics
  - Sustainable Design and Construction
- The Environmental Engineering Program offers degrees with the designation of Environmental Engineering

For detailed information on these programs and degree designations, see the "Programs of Graduate Study in Civil and Environmental Engineering" section of this bulletin.

Admissions and Financial Aid

Applications require online submission of the application form and statement of purpose, followed by three letters of recommendation, results of the General Section of the Graduate Record Examination, and transcripts of all courses taken at colleges and universities. See http://gradadmissions.stanford.edu. Policies for each of the programs in the department are available on the department website. See: http://cee.stanford.edu. Successful applicants are advised as to the degree and program for which they are admitted. If students wish to transfer from one CEE program to another after being accepted, an application for the intradepartmental change must be filed within the department. If, after enrollment at Stanford, students wish to continue toward a degree beyond that for which they were originally admitted, a written application must be made to the Department of Civil and Environmental Engineering.

The department maintains a continuing program of merit-based financial aid for graduate students. Merit-based financial aid consists of teaching assistantships and/or research assistantships for up to half-time work, with the assumption that students spend the rest of their time on coursework and research required for completion of the degree. Fellowship and scholarship awards or loans may supplement assistantships and other basic support. Continued support is generally provided for further study toward the Engineer or Ph.D. degree based on the student's performance, the availability of research funds, and requisite staffing of current research projects.

Research Centers and Facilities

Research in the department related to environmental and water studies is conducted in the Bob and Norma Street Environmental Fluid Mechanics Laboratory (EFML) and the Environmental Engineering and Science Laboratory (EESL). The EESL is home to the National Science Foundation (NSF) supported Engineering Research Center for Re-inventing the Nation's Urban Water Infrastructure (ReNUWIt), a four-university consortium that seeks more sustainable solutions to urban water challenges in the arid west, and the William and Cloy Codiga Resource Recovery Center (CR2C), a new facility for pilot-scale testing of resource recovery technology. Other centers and groups in the department related to environmental engineering include the Environmental Informatics Group, the National Performance of Dams Program (NPDP), and the center for Sustainable Development and Global Competitiveness (SDGC). There is also extensive collaboration with research centers and groups throughout the university, including the Woods Institute for the Environment, the Stanford Program on Water, Health & Development, the Bill Lane Center for the American West, the Carnegie Institution, the Center for Innovation in Global Health, Stanford Bio-X, the Environmental and Natural Resources Law and Policy Program, the Freeman Spogli Institute for International Studies, and the Precourt Institute for Energy.

Several research centers in the department focus on improving the sustainability of the built environment. The John A. Blume Earthquake Engineering Center conducts research on earthquake engineering including advanced sensing and control, innovative materials, and risk hazard assessment. Research and advanced global teamwork education is conducted in the Project Based Learning (PBL) Laboratory. The Center for Integrated Facility Engineering (CIFE) employs advanced information technologies and concepts to integrate the facility development process and enhance the usability, buildability, operability, and sustainability of the built environment. The Global Projects Center (GPC) is a multi-discipline, multi-university research program aimed at improving the performance of global engineering and construction projects, with a special focus on financing and governance of sustainable civil and social infrastructure projects. The Stanford Sustainable Systems Lab (S3L) aims to advance the state of the art in the design, monitoring and management of built environment systems, with a special focus on smart grid, smart buildings and smart infrastructures.

Programs of Graduate Study in Civil and Environmental Engineering

Atmosphere/Energy Program

The Atmosphere/Energy Program in Civil and Environmental Engineering combines atmospheric science with energy science and engineering. The main goals of the program are to educate students and the public, through courses, research, and public outreach, about the causes of climate, air pollution, and weather problems and methods of addressing these problems through renewable and efficient energy systems. In addition, students learn about feedback between the atmosphere and renewable energy systems and the effects of the current energy infrastructure on the atmosphere.

Major focus areas of energy research include examining the resource availability of renewable energies, such as wind, solar, and wave, and studying optimal methods of combining renewable energies together to match energy supply with instantaneous demand. This type of work is generally done through a combination of data analysis, three-dimensional atmospheric computer modeling of wind, solar, wave, and hydroelectric power resources, and transmission load flow computer modeling. Other energy research, performed through three-dimensional computer modeling, focuses on the effects, for example, of hydrogen fuel cell vehicles on air pollution and the ozone layer and the effects of ethanol and diesel vehicles on air quality and climate. Studies also examine the feedback of wind turbines to the atmosphere and the effects of climate change on wind and solar energy resources.

Atmospheric research in the program generally involves laboratory work, field measurements, or three-dimensional computer modeling of the combined atmosphere, ocean, and land surface. An example of laboratory work includes measuring the properties of organic particulate matter that forms in the atmosphere. Examples of fieldwork include measuring exposures to secondhand smoke, allergens, and emissions from building materials.

Computer modeling is performed at a variety of spatial scales, from the globe down to the size of a building or smaller. Some examples of modeling studies include examining the effects of air pollution particles on clouds, rainfall, water supply, ultraviolet radiation, the stratospheric ozone layer, and climate, simulating the dispersion of toxic contaminants in an urban street canyon, studying the effects of aircraft exhaust and biomass burning on climate, studying the effects of carbon dioxide domes over cities on air pollution mortality, and studying the leading causes of global warming and their impacts.

Students interested in the Atmosphere and also Clean Renewable Energy systems would most likely apply to the Atmosphere/Energy Program. Those interested in the Atmosphere and also Water systems would most likely apply to the Environmental Engineering Program. Those interested in Atmospheric topics alone (e.g. weather, climate, pollution and its impacts) could apply to either, depending on the courses of interest.

Environmental Engineering Program

The mission of the Environmental Engineering program is to develop state-of-the-art knowledge, models, and processes which form the core of environmental engineering practice, and to train and educate current and future academic and professional environmental leaders. We do this by synthesizing physical, biological, and chemical facets of engineering and science along with elements of the social sciences into our research and teaching. Ultimately, the goal is to protect and sustain our natural resources and human health and contribute to the sustainable development of physical infrastructure, including systems for wastewater treatment, water supply, renewable energy, and resilient coastal environments.

Research and coursework in the Environmental Engineering program are centered around the five focus areas which include

- Environmental Modeling and Simulation
- Environmental and Geophysical Fluid Mechanics
- Hydrology and Water Resources
- Aquatic Chemistry and Biology and Process Engineering
- Human Health and the Environment

Research in the program spans the physical, chemical, and biological dimensions of Environmental Engineering. Research related to the physical aspects of environmental engineering is conducted in the Bob and Norma Street Environmental Fluid Mechanics Laboratory (EFML), whereas research on the chemical and biological aspects is conducted in the Environmental Engineering and Science Laboratory (EESL). The EESL is home to the National Science Foundation (NSF) supported Engineering Research Center for Re-inventing the Nation's Urban Water Infrastructure (ReNUWIt), a four-university consortium that seeks more sustainable solutions to urban water challenges in the arid west, and the William and Cloy Codiga Resource Recovery Center (CR2C), a facility for pilot-scale testing of resource recovery technology. There is extensive crossover between the EFML and the EESL, reflecting the interdisciplinary nature of environmental engineering that seeks to quantify physical, biological, and chemical processes in the environment in an integrated way. Environmental research is also conducted in numerous centers and groups in the department including the Environmental Informatics Group, the National Performance of Dams Program (NPDP), and the center for Sustainable Development and Global Competitiveness (SDGC). There is also extensive collaboration with research centers and groups throughout the university, including the Woods Institute for the Environment, the Bill Lane Center for the American West, the Carnegie Institution, the Center for Innovation in Global Health, Stanford Bio-X, the Environmental and Natural Resources Law and Policy Program, the Freeman Spogli Institute for International Studies, and the Precourt Institute for Energy.

Courses in the Environmental Modeling and Simulation, Environmental and Geophysical Fluid Mechanics, and Hydrology and Water Resources focus areas concentrate on developing an understanding of the physical processes controlling the movement of mass, energy, and momentum in aquatic environments and the atmosphere. Specific course topics include experimental methods, fluid transport and mixing processes, the fluid mechanics of stratified flows, natural flows in coastal waters, estuaries, lakes, and open channels, and turbulence and its modeling, flow and transport in porous media, stochastic methods in both surface and subsurface hydrology, watershed hydrology and modeling, global atmospheric circulation, the atmospheric boundary layer, air pollution from global to indoor scales, and wind energy.

Courses in the Aquatic Chemistry and Biology, Process Engineering, and Human Health and the Environment focus areas emphasize the chemical, biological, and engineering aspects of air and water quality and pollution fate and transport, along with characterizing human health risks and developing testing strategies to protect public health. Specific course topics include chemical principles and their application to the analysis and solution of problems in aqueous environments, biochemical and biophysical principles of biochemical reactions, physical and chemical unit operations for water treatment, microbial processes for the transformation of environmental contaminants, microbial metabolic pathways in microbial bioenergy systems, the movement and survival of pathogens in the environment, use of microbial bioreactors for degradation of contaminants and recovery of clean water, quantification of human exposure to toxic chemicals and pathogens in the environment, methods to enumerate and isolate organisms used to assess risk of enteric illnesses in drinking and recreational waters, and the impacts of water supply and wastewater management approaches on public health around the globe.

Sustainable Built Environment Program

The Sustainable Built Environment program includes subprograms in Structural Engineering and Geomechanics, and Sustainable Design and Construction. These programs focus on educating practitioners and researchers to plan, design, build, and operate more sustainable buildings and infrastructure.

The Structural Engineering and Geomechanics (SEG) subprogram educates designers and researchers who want to progress beyond traditional life safety code-based design, to develop and disseminate performance-based structural and geotechnical engineering methods and tools that maximize the lifecycle economic value of facilities.

The Sustainable Design and Construction (SDC) subprogram provides courses in sustainable, multi-stakeholder design methods and tools that incorporate lifecycle assessment, project planning and entitlement, green architectural design, lighting, and energy analysis, power systems, transportation, water supply and wastewater treatment to educate students interested in promoting more sustainable development of buildings and infrastructure.

Admission is managed separately for these two subprograms; prospective students should indicate their preference on their application.

Structural Engineering and Geomechanics

The Structural Engineering and Geomechanics (SEG) subprogram encompasses teaching and research in structural design and analysis, structural materials, earthquake engineering and structural dynamics, advanced sensing and structural health monitoring, risk and reliability analysis, disaster resilience, computational science and engineering, solid mechanics, computational mechanics, and geomechanics. The SEG subprogram prepares students for industrial or academic careers.

Students can balance engineering fundamentals with modern computational and experimental methods to customize programs to launch careers as consultants on large and small projects, designers, and engineering analysts.

Structural design and analysis focuses on the conceptual design of structural systems and on computational methods for predicting the static and dynamic, linear and nonlinear responses of structures.

Structural materials research and teaching focuses on the design and analysis of high-performance as well as low-environmental impact materials.

Earthquake engineering and structural dynamics addresses earthquake phenomena, ground shaking, and the behavior, analysis, and design of structures under seismic and other dynamic forces.

Reliability and risk analysis focuses on assessing damage and losses to structures and lifeline systems under earthquakes, wind and other hazards; insights from these assessments are used to engineer more sustainable structures and more resilient communities.

Computational science and engineering emphasizes the application of modern computing methods to structural engineering and geomechanics, and encompasses numerical, structural, and geotechnical analysis.

In the area of geomechanics, students focus on the application of the principles of computational and applied mechanics to problems involving geologic materials including soil and rock, as well as on the use of computational methods for analysis and design of foundations and earth structures.

Sustainable Design and Construction

The Sustainable Design and Construction (SDC) subprogram prepares students for careers in managing the planning, design, construction, and operation of sustainable buildings and infrastructure so that their lifecycle economic value, their net contribution to environmental functions and services, and their social equity are maximized. To give students the breadth and depth necessary to become leaders in practice or research in sustainable design and construction, the SDC program offers four tracks of study: construction, energy, structures, water and sustainable urban systems. In addition to providing critical skills and the necessary industry context, each track offers courses in the following areas of competency: Construction engineering and management; building and infrastructure development; structural performance, design, and analysis; infrastructure systems; energy systems, energy efficiency, and atmosphere.

Classes address advanced topics like modern company and project management methods; cutting-edge information technology, metrics and tools to enhance lifecycle sustainability of the built environment; sensor networks embedded in intelligent buildings and infrastructure; strategy, economics, entrepreneurship and organization design for new businesses; and corporate or governmental initiatives aimed at enhancing the sustainability of buildings and infrastructure.

The SDC subprogram is intended for students with undergraduate degrees in architecture, engineering, science, construction management, economics, or business who wish to pursue careers that enhance the sustainability of the built environment.

Employers of past SDC graduates include: architectural and engineering design firms, constructors, design-build firms, and developers focused on delivering green buildings and infrastructure; energy and sustainability consultants; facility management or sustainability departments within large companies; clean-tech start ups, and venture funds.

SDC Construction (SDC-C)

The SDC-C track includes courses in construction engineering and management and introduces advanced modeling and visualization methods and tools - including artificial intelligence and data science applications - known as virtual design and construction. This track prepares technically qualified students for leadership roles in engineering and management in all phases of the development of major constructed facilities. It emphasizes management techniques useful in organizing, planning, and controlling the activities of diverse specialists working within the unique project environment of the construction industry, and it covers construction engineering aspects of heavy, industrial, and building construction. Additional related course work is available from other programs within the department, from other engineering departments, and from other schools in the University such as Earth Sciences and the Graduate School of Business. SDC-C allows students substantial flexibility to tailor their program of study for careers with general contractors, specialty contractors, real estate or infrastructure developers, or facility owners and operators.

SDC-Energy (SDC-E)

The SDC-Energy (SDC-E) track includes courses on design and construction of buildings and infrastructure systems to produce, distribute, and consume energy sustainably. SDC-E prepares students for careers in design and construction of building energy systems, renewable power generating systems, and smart power grids connected to smart buildings and infrastructure, cleantech venture capital, sustainability-focused public policy, green real estate development, and sustainability management positions.

SDC-E includes courses from the CEE department and several other departments at Stanford on sustainable HVAC design and construction of small scale and large structures, the planning, design and construction of renewable power systems, and sensing and control technologies to link integrated smart grids with intelligent buildings, data centers and infrastructure systems.

SDC-Structures (SDC-S)

The SDC-Structures (SDC-S) track includes courses from construction engineering and management and Structural Engineering and Geomechanics (SEG) to prepare students for careers in design and construction firms that provide integrated design-build project delivery, construction management, and pre-construction services.

This track prepares students for multidisciplinary collaborative teamwork in an integrated design and construction process. The subprogram extends a student's design or construction background with core courses in each of these areas and develops the background needed to understand the concerns and expertise of the many project stakeholders. It includes a comprehensive project-based learning experience.

The SDC-S track is intended for applicants with backgrounds in engineering and science. Applicants should also have a background in the planning, design, or construction of built structures by virtue of work experience and/or their undergraduate education. Knowledge in subjects from the traditional areas of civil engineering is necessary for students to receive the degree and to satisfy prerequisite requirements for some of the required graduate courses. Students with an undergraduate degree in Civil Engineering, and who expect to pursue careers with design or construction firms that emphasize design-build, EPC, or turnkey projects should consider SDC-S.

SDC-Sustainable Urban Systems (SDC-SUS)

The SDC-Sustainable Urban Systems (SDC-SUS) track combines courses by several faculty from the Department of Civil and Environmental Engineering with courses on sustainable design and construction to focus on the urban scale of the built environment. The SDC-SUS track prepares students for careers in sustainable design, construction, and operation of infrastructure systems and communities.

This track offers courses in frameworks for urban-scale planning of infrastructure systems, technologies to model, simulate, analyze, and visualize the built environment at the urban scale, urban planning, and data analysis. The track includes a significant project-based experience on an actual project in a community.

This track is intended for students with a background in urban planning and systems-level understanding of the built environment from economic, environmental, or social perspectives with an interest to enhance the sustainability of the built environment through leadership roles in public agencies, city government, financial institutions, engineering firms, or technology providers.

Bachelor of Science in Civil Engineering

The B.S. in Civil Engineering is an ABET accredited program, which integrates research with engineering education. The B.S. in Civil Engineering offers the opportunity to focus on structures and construction, or on environmental and water studies. Three educational objectives structure the Civil Engineering degree program. Graduates of the program are expected within a few years of graduation to have the ability to:

1. Establish themselves as practicing professionals in civil or environmental engineering or a related field.

2. Pursue graduate study in civil or environmental engineering or other fields.
3. Work effectively as responsible professionals alone or in teams handling increasingly complex professional and societal expectations.

Students who major in Civil Engineering must complete the appropriate requirements for the B.S. degree listed. Each student has elective units, which may be used in any way the student desires, including additional studies in the department of Civil and Environmental Engineering or any other school or department in the University. Because the undergraduate engineering curriculum provides breadth of study, students who intend to enter professional practice in civil engineering should plan to obtain their professional education at the graduate level.

A number of undergraduate programs at Stanford may be of interest to students seeking to specialize in environmental studies. In addition to the Environmental and Water Studies track within the Civil Engineering major, students may consider related programs in the department such as Atmosphere/Energy and Environmental Systems Engineering, as well as programs offered in other departments and schools such as Earth Systems, Geological and Environmental Sciences, Urban Studies, and Human Biology.

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).

Bachelor of Science in Environmental Systems Engineering

For undergraduate studies focusing on Environmental Engineering, two options are available. The undergraduate Civil Engineering major (which is ABET-accredited) offers an Environmental & Water Studies track, and the new Environmental Systems Engineering major (which is not ABET-accredited) offers a choice of focusing on coastal environments, freshwater environments, or urban environments.

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).

Honors Program

This program leads to a B.S. with honors for undergraduates majoring in Civil Engineering or in Environmental Systems Engineering. It is designed to encourage qualified students to undertake a more intensive study of civil and environmental engineering than is required for the normal majors through a substantial, independent research project.

The program involves an in-depth research study in an area proposed to and agreed to by a Department of Civil and Environmental Engineering faculty adviser and completion of a thesis of high quality. A written proposal for the research to be undertaken must be submitted and approved by the faculty advisor in the fourth quarter prior to graduation.

At the time of application, the student must have an overall grade point average (GPA) of at least 3.3 for course work at Stanford; this GPA must be maintained to graduation. The thesis is supervised by a CEE faculty adviser and must involve input from the School of Engineering writing program by means of ENGR 202S Directed Writing Projects or ENGR 199W Writing of Original Research for Engineers. The written thesis must be approved by the thesis adviser. Students are encouraged to present their results in a seminar for faculty and students. Up to 10 units of CEE 199H Undergraduate Honors Thesis, may be taken to support the research and writing (not to duplicate ENGR 202S or ENGR 199W). These units are beyond the normal Civil Engineering or Environmental Systems Engineering major program requirements.

Minor in Civil Engineering or Environmental Systems Engineering

The department offers a minor in Civil Engineering and a minor in 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 courses required for the minors typically have prerequisites. Minors are not ABET-accredited programs.

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.

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.

Coterminal M.S. Program in Civil and Environmental Engineering

Stanford undergraduates who wish to continue their studies for the Master of Science degree in the coterminal program at Stanford must have earned a minimum of 120 units towards graduation. This includes allowable Advanced Placement (AP) and transfer credit. Applicants must submit their application no later than the quarter prior to the expected completion of their undergraduate degree and are expected to meet the Department of Civil and Environmental Engineering application deadlines for coterminal applicants for graduate study (the third Friday of January). Applications are considered once a year during Winter Quarter. An application must display evidence of potential for strong academic performance as a graduate student.

It is recommended that students who contemplate advanced study at Stanford discuss their plans with their advisers in the junior year.

University Coterminal Requirements

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/

cotermdegrees)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first graduate quarter is not a factor. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate adviser be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

Master of Science in Civil and Environmental Engineering

The following programs are available leading to the M.S. degree in Civil and Environmental Engineering:

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

Students admitted to graduate study with a B.S. in Civil Engineering, or equivalent, from an accredited curriculum can satisfy the requirements for the M.S. degree in Civil and Environmental Engineering by completing a minimum of 45 units beyond the B.S. All 45 units must be taken at Stanford. A minimum 2.75 grade point average (GPA) is required for candidates to be recommended for the M.S. degree. No thesis is required.

The program of study must be approved by the faculty of the department and should include at least 45 units of courses in engineering, mathematics, science, and related fields unless it can be shown that other work is pertinent to the student's objectives. Additional program area requirements are available on the department web site and from the department's student services office (Y2E2 room 316).

Candidates for the M.S. in Civil and Environmental Engineering who do not have a B.S. in Civil Engineering may, in addition to the above, be required to complete those undergraduate courses deemed important to their graduate programs. In such cases, more than three quarters is often required to obtain the degree.

Engineer in Civil and Environmental Engineering

A student with an M.S. in Civil Engineering may satisfy the requirements of the degree of Engineer in Civil and Environmental Engineering by completing 45 unduplicated course work and research units for a total of 90 units. Engineer candidates must submit an acceptable thesis (12-15 units) and maintain a minimum GPA of 3.0. The program of study must be approved by a faculty member in the department.

This degree is recommended for those desiring additional graduate education, especially those planning a career in professional practice. The thesis normally should be started in the first quarter of graduate study after the M.S. degree. Programs are offered in the fields of specialization mentioned for the M.S. degree. For students who will continue study toward a CEE Ph.D., the Engineer thesis topic must be significantly different from their doctoral research.

Graduate students who lack adequate background in their area of specialization (e.g. lack a prior degree in civil engineering, if required in their program) or who are not full-time students should expect to be enrolled for more than two years. Engineer degree candidates should develop individually tailored expected-progress timetables in consultation with their program advisers.

For graduate students not currently attending Stanford, admission to study for the Engineer degree in the Department of Civil and Environmental Engineering begins with the office of Graduate Admissions (http://www.stanford.edu/home/admission/index/html).

If you are currently pursuing a graduate degree at Stanford, and wish to apply for the Engineer degree program, submit an Application for Post-Masters Study (available in the department office, Y2E2 Room 314). This form is typically filed during your second quarter of graduate study, by January 15, so that your application may be reviewed during the normal graduate admissions cycle. You may apply at a later date if your adviser feels that it is appropriate to do so.

A minimum of 90 quarter units of full-time graduate study (or equivalent part-time graduate study) is required for the Engineer degree. For most students, the master's degree supplies 45 of these units.

If your master's degree was obtained at another school, you can apply to transfer up to 45 quarter units of residency credit by completing an Application for Transfer Credit for Graduate Work Done Elsewhere. No units need to be transferred if you hold an M.S. degree from Stanford.

Doctor of Philosophy in Civil and Environmental Engineering

The Ph.D. is offered under the general regulations of the University as set forth in the "Graduate Degrees" section of this bulletin. This degree is recommended for those who expect to engage in a professional career in research, teaching, or technical work of an advanced nature. The Ph.D. program requires a total of 135 units of graduate study, at least 90 units of which must be at Stanford. Up to 45 units of graduate study can be represented by the M.S. program described above. Additionally, up to 45 units of graduate study can be represented by the Engineer (ENG) program as described above if both the M.S. and ENG units were all completed at Stanford. Students must maintain a minimum GPA of 3.0 in post-M.S. course work. All candidates for the Ph.D. degree are required to complete CEE 200 in conjunction with a one-quarter teaching assistantship/course assistantship to gain training and instructional experience. Further information on Ph.D. requirements and regulations is found in the department Graduate Handbook.

The program of study is arranged via consultation between the prospective candidate and their dissertation research adviser. This program of study considers the interests of the student, and the background needed for their thesis topic, within the framework of the requirements of the department and the University.

By the end of a student's fourth quarter as an enrolled PhD student, excluding summers, the student is expected to pass the department's General Qualifying Examination (GQE) to be admitted to candidacy for the doctoral degree. The purpose of the GQE is to ensure that the student is adequately prepared to undertake doctoral research and has a well planned research topic. The exam include (1) a written and/or oral general examination of the candidate's doctoral major field,

(2) a presentation and defense of the candidate's doctoral research dissertation proposal, or (3) a combination research proposal and general examination. The GQE is administered by an advisory committee consisting of at least three Stanford faculty members, including a chair who is a faculty member in Civil and Environmental Engineering, and the student's doctoral adviser. When the primary advisor is not a member of the CEE faculty (CEE-Academic Council), there must be a CEE faculty (CEE-Academic Council) co-adviser, and the committee will consist of four examiners, with a minimum of two members who are Academic Council in the CEE department. All members are normally on the Stanford Academic Council. A petition for appointment of one advisory committee member who is not on the Academic Council may be made if the proposed person contributes an area of expertise that is not readily available from the faculty. Such petitions are subject to approval by the department chair. When the primary research adviser is not a member of the CEE Academic Council faculty, there must be a CEE faculty (CEE-Academic Council) co-adviser, and the committee will consist of four examiners, with a minimum of two members who are Academic Council faculty in the CEE department.

Ph.D. Minor in Civil and Environmental Engineering

A Ph.D. minor is a program outside a major department. Requirements for a minor are established by the minor department. Acceptance of the minor as part of the total Ph.D. program is determined by the major department. Application for the Ph.D. minor must be approved by both the major and the minor department, and the minor department must be represented at the University oral examination.

A student desiring a Ph.D. minor in Civil and Environmental Engineering (CEE) must have a minor program adviser who is both a CEE faculty member and a member of the Academic Council. The faculty member must be in the program of the designated minor subfield of CEE. This adviser must be a member of the student's University oral examination committee and the reading committee for the doctoral dissertation.

The program must include at least 20 units of graduate-level course work (courses numbered 200 or above, excluding special studies and thesis) in CEE completed at Stanford University. Units taken for the minor cannot be counted as part of the 45 unduplicated units for the PhD major. The list of courses must form a coherent program and must be approved by the minor program adviser and the CEE chair. A minimum GPA of 3.0 must be achieved in these courses.

Graduate Advising Expectations

Faculty advisers serve as intellectual and professional mentors to their graduate students. They are expected to provide knowledgeable support concerning policies for graduate studies, help prepare their students to be competitive for employment, maintain a high level of professionalism, and establish expectations concerning adviser/advisee relationship consistent with University and department standards. General University policies on advising and the conduct of research can be found at VPGE's Advising and Mentoring (https://vpge.stanford.edu/academic-guidance/advising-mentoring) web site.

It is important to distinguish between master's and doctoral advising. Master's students are assigned academic program advisers randomly, unless they explicitly request a specific faculty to advise them. The process by which a master's student can change advisers is flexible and can be done without any paperwork, provided that the change of adviser is made within the same program. The student, however, is expected to inform their old and new academic advisers, as well as the department's students services office, of such a change. Doctoral students, on the other hand, are expected to be advised by the faculty who admitted them throughout the duration of their doctoral studies. Any change in adviser requires a formal admit letter from the new adviser that includes an explicit commitment to support the student financially throughout the duration of their doctoral studies.

Master's students are expected to meet with their academic program advisers at the beginning of the school year to discuss their courses and proposed year-long academic plans. They are empowered to request an appointment with their adviser at any time throughout the school year to discuss any problems that arise with their studies, or changes with their academic plans.

Doctoral students and their faculty advisers are expected to discuss and agree on how regular meetings will be set up within a day or two of the student's start as a Ph.D. student. The discussion should include meeting frequency and deliverables associated with any of those meetings. They should discuss and agree on how the degree progress will be monitored, for example, through a department annual review process or regular meetings with adviser and thesis committees. They should also discuss all the requirements of the Ph.D. degree, including expectations for the General Qualifying Examination, how and when to select and convene the dissertation reading or thesis committee, when and how to decide when a student is ready to graduate, and when to take the University Oral Examination.

For a statement of University policy on graduate advising, see the "Graduate Advising (http://exploredegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext)" section of this bulletin.

Emeriti: (Professors) Raymond E. Levitt*, Gilbert M. Masters*, Perry L. McCarty*, Henry W. Parker, Martin Reinhard*, Haresh C. Shah, Robert L. Street*, Clyde B. Tatum*, Paul M. Teicholz

Chair: Lynn M. Hildemann

Associate Chair: Ronaldo I. Borja

Professors: Sarah L. Billington, Alexandria B. Boehm, Ronaldo I. Borja (on leave Autumn), Craig S. Criddle, John O. Dabiri, Gregory G. Deierlein, Martin A. Fischer, Oliver B. Fringer, Lynn M. Hildemann, Mark Z. Jacobson, Anne S. Kiremidjian, Peter K. Kitanidis (on leave Winter), Jeffrey R. Koseff, Kincho H. Law, James O. Leckie (on leave Winter), Richard G. Luthy, Eduardo Miranda, William A. Mitch, Stephen G. Monismith, Leonard Ortolano, Alfred M. Spormann (on leave Autumn)

Associate Professors: Jack W. Baker, Jennifer Davis, David L. Freyberg, Michael D. Lepech, Christian Linder, Nicholas T. Ouellette, Ram Rajagopal

Assistant Professors: Catherine Gorlé, Rishee Jain

Courtesy Professor: Margot G. Gerritsen, Peter M. Pinsky

Courtesy Associate Professor: Leif Thomas

Courtesy Assistant Professor: Jenny Suckale

Senior Lecturer: John Barton

Lecturers: Michael Azgour, Deborah Ballati, Michael Bennon, Beverly Choe Harris, Leo Chow, Stanley Christensen, Charles Debbas, Kyle Douglas, Derek Fong, Renate Fruchter, Diana Ginnebaugh, Darryl Goodson, Robert Groves, James Hawk, Kenneth Hayes, Glenn Katz, David Kleiman, Karl Knapp, Drew Krafcik, Nelson Koen Cohen, John Koester, Royal Kopperud, Amy Larimer, Eloi Laurent, Michael Lyons, Sophie Maisnier-Patin, Renë Morkos, Derek Ouyang, Jose Luis Moscovich, Brian O'Kelly, Derek Ouyang, Andrew Peterman, Allison Pieja, Alexander (Sandy) Robertson, Peter Rumsey, Bill Shelander, Brian Shiles, Robert Soden, Charlotte Stanton, J.B. Straubel, Sebastien Tilmans, Isabella Tomanek, Michael Walton, Allison Williams, Peter Williams, Ethen J. Wood, Jon Wren

Adjunct Lecturers: Eduardo Vivanco Antolin, Thomas Beischer, Dimitris Farmakis, Daniel Johnson, Erik Kolderup, Ashby Monk, Peter Rumsey, Mark Sarkisian, Bryan Shiles, Robert Soden, Kristen Stasio, Hattie Stroud, Christopher Wasney

Adjunct Professors: Howard Ashcraft, Vladimir Bazjanac, Terry Beaubois, James Cloern, Angelos Findikakis, Jack Fuchs, Robert Groves, Robert Hickey, Jeremy Isenberg, Calvin Kam, Michael Kavanaugh, Karl Knapp, Mike Lyons, Andrew Manning, Martin McCann Jr., William McDonough, Paul Meyer, Pedram Mokrian, Piotr Moncarz, Jose Luis Moscovitch, Wayne Ott, Paolo Parigi, Benedict Schwegler, Brian Sedar, Patrick Shiel, Michael Steep, Avram Tucker, Antonio Vives, Michael Walton, Jie Wang,Jane Woodward, Jon Wren

Adjunct Associate Professors: Jordan Brandt, Gloria T. Lau, Colin Ong

Adjunct Assistant Professor: Patrick Shiel

Visiting Professor: Alison Kwok

Shimizu Professor: Lydia Bourouiba (Autumn 2018)

* Recalled to active duty.

Overseas Studies Courses in Civil and Environmental 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
OSPAUSTL 10	Coral Reef Ecosystems	3
OSPAUSTL 25	Freshwater Systems	3
OSPAUSTL 30	Coastal Forest Ecosystems	3
OSPMADRD 8A	Cities and Creativity: Cultural and Architectural Interpretations of Madrid	4
OSPSANTG 76	Urban Water	4

Note: OSPAUSTL 10 may count towards the ENVEN-BS and the CE-BS with Specialty in Environmental & Water Studies, however it does not count towards the CE-BS with Specialty in Structures & Construction.