Environmental Engineering

The Environmental Engineering program has a dual mission: to develop state-of-the-art knowledge, models, and processes that form the core of environmental engineering practice, and to train and educate academic and professional environmental leaders. We pursue these goals by synthesizing aspects of physical, biological, and chemical engineering and science along with elements of the social sciences into our research and teaching. Ultimately, our goal is to protect and sustain natural resources and human health by contributing to the sustainable development of physical infrastructure, including systems for water and wastewater management, renewable energy, and resilient coastal environments.

Our curriculum fulfills the diverse needs and interests of students within the interdisciplinary field of Environmental Engineering. The curriculum includes required breadth and depth courses while also offering students the flexibility to choose from five focus areas, including

- Aquatic Chemistry & Biology and Process Engineering
- Environmental and Geophysical Fluid Mechanics
- Environmental Data, Statistics and Modeling
- Human Health and the Environment
- Hydrology and Water Resources

Students interested in biological and chemical aspects of environmental engineering can choose from courses in the Aquatic Chemistry & Biology and Process Engineering focus area. This focus area emphasizes air and water quality and pollution fate and transport, including groundwater remediation and hazardous chemical treatment. Courses concentrate on chemical and biological principles and their application to the analysis and solution of problems in aqueous environments, including quantification and fate of chemicals, pathogens, and nutrients in the environment; 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; and use of microbial bioreactors for degradation of contaminants and recovery of clean water.

Students interested in the physical and mathematical aspects of environmental engineering can choose from courses in the Environmental Data, Statistics and Modeling, Environmental and Geophysical Fluid Mechanics, and Hydrology and Water Resources focus areas. Courses in these areas help students to develop an understanding of the mathematics of and physical processes controlling the movement of mass, energy, and momentum in aquatic environments and the atmosphere. Relevant courses in Environmental and Geophysical Fluid Mechanics address fluid transport and mixing processes; the fluid mechanics of stratified flows; sediment transport processes; natural flows in coastal waters, estuaries, lakes, and open channels; turbulence and its modeling; global atmospheric circulation; the atmospheric boundary layer; air pollution from global to indoor scales; and wind energy. Courses in Hydrology and Water Resources consider watershed hydrology, flow and transport in porous media; remote sensing applications; water resources engineering design and systems analysis; and stochastic methods in surface and subsurface hydrology and in water resources design. Students interested in developing mathematical and statistical models for environmental engineering problems can select courses from the Environmental Data, Statistics and Modeling focus area, which cover statistical, datadriven, and physics-based methods for analysis and modeling of surface water, groundwater, and atmospheric flows.

Students interested in the interface of public health and environmental engineering can select courses from the Human Health and the Environment focus area. Topics covered in this area include quantification of human exposure to biological and chemical contaminants in the environment; methods to enumerate and isolate organisms used to assess risk of enteric illnesses in drinking and recreational waters; modeling of both drivers and health impacts of environmental exposures; and technical, political, and socioeconomic dimensions of water supply and sanitation service provision in both developing and industrialized countries. Students can also pursue coursework in epidemiology and public health policy as part of this focus area, subject to advisor approval.

The program welcomes applicants with backgrounds in all areas of engineering and science who are interested in applying their specialized abilities to the solution of environmental engineering problems. Prospective students who do not have an engineering or science background are encouraged to contact us at cee-admissions@stanford.edu before submitting an application.

DEGREE PROGRAMS

M.S. Degree

Students admitted to graduate standing with a bachelor's degree in Civil and/or Environmental Engineering (or equivalent) will be awarded the degree of Master of Science in Civil and Environmental Engineering by completing the following requirements:

i. The coursework must form a coherent program of study approved by the student's faculty advisor.
ii. A minimum of 45 units of study in residence beyond the bachelor degree, of which at least 27 units must comprise courses within the Department of Civil & Environmental Engineering.
iii. A minimum GPA of 3.0 for MS degree students must be maintained in the quarter being evaluated. Note: Students admitted to an MS program prior to Winter 2023 must meet a minimum of 2.75.
iv. No more than 6 units of coursework that is offered with a letter grade option can be taken for credit/no credit (CR/NC); however, there is no limit on units taken for satisfactory/no credit (S/NC) where a letter grade option is not offered.
v. No more than 9 units of research coursework may count toward the 45 unit requirement.
vi. Maximum 3 units of seminars, including CEE269 seminars.
vii. At least 30 units must be taken at the graduate level (courses numbered 200 or higher). All 100-level courses must be approved by your advisor.
viii. No courses numbered less than 100 can count towards the MS degree.
ix. Non-technical courses, such as remedial English-language instruction (EFSLANG courses checked as required on the Report on English Screening), music courses and physical education, may not be included in the 45 units of required coursework. Students with "required" or "strongly recommended" remedial English courses (such as Linguistics 693A, etc.) must complete these courses or have them waived before applying for graduation.
x. Students may take any courses they wish beyond the 45 program units.

Students will find these planning guidelines useful for devising their own program of study. Each student's program may be tailored to his/her individual goals and objectives, subject to the requirements listed above and the approval of the advisor.

Engineer Degree

The Engineer degree is available for students interested in professional practice who desire advanced work beyond the M.S. A student with a master's degree in Civil and Environmental Engineering (or equivalent) may satisfy the requirements for the degree of Engineer in Civil and Environmental Engineering by completing, in residence, 45 or more units of work including an acceptable thesis (12 to 15 units) and maintaining a B (3.0 GPA) average or higher. Acceptance requires approval by a faculty member who is willing to serve as thesis advisor and has openings for additional students. Consult the CEE Graduate Student Handbook for detailed requirements and procedures.

Ph.D. Degree

The Ph.D. degree is primarily for students planning a career in teaching, research, or technical work of an advanced nature. Candidacy for the Ph.D. degree is formally obtained upon satisfactory completion of the components of the CEE General Qualifying Examination. Candidates for the Ph.D. degree must obtain departmental approval of their course programs and a B (3.0 GPA) average must be maintained for all graduate work. The Ph.D. requires a minimum of two years of study (including 24 units of coursework) beyond the M.S. degree, followed by completion of an acceptable dissertation. Acceptance requires approval by a faculty member who is willing to serve as the dissertation advisor and has openings for additional students. Candidates for the Ph.D. are required to gain teaching experience by completing CEE200 and serving at least one quarter as a teaching assistant. Consult the CEE Graduate Student Handbook for detailed requirements and procedures.

PLANNING GUIDELINES

MS Degree Requirements

Guidelines for Designing a M.S. program

The governing philosophy of the Environmental Engineering program is to ensure proficiency in core areas while also permitting each student to design a program of interest in close consultation with an M.S. program advisor. The degree is kept flexible to foster interaction among students with different interests and to encourage the development of individual programs suitable for a broad range of engineering and science backgrounds and career goals.

Students planning to continue for the Engineer or Ph.D. degrees should note that the first-year program might well include additional courses in topics related to their research interests. Students are encouraged to check the detailed course descriptions at explorecourses.stanford.edu.

Undergraduate Prerequisites

The Environmental Engineering Program is open to applicants with backgrounds in all areas of engineering and science. Certain basic subjects from the traditional areas of civil and environmental engineering are considered essential for students who will receive the M.S. degree in Civil and Environmental Engineering. These requirements are usually fulfilled through completion of a B.S. Degree in Civil Engineering or Environmental Engineering or a related field.

The following courses are required undergraduate courses needed to enroll in the Environmental Engineering M.S. program. These courses may be taken at Stanford, although they cannot count toward the M.S. degree.

Mathematics, Statistics, and Chemistry (Required)
Calculus, at the level of Math 51 ***or*** CME 100.
Statistics and Probability, at the level of Stats 110 ***or*** Stats 116.
Chemistry, at the level of Chem 31A ***and*** Chem 31B.

Students must have the necessary prerequisites listed below in fluid mechanics and aquatic chemistry and biology. The prerequisite for fluid mechanics can be satisfied by taking CEE101B/E or a similar course in fluid mechanics, and the prerequisite for aquatic chemistry and biology can be satisfied by taking CEE177 or CEE270M or a similar course in aquatic chemistry and biology. Because it is an introductory-level course, CEE101B/E cannot count toward the M.S. degree, while CEE177 can count toward the M.S. degree because it is more advanced. However, only one of CEE177 or CEE270M can count toward the degree, but not both.

Fluid Mechanics			
Mechanics of Fluids	CEE 101B/E	3-4	Aut, Sum

Aquatic Chemistry and Biology			
Aquatic Chem. & Biology	CEE 177	4	Aut
-or-			
Aquatic and Org. Chem. for Env. Engineering	CEE 270M	3	Sum

M.S. – ENVIRONMENTAL ENGINEERING

Guidelines for Designing a M.S. Program in Environmental Engineering (Please Read Carefully)

The M.S. degree in Environmental Engineering is designed to be flexible to meet the career goals of the student. In order to ensure proficiency in a core related to Environmental Engineering, every student must complete 45 units of coursework in the following areas:

- Environmental Engineering Core (9 units)
- Seminars (1 unit)
- Environmental Management, Policy, and Law (3 units)
- Focused Electives (18 units)
- Breadth Electives (14 units)

Courses related to these areas are listed on the following pages. Note that the 14 units of Breadth Electives should be earned by completing courses that contribute to a coherent program of study in Environmental Engineering. The program of study must be approved by the M.S. program advisor. No more than 9 of the 14 units of Breadth Electives may be taken in Computer Science and/or Statistics without advisor approval.

Students obtaining the M.S. degree over quarters spanning more than one academic year must adhere to the degree requirements published during the academic year of their first quarter at Stanford. For example, students beginning the M.S. degree during any quarter of the 2022-2023 academic year must adhere to the 2022-2023 degree requirements handout. Any deviations must be approved by the academic advisor.

Please consult explorecourses.stanford.edu for updated information on courses, including prerequisites and scheduling.

MS Degree Requirements

Environmental Engineering Core

Environmental and Process Engineering (Required)

Movement and Fate of Organic Contaminants in Waters	CEE 270	3	Aut	Luthy

Hydrology and Water Resources (At least 1 course. 266C is encouraged unless lacking prior coursework. Consult with the instructor to determine the best placement.)

Watershed Hydrologic Processes and Models	CEE 266A	3	Aut	Freyberg
Water Resources and Hazards	CEE 266B	3	Win	Freyberg
Dams, Reservoirs, and Their Sustainability	CEE 266C	3	Spr	Freyberg

Fluid Mechanics (At least 1 course)

Hydrodynamics	CEE 262A	3-4	Aut	Ouellette
Rivers, Streams, and Canals	CEE 262E	3	Spr	Fong

Seminars (At least 1 unit of 269)

Environmental Engineering Seminar	CEE 269A, B or C	1	Aut/Win/Spr	

Environmental Management, Policy and Law (At least 3 units)

Air Pollution & Global Warming: History, Science, Solns	CEE 263D	3	Win (23-24)	Jacobson
Water & Sanitation in Developing Countries	CEE 265D	3	Spr	Davis
Water Resources Systems Analysis	CEE 266G	3	Aut	Fletcher
The Business of Water	CEE 273B	2	Win	Kline/Thompson *
California Coast: Science / Policy / Law	CEE 275A	3-4	Spr (23-24)	Boehm
Environmental Policy Analysis	CEE 275D	4	Aut	Mauter
Addressing Deep Uncertainty in Systems Models for Sustainability	CEE 366A	3	Win	Fletcher

** Instructor is not in the CEE Department.*

Focused Electives (At least 18 units total)

Depth requirement: At least 3 courses from 1 focus area
Breadth requirement: At least 1 course each from an additional 2 focus areas

Any course listed in multiple focus areas can only be counted toward one focus area in the program of study. An Environmental Engineering core course can be counted as a core or as an elective, but not both. To help with planning, courses not regularly offered are indicated by the academic year in which they will be offered. Students may enroll in core electives that are not listed below but are relevant to the focus areas, subject to approval by the M.S. program advisor.

If a course listed below has the notation *(**Breadth Elective Only)*, it may be counted toward the 14-unit breadth elective requirement, but it may not be counted toward the focused electives. Note that some focus areas have required courses if those focus areas are chosen to fulfill the depth requirement for the focused electives.

Instructors with an asterisk (*) are not in the CEE Department. Due to uncertainty in course scheduling during this time, we recommend confirming the status of courses taught by these instructors.

Aquatic Chemistry & Biology and Process Engineering

Aquatic Chemistry and Biology	CEE 177	4	Aut	Criddle
Aquatic and Org. Chem. for Env. Engineering	CEE 270M	3	Sum	Mitch
Physical and Chemical Treatment Processes	CEE 271A	3	Win	Luthy
Environmental Organic Reaction Chemistry	CEE 270B	2-3	Spr	Mitch
Environmental Biotechnology	CEE 271B	4	Win	Criddle
Desalination for a Circular Water Economy	CEE 273M	3	Spr	Mauter
Environmental Microbiology	CEE 274A	3	Aut	Spormann
Pathogens and Disinfection	CEE 274D	3	Spr	Criddle
Environmental Health Microbiology Lab	CEE 274P	4	Aut	Boehm
Providing Safe Water for the Developing and Developed World	CEE 279D	3	Aut	Mitch
SARS-CoV-2 in the Environment	CEE 371C	3	Win	Boehm

Environmental and Geophysical Fluid Mechanics

Coastal Processes *(**Breadth Elective Only)*	CEE 162F	3	Aut	Fringer
Physics of Wind	CEE 261A	3	Win	Gorlé
Wind Engineering for Sustainable Cities	CEE 261C	3	Spr	Gorlé
Hydrodynamics	CEE 262A	3-4	Aut	Ouellette
Transport and Mixing in Surface Water Flows	CEE 262B	3-4	Win	Monismith
Coastal Ocean Modeling	CEE 262C	3	Spr	Fringer
Introduction to Physical Oceanography	CEE 262D	4	Win	Fong
Rivers, Streams, and Canals	CEE 262E	3	Spr	Fong
Ocean Waves	CEE 262F	3	Aut	Monismith
Observational Methods in Coastal Oceanography	CEE 262H	3	Spr	Monismith
Atmos., Ocean, and Climate Dynamics: Ocean Circulation	CEE 262I	3	Win	Thomas *
Weather and Storms	CEE 263C	3	Aut	Jacobson
Chaos and Turbulence	CEE 363B	3	Spr (23-24)	Ouellette
Geophysical Fluid Dynamics	CEE 363F	3	Spr	Thomas *

Environmental Data, Statistics and Modeling

Computations in Civil and Environmental Engineering	CEE 201D	3	Aut	Kitanidis
Nonlinear Dynamics	CEE 201E	3	Spr	Ouellette
Probabilistic Models in Civil Engineering	CEE 203	3-4	Aut	Baker
Decision Analysis in Civil and Environmental Engineering	CEE 206	3	Sum	Kiremidjian
Data Analytics for Physical Systems	CEE 254	3-4	Aut	Noh
Imaging with Incomplete Information	CEE 260G	3-4	Spr	Kitanidis
Physics of Wind	CEE 261A	3	Win	Gorlé
Data Assimilation	CEE 261D	3	Win	Kitanidis
Coastal Ocean Modeling	CEE 262C	3	Spr	Fringer
Quantitative Methods for Marine Ecology and Conservation	CEE 264H	4	Win (23-24)	De Leo *, et al.
Stochastic Hydrology	CEE 266F	3	Win (23-24)	Fletcher
Uncertainty Quantification	CEE 362A	3	Aut	Gorlé
Addressing Deep Uncertainty in Systems Models for Sustainability	CEE 366A	3	Win	Fletcher

Human Health and the Environment

Air Quality Management	CEE 172	3	Spr	Kopperud
Air Pollution & Global Warming: History, Science, Solns	CEE 263D	3	Win (23-24)	Jacobson
Water & Sanitation in Developing Countries	CEE 265D	3	Spr	Davis
Pathogens and Disinfection	CEE 274D	3	Spr	Criddle
Environmental Health Microbiology Lab	CEE 274P	4	Aut	Boehm
Air Pollution Fundamentals	CEE 278A	3	Aut	Kopperud
Wastewater Treatment: From Disposal to Resource Recovery	CEE 279E	3	Win	Mitch
SARS-CoV-2 in the Environment	CEE 371C	3	Win	Boehm

Hydrology and Water Resources

Water & the Environment: Current Challenges and Solutions	CEE 177E	2	Win	Mauter
Physical Hydrogeology	CEE 260A	4	Aut	Gorelick *
Contaminant Hydrogeology and Reactive Transport	CEE 260C	3	Win	Gorelick *
Remote Sensing of Hydrology	CEE 260D	3	Spr	Konings *
Imaging with Incomplete Information	CEE 260G	3-4	Spr	Kitanidis
Watershed Hydrologic Processes and Models	CEE 266A	3	Aut	Freyberg
Water Resources and Hazards	CEE 266B	3	Win	Freyberg
Dams, Reservoirs, and Their Sustainability	CEE 266C	3	Spr	Freyberg
Stochastic Hydrology	CEE 266F	3	Win (23-24)	Fletcher
Water Resources Systems Analysis	CEE 266G	3	Aut	Fletcher