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, data-

driven, 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, including CEE 398 "Report on Civil Engineering Training."
vi. Maximum 3 units of seminars, including CEE269.
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 more than 2 units of Curricular Practical Training (i.e., CEE 398 "Report on Civil Engineering Training"). These units count toward the 9 units of research coursework, and enrollment in CEE 398 is subject to advisor approval.
ix. No courses numbered less than 100 can count towards the MS degree.
x. 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.
xi. 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.

PLANNING GUIDELINES

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

Required 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.

Recommended Prerequisites

The prerequisites listed below are not required to apply to or enroll in the program, although they may be necessary depending on the courses that will make up the M.S. program of study. For example, if a student is interested in coursework related to environmental and geophysical fluid mechanics, then an undergraduate course in fluid mechanics at the level of CEE101B is a prerequisite for those courses. Similarly, a course in aquatic chemistry and biology at the level of CEE177 is a prerequisite for courses in the M.S. program of study related to aquatic chemistry and biology or process engineering.

Because it is an introductory-level course, 101B/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. Some courses can also be taken online prior to enrolling at Stanford including CEE101E and CEE270M.

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 (10 units)
- Seminar (1 unit)
- Environmental Management, Policy, and Law (3 units)
- Focused Electives (18 units)
- Breadth Electives (13 units)

Courses related to these areas are listed on the following pages. Note that the 13 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 13 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 2024-2025 academic year must adhere to the 2024-2025 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.

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 (Required)

Hydrologic Processes, Water Resources and Hazards	CEE 266B	4	Spr	Freyberg

* With advisor approval, students may enroll in an alternate course from the Hydrology and Water Resources focus area if scheduling does not permit enrollment in CEE 266B.

Fluid Mechanics (At least 1 course)

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

Seminar (Required)

Environmental Engineering Seminar	CEE 269	1	Aut	

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

Equitable Infrastructure Solutions	CEE 245E	3	Win	Osman
Water & Sanitation in Developing Countries	CEE 265D	3	Spr	Davis, J.
Environmental Governance and Climate Resilience in the Face of Wildlife Risk	CEE 265F	3	Win	Fong
Water Resources Systems Analysis	CEE 266G	3	Aut	Fletcher
The Business of Water	CEE 273B	2	Aut	Kline/Thompson *
Water Supply and Management in California and the West	CEE 279X	2	Spr	Luthy

** 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 13-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	Shin
Aquatic and Org. Chem. for Env. Engineering	CEE 270M	3	Sum	Mitch
Physical and Chemical Treatment Processes	CEE 271A	3	Win	Luthy
Fundamentals of Applied Research Design	CEE 270F	3	Win	Davis, J.
Environmental Biotechnology	CEE 271B	4	Win	Shin
Environmental Microbiology	CEE 274A	3	Win	Spormann
Environmental Health Microbiology Lab	CEE 274P	4	Aut	Boehm
Providing Safe Water for the Developing and Developed World	CEE 279D	3	Win	Mitch

Environmental and Geophysical Fluid Mechanics

Coastal Processes *(**Breadth Elective Only)*	CEE 162F	3	Aut	Baker, C.
WindWise: CFD for Civil Engineers and Architects	CEE 261C	3	Win	Gorlé
Hydrodynamics	CEE 262A	3-4	Aut	Fringer
Transport and Mixing in Surface Water Flows	CEE 262B	3-4	Win	Monismith
Introduction to Physical Oceanography	CEE 262D	3	Win	Davis, K. *
Rivers, Streams, and Canals	CEE 262E	3	Spr	Fringer
Ocean Waves	CEE 262F	3	Spr	Baker, C.
Weather and Storms	CEE 263C	3	Win	Jacobson
Topics in Fundamental Turbulence	CEE 363D	2	Win	Ouellette

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, J.
Data Analytics for Physical Systems	CEE 254	3-4	Aut	Noh
Imaging with Incomplete Information	CEE 260G	3-4	Win	Kitanidis
WindWise: CFD for Civil Engineers and Architects	CEE 261C	3	Win	Gorlé
Stochastic Hydrology	CEE 266F	3	Win	Fletcher
Fundamentals of Applied Research Design	CEE 270F	3	Win	Davis, J.
Introduction to Fuzzy Set QCA	CEE 277A	3	Win	Davis, J.
Uncertainty Quantification	CEE 362A	3	Spr	Gorlé
Addressing Deep Uncertainty in Systems Models for Sustainability	CEE 366A	3	Spr	Fletcher

Human Health and the Environment

Air Quality Management	CEE 172	3	Spr	Kopperud
Water & Sanitation in Developing Countries	CEE 265D	3	Spr	Davis, J.
Fundamentals of Applied Research Design	CEE 270F	3	Win	Davis, J.
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	Spr	Mitch

Hydrology and Water Resources

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 (25-26)	Konings *
Imaging with Incomplete Information	CEE 260G	3-4	Win	Kitanidis
Hydrologic Processes, Water Resources and Hazards	CEE 266B	4	Spr	Freyberg
Stochastic Hydrology	CEE 266F	3	Win	Fletcher
Water Resources Systems Analysis	CEE 266G	3	Aut	Fletcher
Fundamentals of Applied Research Design	CEE 270F	3	Win	Davis, J.
Water Supply and Management in California and the West	CEE 279X	2	Spr	Luthy