Environmental engineering encompasses the scientific assessment and development of engineering solutions to environmental problems affecting land, water, and air (the biosphere). The field addresses broad environmental issues, including the safety of drinking water, groundwater protection and remediation, wastewater treatment, indoor and outdoor air pollution, climate change, solid and hazardous waste disposal, cleanup of contaminated sites, the prevention of pollution through product and process design, and strategies for sustainable water and energy use and production.

Environmental engineers must balance competing technical, social, and legal issues concerning the use of environmental resources. Because of the complexity of these challenges, environmental engineers need a broad understanding not only of engineering disciplines but also of chemistry, biology, geology, and economics. Accordingly, the program allows students in the major to select an emphasis on environmental engineering technology, sustainability, global health, economics, or energy and climate change. The program prepares students for leadership positions in industry and government agencies or for further studies in engineering, science, business, law, and medicine.

Two degree programs are offered: the B.S. in Environmental Engineering, and the B.A. in Engineering Sciences (Environmental). The B.S. degree program in Environmental Engineering is designed for students who desire a strong background in environmental engineering leading to a career in the field. The B.A. degree program in Engineering Sciences (Environmental) is intended for students whose careers will involve, but not be dominated by, the skills of environmental engineering. The B.A. program is appropriate for those contemplating a career in which scientific and technological problems can play an important role, as is often the case in law, business, medicine, or public service.

Students are held to the requirements in place when they declared their major. However, with approval from the director of undergraduate studies (DUS), the following prerequisites and major requirements, updated for the academic year 2023-2024, may be fulfilled by students who declared the major in a prior term.

**PREREQUISITES**

**B.A. degree program in Engineering Sciences (Environmental)** The B.A. degree program requires MATH 112 and 115; a two-term lecture sequence in chemistry; and PHYS 170, 171.

**B.S. degree program in Environmental Engineering** The B.S. degree program has the following prerequisites in mathematics and basic sciences: MATH 112, 115; MATH 120 or ENAS 151; ENAS 194; ENAS 130 or S&DS 230; a two-term lecture sequence in chemistry, with corresponding labs; PHYS 180, 181; BIOL 101 and 102 or BIOL 103 and 104.
MARKETING, B.A.

Prerequisites  BUS 101, MATH 112, 115; two-term lecture sequence in marketing; or one term course in marketing

Number of courses  12 term courses beyond prereqs (incl senior req) 

Specific courses required  BUS 101; MATH 112; BUS 201; and BUS 301 or 311

Distribution of courses  3 electives approved by DUS 

Senior requirement  BUS 401 and 411

ENVIRONMENTAL ENGINEERING, B.A.

Prerequisites  MATH 112, 115; two-term lecture sequence in chemistry; or one term course in chemistry

Number of courses  12 term courses beyond prereqs (incl senior req) 

Specific courses required  ENVE 120; ENVE 360; and ENVE 373 or 377

Distribution of courses  5 electives approved by DUS 

Senior requirement  ENVE 416 or 490
**Environmental Engineering**

**Senior requirement**  ENVE 416 or ENVE 490

**FACULTY ASSOCIATED WITH THE PROGRAM IN ENVIRONMENTAL ENGINEERING**

**Professors**  Paul Anastas (Forestry & Environmental Studies), Michelle Bell (Forestry & Environmental Studies), Ruth Blake (Geology & Geophysics), Menachem Elimelech (Chemical & Environmental Engineering), Edgar Hertwich (Forestry & Environmental Studies), Edward Kaplan (School of Management), Jaehong Kim (Chemical & Environmental Engineering), Jordan Peccia (Chemical & Environmental Engineering), Lisa Pfefferle (Chemical & Environmental Engineering), Julie Zimmerman (Chemical & Environmental Engineering)

**Associate Professors**  John Fortner (Chemical & Environmental Engineering), Drew Gentner (Chemical & Environmental Engineering)

**Courses**

* ENVE 120b / CENG 120b / ENAS 120b, Introduction to Environmental Engineering  
  John Fortner  
  Introduction to engineering principles related to the environment, with emphasis on causes of problems and technologies for abatement. Topics include air and water pollution, global climate change, hazardous chemical and emerging environmental technologies. Prerequisites: high school calculus and chemistry or CHEM 161, 165 or CHEM 163, 167 (may be taken concurrently) or permission of instructor.  
  QR, SC

* ENVE 210a / CENG 210a, Principles of Chemical Engineering and Process Modeling  
  Staff  
  Analysis of the transport and reactions of chemical species as applied to problems in chemical, biochemical, and environmental systems. Emphasis on the interpretation of laboratory experiments, mathematical modeling, and dimensional analysis. Lectures include classroom demonstrations. Prerequisite: MATH 115 or permission of instructor.  
  QR, SC  
  0 Course cr

* ENVE 215b, Environmental Engineering Practice  
  Jaehong Kim  
  Focus on the technical tools of environmental engineering and science, with emphasis on data acquisition and integration, experimental project design and problem solving, and science and engineering communication. Students emerge competent in the skills needed for environmental exploration and communication and armed with the tools of discovery. Prerequisite: ENVE 120.

* ENVE 314a / CENG 314a, Transport Phenomena I  
  Kyle Vanderlick  
  First of a two-semester sequence. Unified treatment of momentum, energy, and chemical species transport including conservation laws, flux relations, and boundary conditions. Topics include convective and diffusive transport, transport with homogeneous and heterogeneous chemical reactions and/or phase change, and interfacial transport phenomena. Emphasis on problem analysis and mathematical modeling, including problem formulation, scaling arguments, analytical methods, approximation techniques, and numerical solutions. Prerequisite: ENAS 194 or permission of the instructor.  
  QR, SC  
  0 Course cr
ENVE 315b / CENG 315b, Transport Phenomena II  Amir Haji-Akbari
Unified treatment of momentum, energy, and chemical species transport including
conservation laws, flux relations, and boundary conditions. Topics include convective
and diffusive transport, transport with homogeneous and heterogeneous chemical
reactions and/or phase change, and interfacial transport phenomena. Emphasis on
problem analysis and mathematical modeling, including problem formulation, scaling
arguments, analytical methods, approximation techniques, and numerical solutions.
Prerequisite: ENAS 194 or permission of instructor.  QR, SC

* ENVE 320b / ENRG 320b / MENG 320b, Energy, Engines, and Climate  Staff
The course aims to cover the fundamentals of a field that is central to the future of the
world. The field is rapidly evolving and, although an effort will be made to keep abreast
of the latest developments, the course emphasis is on timeless fundamentals, especially
from a physics perspective. Topics under consideration include: key concepts of climate
change as a result of global warming, which is the primary motivator of a shift in
energy supply and technologies to wean humanity off fossil fuels; carbon-free energy
sources, with primary focus on solar, wind and associated needs for energy storage
and grid upgrade; and, traditional power plants and engines using fossil fuels, that are
currently involved in 85% of energy conversion worldwide and will remain dominant
for at least a few decades. Elements of thermodynamics are covered throughout the
course as needed, including the definition of various forms of energy, work and heat
as energy transfer, the principle of conservation of energy, first law and second law, and
rudiments of heat engines. We conclude with some considerations on energy policy and
with the "big picture" on how to tackle future energy needs. The course is designed for
juniors and seniors in science and engineering. Prerequisite: MENG 211 or permission
from the instructor.  SC

ENVE 360b / ENAS 360b, Green Engineering and Sustainable Design  Julie
Zimmerman
Study of green engineering, focusing on key approaches to advancing sustainability
through engineering design. Topics include current design, manufacturing, and
disposal processes; toxicity and benign alternatives; policy implications; pollution
prevention and source reduction; separations and disassembly; material and
energy efficiencies and flows; systems analysis; biomimicry; and life cycle design,
management, and analysis. Prerequisites: CHEM 161, 165 or 163, 167 (or CHEM 112,
113, or 114, 115), or permission of instructor.

ENVE 373a / CENG 373a, Air Pollution Control  Drew Gentner
An overview of air quality problems worldwide with a focus on emissions, chemistry,
transport, and other processes that govern dynamic behavior in the atmosphere.
Quantitative assessment of the determining factors of air pollution (e.g., transportation
and other combustion–related sources, chemical transformations), climate change,
photochemical “smog,” pollutant measurement techniques, and air quality management
strategies. Prerequisite: ENVE 120.  QR, SC  RP

* ENVE 377b / CENG 377b, Water-Energy Nexus  Lea Winter
This course explores processes and technologies at the water-energy nexus. We utilize
chemical and environmental engineering fundamentals to explore the links between
maintaining clean water supply and energy security globally, as well as implications
for environmental contamination and climate change. We develop a quantitative
understanding of water chemistry and energy considerations for topics including
traditional water and wastewater treatment, energy recovery from wastewater, membrane processes, water electrolysis for energy storage and electrochemical contaminant conversion, industrial water consumption and wastewater production, underground water sources and water for oil and gas, opportunities for reuse of nontraditional source waters and contaminant valorization, and considerations for decentralization, resilience, and electrification. Quantitative understanding of these processes will be attained based on mass and energy balances, systems engineering, thermodynamics, and kinetics. Prerequisite: ENVE 120 or permission of instructor. The course is primarily designed for juniors and seniors majoring in environmental engineering, but students in other engineering majors are welcome. Students in non-engineering majors are also welcome but are encouraged to communicate with the instructor to make sure they have sufficient background knowledge in required mathematics. QR, SC

**ENVE 416b / CENG 416b, Chemical Engineering Process Design** Yehia Khalil
Study of the techniques for and the design of chemical processes and plants, applying the principles of chemical engineering and economics. Emphasis on flowsheet development and equipment selection, cost estimation and economic analysis, design strategy and optimization, safety and hazards analysis, and environmental and ethical considerations. Enrollment limited to seniors majoring in Chemical Engineering or Environmental Engineering. QR, SC

**ENVE 441a, Biological Processes in Environmental Engineering** Jordan Peccia
Fundamental aspects of microbiology and biochemistry, including stoichiometry, kinetics, and energetics of biochemical reactions, microbial growth, and microbial ecology, as they pertain to biological processes for the transformation of environmental contaminants; principles for analysis and design of aerobic and anaerobic processes, including suspended- and attached-growth systems, for treatment of conventional and hazardous pollutants in municipal and industrial wastewaters and in groundwater. Prerequisites: CHEM 161, 165, or 163, 167 (or CHEM 112, 113, or 114, 115, or 118); MCDB 290 or equivalent; or with permission of instructor. SC

**ENVE 448a, Environmental Transport Processes** Menachem Elimelech
Analysis of transport phenomena governing the fate of chemical and biological contaminants in environmental systems. Emphasis on quantifying contaminant transport rates and distributions in natural and engineered environments. Topics include distribution of chemicals between phases; diffusive and convective transport; interfacial mass transfer; contaminant transport in groundwater, lakes, and rivers; analysis of transport phenomena involving particulate and microbial contaminants. Prerequisite: ENVE 120 or permission of instructor. QR, SC

[ **ENVE 473, Air Quality and Energy** ]

* **ENVE 490a or b, Senior Project** Staff
Individual research and design projects supervised by a faculty member in Environmental Engineering, or in a related field with permission of the director of undergraduate studies.