ENVIRONMENTAL ENGINEERING

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FACULTY ASSOCIATED WITH THE PROGRAM IN ENVIRONMENTAL ENGINEERING

Professors Paul Anastas (Forestry & Environmental Studies), Michelle Bell (Forestry & Environmental Studies), Gaboury Benoit (Forestry & Environmental Studies), Ruth Blake (Geology & Geophysics), Stephen Edberg (School of Medicine), Menachem Elimelech (Chemical & Environmental Engineering), Thomas Graedel (Forestry & Environmental Studies), Edward Kaplan (School of Management), Yehia Khalil (Adjunct) (Chemical & Environmental Engineering), Lisa Pfeifferle (Chemical & Environmental Engineering), Joseph Pignatello (Adjunct) (Chemical & Environmental Engineering), James Saiers (Forestry & Environmental Studies)

Associate Professors Jaehong Kim (Chemical & Environmental Engineering), Jordan Peccia (Chemical & Environmental Engineering), Julie Zimmerman (Chemical & Environmental Engineering)

Assistant Professors Drew Gentner (Chemical & Environmental Engineering), Desiree Plata (Chemical & Environmental Engineering)

Environmental engineering encompasses the scientific assessment and development of engineering solutions to environmental problems affecting land, water, and air (the biosphere). The field embraces broad environmental concerns, including the safety of drinking water, groundwater protection and remediation, wastewater treatment, indoor and outdoor air pollution, 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.

Requirements of the major 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.

Prerequisites The B.S. degree program has the following prerequisites in mathematics and basic sciences: MATH 112, 115; MATH 120 or ENAS 151; ENAS 194; a two-term lecture sequence in chemistry, with corresponding labs; PHYS 180, 181; and BIOL 101 and 102 or 103 and 104. 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 requires at least twelve term courses beyond the prerequisites, including the senior requirement. Students take CENG 300 or MENG 211, ENVE 120, 360, 373, 377, and either 315 or 448, EVST 344, and MENG 361 or F&ES 714. At least three electives must be chosen in consultation with the director of undergraduate studies, preferably within one of the following tracks: environmental engineering technology, sustainability, global health, economics, or energy and climate change.

B.A. degree program in Engineering Sciences (Environmental) The B.A. degree program requires nine term courses beyond the prerequisites, including the senior requirement. Students take ENVE 120, 360, and either 373 or 377. Five electives must be chosen in consultation with the director of undergraduate studies.

Senior requirement Students in the B.S. program must pass ENVE 416 in their senior year. Students in the B.A. program must pass ENVE 490 in their senior year.

Credit/D/Fail No course taken Credit/D/Fail may count toward the major, including prerequisites.

REQUIREMENTS OF THE MAJOR

ENVIRONMENTAL ENGINEERING, B.S.

Prerequisites MATH 112, 115; MATH 120 or ENAS 151; ENAS 194; two-term lecture sequence in chemistry, with labs; PHYS 180, 181; BIOL 101 and 102 or 103 and 104

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

Specific courses required CENG 300 or MENG 211; ENVE 120, 360, 373, 377; ENVE 315 or 448; EVST 344; MENG 361 or F&ES 714

Distribution of courses 3 electives as specified

Senior requirement ENVE 416
ENGEERING SCIENCES (ENVIRONMENTAL), B.A.

Prerequisites  MATH 112, 115; two-term lecture sequence in chemistry; PHYS 170, 171
Number of courses  9 term courses beyond prereq (incl senior req)
Specific courses required  ENVE 120, 360; ENVE 373 or 377
Distribution of courses  5 electives approved by DUS
Senior requirement  ENVE 490

Courses

* ENVE 120b / CENG 120b / ENAS 120b, Introduction to Environmental Engineering  Jordan Peccia
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 202b / CHEM 102b / EVST 102b, Introduction to Green Chemistry  Paul Anastas
Overview of the basic concepts and methods needed to design processes and synthesize materials in an environmentally benign way. Related issues of global sustainability. Case studies that suggest possible solutions for the serious environmental and toxicological issues currently facing industry and society. Intended for non–science majors with a basic high school background in chemistry and physics, as well as high school algebra. Does not satisfy premedical chemistry requirements or requirements for the Chemistry major.  QR, SC

ENVE 210a / CENG 210a, Principles of Chemical Engineering and Process Modeling  André Taylor
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 120 or permission of instructor.  QR, SC

ENVE 210b / CENG 210b, Environmental Technology in the Developing World  Drew Gentner
Practical application of environmental engineering fundamentals to solve real-world environmental and human-health problems in underdeveloped regions of the world. Issues related to water and wastewater treatment, water- and air-quality monitoring and control, subsurface remediation, and hygienic infrastructure. Includes a weeklong field trip to Nicaragua during spring break. Prerequisites: ENVE 373 and 377. Priority to Environmental Studies majors. ½ Course cr

ENVE 315b / CENG 315b, Transport Phenomena  Michael Loewenberg
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 327a / F&ES 327a / G&G 327a, Atmospheric Chemistry  Nadine Unger
Study of the chemical and physical processes that determine the composition of the atmosphere; implications for climate, ecosystems, and human welfare. Origin of the atmosphere; photolysis and reaction kinetics; atmospheric transport of trace species; stratospheric ozone chemistry; tropospheric hydrocarbon chemistry; oxidizing power, nitrogen, oxygen, sulfur, and carbon cycles; interactions between chemistry, climate, and biosphere; aerosols, smog, and acid rain. Prerequisites: CHEM 161, 165, or 167 (or CHEM 115 or 118), and MATH 120, or equivalents. ENAS 194 recommended.  QR, SC

ENVE 335b / CENG 335b, 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 210.  QR, SC

* ENVE 377a / CENG 377a, Water Quality Control  Jaehong Kim
Study of the preparation of water for domestic and other uses and treatment of wastewater for recycling or discharge to the environment. Topics include processes for removal of organics and inorganics, regulation of dissolved oxygen, and techniques such as ion exchange, electrodialysis, reverse osmosis, activated carbon adsorption, and biological methods. Prerequisite: ENVE 120 or permission of instructor.  SC, RP

* ENVE 410Lb, Environmental Technology in the Developing World  Jaehong Kim
Practical application of environmental engineering fundamentals to solve real-world environmental and human-health problems in underdeveloped regions of the world. Issues related to water and wastewater treatment, water- and air-quality monitoring and control, subsurface remediation, and hygienic infrastructure. Includes a weeklong field trip to Nicaragua during spring break. Prerequisites: ENVE 373 and 377. Priority to Environmental Studies majors. ½ Course cr
ENVE 416b / CENG 416b, Chemical Engineering Process Design  Paul Van Tassell and Corey Wilson
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 RP

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 473b, Air Quality and Energy  Drew Gentner
The production and use of energy explored as a source of air pollution worldwide. Assessment of emissions and physical/chemical processes; the effects of emissions from energy sources; the behavior of pollutants in energy systems and in the atmosphere. Topics include traditional and emerging energy technology, climate change, atmospheric aerosols, tropospheric ozone, and transport/modeling/mitigation. Prerequisite: ENVE 373 or equivalent. SC

* ENVE 490a or b, Senior Project  Jordan Peccia
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.