

**ENVIRONMENTAL  
ENGINEERING** **ENE**

**Department of Civil and  
Environmental Engineering  
College of Engineering**

**280 Principles of Environmental Engineering and Science**  
Fall, Spring. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: (CEM 141 or CEM 151 or LB 171) and ((MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently))

Physical, chemical and biological processes related to environmental science and engineering. Environmental systems analysis with application to air, water and soil. Analysis of environmental problems and development of engineering solutions.

**421 Engineering Hydrology**  
Fall. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: CE 321 and (GLG 201 or GLG 301) R: Open to juniors or seniors or graduate students in the College of Engineering or in the College of Natural Science or in the Department of Plant, Soil and Microbial Sciences.

Hydrologic design of storm water systems. Equilibrium hydrograph analysis, unit hydrographs, infiltration, hydrograph synthesis, and reservoir routing. Groundwater: Darcy's law, flow nets, well hydraulics, design of capture wells.

**422 Applied Hydraulics**  
Spring. 3(2-2) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: CE 321 or ME 332 R: Open to juniors or seniors or graduate students in the College of Engineering.

Fundamentals of open-channel flow. Rapidly and gradually varied nonuniform flow analysis. Confined flows past submerged bodies, in pipe networks, and in turbo machinery. Design applications.

**480 Environmental Measurements Laboratory**  
Fall. 1(0-3) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: (CEM 161 or CEM 185H or LB 171L) and ENE 280 R: Open to juniors or seniors or graduate students in the College of Engineering.

Basic chemical and microbiological methods used in the analysis of environmental media. Laboratory safety, quality assurance, quality control, and statistics used in laboratory analysis. Related technical communication, laboratory report writing.

**481 Environmental Chemistry: Equilibrium Concepts**  
Fall. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: ((CEM 141 and CEM 142) or (CEM 151 and CEM 152) or (CEM 181H and CEM 182H) or (LB 171 and LB 172)) and (ENE 280 or BE 230 or GLG 201 or GLG 301 or approval of department)

Chemistry of natural environmental systems and pollutants. Equilibrium concepts and calculations for acid-base, solubility, complexation, redox and phase partitioning reactions and processes. Applications to ecosystem analysis, pollutant fate and transport, and environmental protection.

**483 Water and Wastewater Engineering**  
Fall. 3(3-1) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: (ENE 280 or BE 230) and (CE 321 or CHE 311) R: Open to juniors or seniors or graduate students in the College of Engineering.

Engineering and scientific basis and design of physical, chemical and biological methods for the treatment of drinking water and wastewater. Operation process selection and design.

**485 Landfill Design**  
Spring. 3(3-0) Interdepartmental with Civil Engineering. Administered by Civil Engineering. P: ENE 280 and CE 312

Geotechnical and environmental design of solid waste landfills.

**487 Microbiology for Environmental Science and Engineering**  
Spring. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: ENE 280

Fundamentals of microbiology. Application of these concepts to environmental processes such as wastewater treatment, human health and bioremediation.

**489 Air Pollution: Science and Engineering**  
Spring. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: (CEM 141 or CEM 151 or LB 171) and (MTH 133 or MTH 153H or LB 119) and (ENE 280 or BE 230) and (CE 321 or CHE 311) R: Open to juniors or seniors or graduate students in the College of Engineering.

Basic physical and chemical principles governing indoor and atmospheric air pollution. Elements of air pollution meteorology, climate change, atmospheric transformations and transport. Air pollution sources and methods for their control. The role of local, state and federal government in air pollution control.

**490 Independent Study**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to juniors or seniors in the Department of Civil and Environmental Engineering. Approval of department.

Environmental engineering problem of specific interest to the student and a faculty member. May be analysis or design.

**492 Selected Topics in Environmental Engineering**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department.

Selected topics related to environmental engineering, fluid mechanics and hydrology.

**800 Environmental Engineering Seminar**  
Fall, Spring. 1(1-0) R: Open only to Environmental Engineering majors.

Current research in environmental engineering.

**801 Dynamics of Environmental Systems**  
Spring. 3(3-0)

Principles of mass balance, reaction kinetics, mass transfer, reactor theory in environmental engineering.

**802 Physicochemical Processes in Environmental Engineering**  
Fall. 3(3-0) RB: ENE 801

Physical and chemical principles of air and water pollution control and environmental contaminants in water, air and soils.

**803 Water Quality and Public Health**  
Spring of odd years. 3(3-0)

Principles, applications, and latest research in the area of water quality and public health. Various chemical and microbiological water contaminants and their health effects. Concepts of public health and epidemiology, principles of toxicology, exposure characterization and risk assessment approaches, water management alternatives, and global issues of concern.

**804 Biological Processes in Environmental Engineering**  
Fall. 3(3-0) RB: ENE 801 or concurrently

Engineering of microbial processes used in wastewater treatment, in-situ bioreclamation, and solid waste stabilization.

**805 Contaminated Site Remediation**  
Spring of odd years. 3(3-0) RB: Undergraduate classes in environmental engineering.

Key topics within contaminated site remediation. Regulations relevant to remediation. Site characterization and assessment. Removal technologies, mechanisms involved, variations in approaches, advantages and limitations. Case studies for each method. Overview of air treatment technologies. Remediation approaches for problematic groundwater contaminants.

**806 Environmental Engineering Process Laboratory**  
Spring. 3(2-4) P: ENE 480 and ENE 802 and ENE 804 R: Open to graduate students in the Environmental Engineering major.

Development of skills related to planning, design, and execution of processes related to environmental engineering, enhance decision making skills, teamwork, analysis of data, report writing, and oral presentation.

**811 Membrane Processes**  
Spring of odd years. 3(3-0) RB: (CE 321 or concurrently) and Calculus through differential equations, Physical chemistry

Fundamental principles and applications of membrane processes in environmental engineering, emphasizing solid-liquid separations and pressure-driven membrane systems.

## Environmental Engineering—ENE

### 821 Groundwater Hydraulics

Fall. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering.

Physical properties of porous media. Equations of flow in saturated media. Flow nets, well flow and parameter measurement. Transport processes and the advective-dispersion equation for conservative contaminants.

### 822 Groundwater Modeling

Spring of even years. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering.

Analysis and modeling of groundwater flow, surface water and groundwater interaction, and reactive contaminant transport. Applied numerical methods for solving groundwater flow and contaminant transport equations. Case studies.

### 829 Mixing and Transport in Surface Waters

Fall of odd years. 3(3-0) Interdepartmental with Civil Engineering. Administered by Environmental Engineering. P: ENE 801

Waves, tides and shallow-water processes. Numerical solutions and applications of shallow-water equations to lakes, rivers and estuaries. Principles and processes of sediment transport, and dispersion of materials in surface waters. Wind-driven circulation in Lake Michigan.

### 880 Independent Study in Environmental Engineering

Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to Environmental Engineering majors.

Solution of environmental engineering problems not related to student's thesis.

### 890 Selected Topics in Environmental Engineering

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to students in the Environmental Engineering major.

Selected topics in new or developing areas of environmental engineering.

### 892 Master's Research Project

Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. R: Open only to master's students in the Environmental Engineering major. Approval of department.

Master's degree Plan B individual student research project. Original research, research replication, or survey and reporting on a research topic.

### 899 Master's Thesis Research

Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course.

Master's thesis research.

### 900 Research Strategies and Methods in Environmental Engineering and Science

Spring. 1(1-0) Interdepartmental with Geological Sciences. Administered by Environmental Engineering. R: Open to graduate students in the Department of Civil and Environmental Engineering and open to graduate students in the Department of Geological Sciences. Not open to students with credit in CE 900.

Criteria for quality research, scientific method, scientific arguments, statistical testing, critical thinking skills, reviewing journal articles, literature synthesis, writing proposals and papers, giving presentations, responsible conduct of research.

### 999 Doctoral Dissertation Research

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.

Doctoral dissertation research.