Environmental Engineering (M.S.ENV.E.)

About The Program:

The M.S.Env.E. program is designed to provide students with the opportunity to develop a greater technical competency in the general area of Environmental Engineering. Students are motivated to grow intellectually through the continued search for and use of knowledge, and are provided with the catalyst to become active, articulate, and socially aware individuals. Graduates of the program are key contributors to the civil engineering and environmental engineering professions.

Career Options: Graduates with the M.S.Env.E. in Environmental Engineering are employed by various engineering companies as well as government agencies in design, analysis, and applications. Typical examples are water treatment facilities and regulatory agencies engaged in environmental regulation and pollution control; companies involved in construction project management; and those involved in structural design and analysis of buildings, bridges, and other structures. Students who complete an M.S.Env.E. with a thesis are prepared to enter a doctoral program.

Prerequisites for Admission: An undergraduate degree in Science, Technology, or Engineering from an ABET-accredited or equivalent institution. Students with an undergraduate degree in a related field may also be considered, though they may require some prerequisite coursework.

Areas of Specialization:
For each of the two areas of specialization, research includes:

- Civil Engineering Systems — three major branches of civil engineering: construction engineering, structural engineering, and transportation engineering.
- Environmental Engineering — the fundamentals and applications of water resources engineering, pollution in natural systems (water and air), and engineered treatment and remediation systems.

For the M.S.Env.E. program, students also choose between three tracks:

1. The Thesis Track is intended for students pursuing advanced research and includes 24 credits of didactic coursework, 3 credits of Project (CEE 9995), and 3 credits of Thesis (CEE 9996).
2. The Project Track introduces students to applied research and includes 27 credits of didactic coursework and 3 credits of Project (CEE 9995).
3. The Coursework Track provides students with an advanced engineering background for their future in the engineering profession through 30 credits of didactic coursework.

In the first term, the student and the CEE Graduate Program Director establish a graduate Plan of Study that outlines all required courses and the sequence for the student to follow. This form is used to track the student's progress as the various benchmarks in the program are completed. Once established, any revisions to the Plan of Study require approval in advance. However, if considering whether to change one's track, the student should note that:

- "Thesis" credits (CEE 9996) can only be applied toward the Thesis M.S.Env.E. Track and cannot be applied to either the Project or Coursework Tracks.
- "Project" credits (CEE 9995) can be applied toward the Thesis and Project M.S.Env.E. Tracks but cannot be used for the Coursework Track.

Requirements of Programs:

- **Total Credit Hours**: 30
- **Culminating Events**:

Thesis Track:
The culminating events in the Thesis Track are typically undertaken during the last two successive terms of study. Successful completion requires the following:

Thesis Proposal — CEE 9995 Project (3 credits)

Under the guidance of the advisor, the student conducts independent research on an applied engineering topic of current interest and registers for CEE 9995. This work includes the research and preliminary results that form the basis of an extended study that the student plans to carry on in CEE 9996 Thesis in the following term. The student submits a research report as her/his Thesis Proposal to a committee consisting of three or more faculty members, including the faculty advisor, and presents her/his proposal in an open College-wide seminar, which is scheduled and posted at least 10 business days in advance of the presentation date. Immediately following the presentation, the student's advisory committee questions the student about the details and strategy of the proposed research. The committee then accepts, accepts with revisions, or rejects the proposal. The student must pass the Thesis Proposal before registering for CEE 9996. If the student fails Thesis Proposal, s/he may either re-register for CEE 9995 (1 credit) in the next regular term and repeat the entire proposal process or consider switching to the Project or Coursework Track. *NOTE: A second failure of Thesis Proposal results in automatic dismissal from the University.* If switching to another track, the Plan of Study form requires updating and appropriate approvals.

Thesis Defense — CEE 9996 Thesis (3 credits)

The student should register for CEE 9996 in the term that s/he plans to defend the thesis. The thesis document should be prepared in a format compliant with University standards. (See Graduate School Policy 02.26.12.02.) Two weeks prior to the thesis defense, the student provides the committee with a copy of the completed thesis and posts an announcement of the defense, which is to take place during a regular academic term (i.e., not scheduled during study days, final exams, or the breaks between terms). If the student is to graduate in the same term as the thesis defense is held, then the defense should take place at least 30 days prior to the end of the term.

The thesis defense is an open College seminar in which the student presents the concepts and results of her/his research. Immediately following the defense, the thesis committee convenes to closely examine the student's research and decide to accept the thesis as provided, accept the thesis with revisions, or not accept the thesis. If the thesis is accepted, a letter grade for CEE 9996 is assigned. If the thesis is accepted with revisions, then the student must submit the revised thesis within 30 days and with the approval of the Thesis Committee. If the thesis is not accepted, but the committee decides to not fail the student, an "R" grade is assigned to CEE 9996. In the following term, the student registers for one credit of ENGR 9991 Directed Research until s/he is again prepared to attempt the defense. The defense procedures described above are then carried out again in the term that the student is prepared to defend the thesis.

Project Track:
The culminating event for the Project Track is CEE 9995 Project. This entails a one-term research activity done under the supervision of a full-time faculty advisor on an applied engineering topic of interest. Near the end of the term, the student prepares a report of her/his findings and presents the study in an open departmental seminar. Both the seminar and the written report are used to determine the student's grade for CEE 9995. The grade is determined jointly by the advisor and another designated grader selected by the Graduate Program Director.

Coursework Track:
No culminating event is warranted for the Coursework Track.

Core Courses (Thesis Track)

Choose one from the following:

Physical Principals of Environmental Systems - Basic principles of process engineering as they relate to pollution control are studied, including heat and mass transfer; mixing, chemical, and biological reactions; and reaction and kinetics.

Advanced Physical/Chemical Treatment Processes – There are numerous sites in the environment where surface water, ground water or soil is contaminated with toxic chemicals. In addition, many industrial wastewater and air emissions contain toxic chemicals which required treatment. Due to the chemical toxicity, we rely on physical and chemical processes for the decontamination of the fluid stream. Some of the commonly used treatment technologies are carbon absorption, air stripping and scrubbing. Of late, advanced oxidations processes have been examined and implemented as well. These processes are also used to produce high quality drinking water. The course deals with the analysis and design of some commonly used advanced physical/chemical processes for treatment of contaminated water and air. This course complements, and builds upon the fundamental science discussed in other courses in the curriculum on physical and chemical principles. In this course, emphasis will be placed on understanding the basic science, and the engineering design principles. Treatment of water, wastewater and air using processes such as air stripping, scrubbing, carbon absorption and advanced oxidation processes will be discussed, and design of the treatment systems will be conducted.

Choose one from the following:

Chemical Principles of Environmental Systems – This course focuses on the essential chemical principles necessary to understand the nature of commonly occurring pollution problems and engineering approaches to their solutions; thermodynamics, chemical equilibria, acid-base chemistry, carbonate system, Redox chemistry, and adsorption/desorption phenomena.

Environmental Organic Chemistry – This is an advanced course focusing on examination of processes that affect the behavior and date of anthropogenic organic contaminants in aquatic environments. The lectures will focus on intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physiochemical transformation reactions of organic contaminants.

Choose one from the following:

Advanced Biological Wastewater Treatment – Biological processes play a central role in wastewater treatment and are used in every wastewater treatment plant to remove organic compounds, nutrients, and other compounds from the water before discharging it back to the environment. The objective of the course is to provide environmental engineers and scientists with advanced concepts and quantitative tools necessary for understanding environmental processes and designing environmental treatment systems related to wastewater including advanced aerobic and anaerobic processes. The course integrates the use of microbiological principles into engineering wastewater treatment process. The course will provide a better understanding of interesting and complex environmental topics related to sustainable environmental remediation and protection. The course is valuable as a prerequisite to more advanced research in environmental engineering, as a technical education to stimulate graduate students' interest in environmental sustainability, and as an introduction to environmental constraints that are increasingly important to other engineering disciplines.

Environmental Biotechnology – Biotechnology plays a central role in environmental science and engineering, including wastewater treatment, pathogen control, and biodegradation. The objective of the course is to provide environmental engineers and scientists with advanced concepts and quantitative tools that are necessary for understanding environmental processes and designing environmental protection systems.

Electives

Select five from the following:

Engineering Hydrology - Quantifying water flow in watersheds is a crucial step in the design of environmental facilities, such as drinking water treatment plants, and in delineating floodplains. This course deals with the water cycle over watersheds by addressing the motion of water masses in the atmosphere and in surface and subsurface systems. Students who successfully pass this class are able to deal with most hydrology problems treated in the industry sector.

Fate of Pollutants in Subsurface Environments - This course focuses on integrated chemical, physical, and microbiological principles of contaminant fate and transport processes necessary in the use of engineered approaches toward selecting and implementing subsurface cleanup options. It also covers abiotic processes, biotic processes, empirical models, and vulnerability mapping.

Contaminant Dynamics in Urban Streams - This course will focus on environmental systems near the air:water and water:sediment interfaces. These systems are by definition boundary or edge systems and are therefore exceptionally important to aquatic ecosystem functioning. After briefly discussing the air:water interface in rivers and lakes, the course will focus on the water:sediment interface. It is here that steep gradients in chemical concentration can be found and significant nutrient cycling occurs. In addition, studies have shown that significant ecosystem productivity and respiration occurs within the bed sediments of flowing water. The course will discuss the concept of transient storage and hyporheic exchange; issues surrounding modeling of transient storage and hyporheic exchange; phosphorus and nitrogen biogeochemistry within the hyporheic zone; and biotic/abiotic nutrient cycling.

Environmental Hydrology - Topics include the physics of surface and subsurface circulation and storage of water and the transport of contaminants in watersheds, soils, aquifers, rivers, the ocean, and the atmosphere, as well as the laws and equations that govern the recharge, flow, storage, and discharge of water in natural environments. Emphasis is given to qualitative analysis and quantitative evaluation methods of the different hydrologic processes with potential applications in surface and groundwater resources engineering, and environmental analysis. Analytical and numerical procedures to solve the arising equations are presented, along with the most commonly used models to solve water resources problems. Also studied are engineering methods for the sustainable use of water resources; engineering methods for the containment and treatment of surface and groundwater pollution; and the restoration of aquifers.

Urban Streams and Stormwater Management - Stormwater management has become a significant issue in recent years. In the past, the typical thinking was "get it out of my town," which resulted in downstream communities suffering the brunt of poor or inadequate management. In fact, only the rate of runoff was addressed, not the volume nor the quality of that runoff. In urban areas, the volume of runoff increases significantly due to additional impervious cover (e.g., pavement and rooftops), and urban stormwater runoff causes water quality degradation due to excess amounts of nutrients, metals, bacteria, and sediment. This course addresses the impact of improperly controlled runoff on urban streams and how the rate, volume, and quality of urban stormwater runoff can be properly controlled through appropriate Best Management Practice (BMP) implementation.
Air Pollution Control - Topics include theory and principles of the design and operation of the major categories of air pollution control equipment, and an introduction to dispersion modeling. An extensive design problem is a major course component.

Aquatic Toxicology in Environmental Engineering - This course provides an introduction to the basic concepts of toxicology necessary to understand the effects of contaminants in the water environment. Specific topics include sources and classes on aquatic contaminants, environmental chemistry that influences behavior in the aquatic environment, the disposition and metabolism of these substances that affect their toxicity, and the physiological response of exposure in aquatic species and humans. The course will provide an overview of aquatic toxicity testing methods and application of toxicity data in the risk assessment of aquatic exposures to emerging contaminants, such as pesticides, pharmaceuticals, and natural products. Case studies will cover historical and contemporary examples of contaminant-driven effects.

Water and Wastewater Systems Design - This course covers the design of water distribution and sewage handling facilities, including sewers, pumping stations, seepage beds, septic tanks, spray irrigation, and natural treatment systems, such as overload and swamp treatment.

Non-Didactic Courses

Project - A project is assigned with the approval of the Civil and Environmental Engineering Graduate Committee and conducted under the supervision of a graduate faculty advisor. An oral presentation in an open seminar and a written report are required to complete the independent project. Projects related to industrial applications are encouraged. For non-thesis students only.

Thesis - Master's thesis. May be taken twice.

Core Courses (Project Track)

Choose one from the following:

Physical Principals of Environmental Systems - Basic principles of process engineering as they relate to pollution control are studied, including heat and mass transfer; mixing, chemical, and biological reactions; and reaction and kinetics.

Advanced Physical/Chemical Treatment Processes – There are numerous sites in the environment where surface water, ground water or soil is contaminated with toxic chemicals. In addition, many industrial wastewater and air emissions contain toxic chemicals which required treatment. Due to the chemical toxicity, we rely on physical and chemical processes for the decontamination of the fluid stream. Some of the commonly used treatment technologies are carbon absorption, air stripping and scrubbing. Of late, advanced oxidations processes have been examined and implemented as well. These processes are also used to produce high quality drinking water. The course deals with the analysis and design of some commonly used advanced physical/chemical processes for treatment of contaminated water and air. This course complements, and builds upon the fundamental science discussed in other courses in the curriculum on physical and chemical principles. In this course, emphasis will be placed on understanding the basic science, and the engineering design principles. Treatment of water, wastewater and air using processes such as air stripping, scrubbing, carbon absorption and advanced oxidation processes will be discussed, and design of the treatment systems will be conducted.

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Environmental Organic Chemistry – This is an advanced course focusing on examination of processes that affect the behavior and date of anthropogenic organic contaminants in aquatic environments. The lectures will focus on intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physiochemical transformation reactions of organic contaminants.

Choose one from the following:

Advanced Biological Wastewater Treatment – Biological processes play a central role in wastewater treatment and are used in every wastewater treatment plant to remove organic compounds, nutrients, and other compounds from the water before discharging it back to the environment. The objective of the course is to provide environmental engineers and scientists with advanced concepts and quantitative tools necessary for understanding environmental processes and designing environmental treatment systems related to wastewater including advanced aerobic and anaerobic processes. The course integrates the use of microbiological principles into engineering wastewater treatment process. The course will provide a better understanding of interesting and complex environmental topics related to sustainable environmental remediation and protection. The course is valuable as a prerequisite to more advanced research in environmental engineering, as a technical education to stimulate graduate students' interest in environmental sustainability, and as an introduction to environmental constraints that are increasingly important to other engineering disciplines.

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Electives

Select six from the following:

Engineering Hydrology - Quantifying water flow in watersheds is a crucial step in the design of environmental facilities, such as drinking water treatment plants, and in delineating floodplains. This course deals with the water cycle over watersheds by addressing the motion of water masses in the atmosphere and in surface and subsurface systems. Students who successfully pass this class are able to deal with most hydrology problems treated in the industry sector.

Fate of Pollutants in Subsurface Environments - This course focuses on integrated chemical, physical, and microbiological principles of contaminant fate and transport processes necessary in the use of engineered approaches toward selecting and implementing subsurface cleanup options. It also covers abiotic processes, biotic processes, empirical models, and vulnerability mapping.

Contaminant Dynamics in Urban Streams - This course will focus on environmental systems near the air:water and water:sediment interfaces. These systems are by definition boundary or edge systems and are therefore exceptionally important to aquatic ecosystem functioning. After briefly discussing the air:water interface in rivers and lakes, the course will focus on the water:sediment interface. It is here that steep gradients in chemical concentration can be found and significant nutrient cycling occurs. In addition, studies have shown that significant ecosystem productivity and respiration occurs within the bed sediments of flowing water. The course will discuss the concept of transient storage and hyporheic exchange; issues surrounding modeling of transient storage and hyporheic exchange; phosphorus and nitrogen biogeochemistry within the hyporheic zone; and biotic/abiotic nutrient cycling.

Environmental Hydrology - Topics include the physics of surface and subsurface circulation and storage of water and the transport of contaminants in watersheds, soils, aquifers, rivers, the ocean, and the atmosphere, as well as the laws and equations that govern the recharge, flow, storage, and discharge of water in natural environments. Emphasis is given to qualitative analysis and quantitative evaluation methods of the different hydrologic processes with potential applications in surface and groundwater resources engineering, and environmental analysis. Analytical and numerical procedures to solve the arising equations are presented, along with the most commonly used models to solve water resources problems. Also studied are engineering methods for the sustainable use of water resources; engineering methods for the containment and treatment of surface and groundwater pollution; and the restoration of aquifers.

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Core Courses (Coursework Track)

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Courses:

Click HERE for more information on the courses below.

- Probability and Statistics in Engineering
- Probability Statistics in Engineering
- Special Topics
- Transportation Systems Management
- Transportation Engineering
- Structural Design of Pavements
- Bridge Design
- Transportation Engineering Materials
- Intelligent Transportation Systems
- Airport Engineering
- Pavement Management and Traffic Systems Management
- Introduction to Geosynthetics
- Pavement Rehabilitation and Maintenance
- Construction Administration
- Engineering Project Management
- Construction Financial Management
- Construction Equipment Management
- Geotechnical Engineering
- Structural CADD Systems
- Structural Dynamics
- Behavior and Design of Steel Structures
- Structural Mechanics
- Behavior and Design of Masonry Structures
- Behavior and Design of Reinforced Concrete Structures
- Earthquake Engineering and Seismic Design
- Life Cycle Assessment and Carbon Footprinting
- Engineering Hydrology
- Fate of Pollutants in Subsurface Environments
- Contaminant Dynamics in Urban Streams
- Environmental Hydrology
- Urban Streams and Stormwater Management
- Physical Principals of Environmental Systems
- Chemical Principles of Environmental Systems
- Mathematical Modeling
- Air Pollution Control
- Weather Monitoring and Forecasting
- Solid Wastes Engineering
- Environmental Chemistry
- Environmental Organic Chemistry
- Chemistry for Environmentally Sustainable Engineering
- Sustainable Development and Industrial Ecology
- Sustainability Aspects of Water Supply and Wastewater Treatment
- Membrane Separation in Wastewater Treatment
- Biological Principles of Environmental Systems
- Environmental Biotechnology
- Advanced Biological Wastewater Treatment
- Aquatic Toxicology in Environmental Engineering
- Environmental Engineering
- Advanced Soil Mechanics
- Foundation Engineering
- Earth Retaining Systems
- Geotechnical Earthquake Engineering
- Advanced Project Management
- Advanced Physical/Chemical Treatment Processes
- Advanced Chemical Principles of Environmental Systems. 3
- Computer Modeling of Environmental Transport
- Water and Wastewater Systems Design
- Independent Study I
- Directed Research
- Project
- Thesis