

MASTER OF SCIENCE IN ENGINEERING IN CIVIL AND ENVIRONMENTAL ENGINEERING

Civil and Environmental Engineering Graduate Program Director

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Program Description

Civil and environmental engineers apply scientific and engineering knowledge to protect and improve the infrastructure, public health, and the natural and built environment. Graduate study in Civil and Environmental Engineering (CEE) provides students with advanced scientific and engineering knowledge in their field of interest, and develops their abilities to formulate solutions to new and complex problems in the context of current social, global, environmental, and economic considerations. These objectives are accomplished by flexible plans of study designed to meet the needs of graduate students. Graduates find fulfilling careers in public and private industries and consulting practices, and are prepared for doctoral-level study leading to research/teaching careers. The CEE program offers five different plans - thesis, non-thesis, management, internship and accelerated 4+1 MSE. It offers advanced courses in all five sub-disciplines of Civil and Environmental Engineering based on available faculty expertise:

- Structural engineering
- Geotechnical engineering
- Transportation engineering
- Environmental engineering
- Water resources engineering

Facilities for advanced study and research are located in Moser Hall, which houses a variety of well-equipped laboratories. These include the Graduate Research Lab, Strength of Materials Lab, Hydraulics/Fluid Mechanics Lab, Environmental Engineering Lab, Geotechnical Engineering Lab, Surveying Lab, and Concrete Mixtures Lab. In addition, the STEM College Open Computer Lab provides access to a large number of modern workstations equipped with high-speed internet connections and latest software for modeling in various fields of research. The Graduate Research Lab is equipped with state-of-the-art computers and cutting-edge modeling software for research.

Admission Requirements

Applicants must meet all of the general requirements for admission into Graduate Studies. Admission to the CEE program is selective and based on the academic and professional qualifications of the applicant. Although GRE is not required for admission, applicants with lesser qualifications may be granted provisional graduate student status based on the evaluation of their undergraduate transcripts, standardized test (e.g., GRE) results, work experience, and other professional qualifications. Graduate assistantship is offered to highly qualified applicants based on the needs of the program and the availability of funding.

The Master of Science in Engineering (MSE) may be characterized as being both career-oriented and flexible. Five different program plans are available to accommodate the needs of nearly every engineering graduate student. Graduate students enrolled in the CEE graduate program must complete:

- 30 semester hours for the thesis plan,
- 30 semester hours for the non-thesis plan,
- 33 semester hours for the management plan,
- 30 semester hours for the internship plan, or
- 30 semester hours for the accelerated 4+1 MSE plan*.

*The accelerated 4+1 MSE plan is only available to students already in the YSU Civil Engineering undergraduate program.

The degree requirements consist of core courses, technical courses, graduate internships, and thesis or project courses. The management plan requires a series of management courses. The internship plan requires 6-9 semester hours of graduate-level internship courses. The internship must be in the civil and environmental engineering discipline, be comparable to a graduate course work, and have to approved by the Graduate Program Director.

The CEE program is designed to provide graduate students with the knowledge and skills necessary to excel in professional careers and/or to pursue a PhD or doctoral degree in Civil Engineering. To obtain a list of core and technical courses required in the CEE graduate program, contact the Graduate Program Director.

Program Requirements General Requirements

At the time of initial enrollment, the student will select a program plan (thesis, non-thesis, management, or internship) and research area (structural, geotechnical, transportation, environmental, water resources) available through faculty expertise and consultation. The general requirements for each plan are listed under Program Plans above.

Graduate students must meet the Graduate Program Director each semester before registering for courses. In cooperation with an assigned faculty advisor and the Graduate Program Director, each student will establish a set of academic goals and desired outcomes, and a coursework plan to meet those objectives. Upon completion of the graduate program, all students will complete either a written or an oral assessment of the effectiveness of the program in meeting their established goals and outcomes.

Thesis students, who have registered for all required thesis hours and have completed all course requirements but have not finished the thesis, are required to maintain current student status if they expect to utilize any University service (e.g., parking, computers, library, advisors' assistance, thesis defense, etc.). This can normally be accomplished by registering for at least one semester hour of thesis credit.

Thesis Plan

Graduate students choosing the thesis plan are required to complete 30 semester hours of graduate coursework. This generally consists of:

- 6 semester hours of core courses,
- 18 semester hours of technical concentration courses, and
- 6 semester hours of thesis.

This plan is strongly recommended for all candidates who wish to continue their graduate studies beyond the master's degree. All teaching and graduate assistants are required to choose this option. The thesis provides firsthand research experience with experimental design, literature searches, research methodology, technical report writing, and oral presentation of research results. Additionally, the thesis option can lead the graduate student to a higher level of expertise in the chosen area of specialization. Students enrolled in this plan are required to have a thesis proposal approved by the faculty advisor and the Graduate Program Director before the end of their second semester into the CEE graduate program.

COURSE	TITLE	S.H.
Mathematics/Computer Science Courses		6
		s.h.

MATH 6910	Advanced Engineering Mathematics 1	
MATH 6911	Advanced Engineering Mathematics 2	
or		
CSCI 6951	Data Science and Machine Learning	
Master's Thesis		
CEEN 6990	Thesis	6
		S.H.
Civil Environmental Engineering Technical Electives A minimum of 9 s.h. must be at the 6900 level. Only one course outside the CEEN program is allowed.		18
		s.h.
CEEN 5820	Pavement Material and Design	3
CEEN 5836	Environmental Water Chemistry	3
CEEN 5837	Environmental Engineering Design	3
CEEN 5849	Structural Analysis 2	3
CEEN 5855	Reinforced Concrete Design	3
CEEN 5856	Steel Design	3
CEEN 5869	Design of Air Pollution Control Systems	3
CEEN 5880	Advanced Hydraulics	3
CEEN 5884	Solid and Hazardous Waste Management	3
CEEN 6910	Advanced Strength of Materials	3
CEEN 6923	Pavement Rehabilitation	3
CEEN 6932	Natural Systems Engineering	3
CEEN 6956	Advanced Soil Mechanics	3
CEEN 6958	Structural Dynamics	3
CEEN 6967	Biological Treatment Processes	3
CEEN 6973	Watershed Modeling	3
CEEN 6977	Hydrology	3
CEEN 6979	Water Quality Modeling	3
CEEN 6982	Foundation Engineering	3
CEEN 6983	Bridge Engineering	3
Outside CEEN (only 1 course)		
CHEN 5820	Industrial Pollution Control	3
ENST 5830	Toxicology and Risk Assessment	3
GIS 6901	Introduction to Geographic Information Science	3
GIS 6903	Advanced Geographic Information Science	3
MECH 5884	Finite Element Analysis	3

Non-thesis Plan

The non-thesis plan is designed for students who wish to enhance their knowledge and skills to succeed in careers as practicing engineers, but are unlikely to pursue a PhD or a doctoral degree. A total of 30 semester hours of coursework is required for this plan. This generally consists of:

- 6 semester hours of core courses,
- 21 semester hours of technical concentration courses, and
- 3 semester hours of project.

Non-thesis students must complete the graduate project under the guidance of a faculty advisor. Students enrolled in this plan are required to have a project proposal approved by the faculty advisor and the Graduate Program Director before the end of their second semester into the CEE graduate program. Graduate students enrolled in a graduate project course will be required to defend the results of his or her project by giving a presentation to the engineering faculty and students.

COURSE	TITLE	S.H.
Mathematics/Computer Science Courses		
		6
		s.h.
MATH 6910	Advanced Engineering Mathematics 1	
MATH 6911	Advanced Engineering Mathematics 2	
or		
CSCI 6951	Data Science and Machine Learning	

CSCI 6951	Data Science and Machine Learning	
Graduate Projects		
CEEN 6989	Graduate Projects	3
		s.h.
Civil Environmental Engineering Technical Electives A minimum of 9 s.h. must be at the 6900 level. Only one course outside the CEEN program is allowed.		21
		s.h.
CEEN 5820	Pavement Material and Design	3
CEEN 5836	Environmental Water Chemistry	3
CEEN 5837	Environmental Engineering Design	3
CEEN 5849	Structural Analysis 2	3
CEEN 5855	Reinforced Concrete Design	3
CEEN 5856	Steel Design	3
CEEN 5869	Design of Air Pollution Control Systems	3
CEEN 5880	Advanced Hydraulics	3
CEEN 5884	Solid and Hazardous Waste Management	3
CEEN 6910	Advanced Strength of Materials	3
CEEN 6923	Pavement Rehabilitation	3
CEEN 6932	Natural Systems Engineering	3
CEEN 6956	Advanced Soil Mechanics	3
CEEN 6958	Structural Dynamics	3
CEEN 6967	Biological Treatment Processes	3
CEEN 6973	Watershed Modeling	3
CEEN 6977	Hydrology	3
CEEN 6979	Water Quality Modeling	3
CEEN 6982	Foundation Engineering	3
CEEN 6983	Bridge Engineering	3
Outside CEEN (only 1 course)		
CHEN 5820	Industrial Pollution Control	3
ENST 5830	Toxicology and Risk Assessment	3
GIS 6901	Introduction to Geographic Information Science	3
GIS 6903	Advanced Geographic Information Science	3
MECH 5884	Finite Element Analysis	3

Management Plan

Students who have been in the work arena and are moving into an engineering management role may wish to choose the management plan. A total of 33 semester hours of coursework is required for this plan. This generally consists of:

- 6 semester hours of core courses,
- 6-9 semester hours of business courses,
- 15-18 semester hours of technical courses, and
- 3 semester hours of graduate project.

Students enrolled in this plan are required to have a project proposal approved by the faculty advisor and the CEE Graduate Program Director before the end of their second semester into the program. A graduate student enrolled in a graduate project course will be required to defend the results of his or her project by giving a presentation to the engineering faculty and students. Students with the Management Plan should consult the Graduate Program Director and the faculty advisor to develop their course plan.

COURSE	TITLE	S.H.
Mathematics/Computer Science Courses		
		6
		s.h.
MATH 6910	Advanced Engineering Mathematics 1	
MATH 6911	Advanced Engineering Mathematics 2	
or		
CSCI 6951	Data Science and Machine Learning	

Business Courses		6-9 s.h.
ISEN 6920	Project Management	3
ISEN 6935	Decision Analysis for Engineering	3
ISEN 6939	Operations & Supply Chain Strategy	3
OMBA 6923	Corporate Financial Management	3
OMBA 6944	Operations & Supply Chain Management	3
OMBA 6948	Project Management	3
Graduate Projects		
CEEN 6989	Graduate Projects	3 s.h.
Civil Environmental Engineering Technical Electives		15-18 s.h.
A minimum of 9 s.h. must be at the 6900 level. Only one course outside the CEEN program is allowed.		
CEEN 5820	Pavement Material and Design	3
CEEN 5836	Environmental Water Chemistry	3
CEEN 5837	Environmental Engineering Design	3
CEEN 5849	Structural Analysis 2	3
CEEN 5855	Reinforced Concrete Design	3
CEEN 5856	Steel Design	3
CEEN 5869	Design of Air Pollution Control Systems	3
CEEN 5880	Advanced Hydraulics	3
CEEN 5884	Solid and Hazardous Waste Management	3
CEEN 6910	Advanced Strength of Materials	3
CEEN 6923	Pavement Rehabilitation	3
CEEN 6932	Natural Systems Engineering	3
CEEN 6956	Advanced Soil Mechanics	3
CEEN 6958	Structural Dynamics	3
CEEN 6967	Biological Treatment Processes	3
CEEN 6973	Watershed Modeling	3
CEEN 6977	Hydrology	3
CEEN 6979	Water Quality Modeling	3
CEEN 6982	Foundation Engineering	3
CEEN 6983	Bridge Engineering	3
Outside CEEN (only 1 course)		
CHEN 5820	Industrial Pollution Control	3
ENST 5830	Toxicology and Risk Assessment	3
GIS 6901	Introduction to Geographic Information Science	3
GIS 6903	Advanced Geographic Information Science	3
MECH 5884	Finite Element Analysis	3

Internship Plan

Students enrolled in this plan are required to have an internship proposal approved by the Graduate Program Director before the end of their first semester into the CEE program. The graduate internship must be approved by the CEE Graduate Program Director on a case by case basis for graduate course credit. The internship shall be in the civil and environmental discipline and be comparable to a graduate course work. Graduate internship in responsible charge will require at least 400 hours of work for 3 semester hours of graduate credit. Internship students are strongly encouraged to consult with the STEM Professional Practices Office to seek internship opportunities. A total of 30 semester hours of coursework is required for this plan. This generally consists of:

- 6 semester hours of core courses,
- 6-9 semester hours of internship courses,
- 12-15 semester hours of technical courses, and
- 3 semester hours of graduate project.

Students enrolled in this plan are required to have a project proposal approved by the faculty advisor and the CEE Graduate Program Director before

the end of their second semester into the program. A graduate student enrolled in a graduate project course will be required to defend the results of his or her project by giving a presentation to the engineering faculty and students. Students with the Internship Plan should consult the Graduate Program Director and the faculty advisor to develop their course plan.

COURSE	TITLE	S.H.
Mathematics/Computer Science Courses		6 s.h.
MATH 6910	Advanced Engineering Mathematics 1	
MATH 6911	Advanced Engineering Mathematics 2	
or		
CSCI 6951	Data Science and Machine Learning	
Internship Courses		6-9 s.h.
STEM 6990	STEM Graduate Internships	3 S.H.
Graduate Projects		
CEEN 6989	Graduate Projects	3 s.h.
Civil Environmental Engineering Technical Electives		12-15 s.h.
A minimum of 9 s.h. must be at the 6900 level. Only one course outside the CEEN program is allowed.		
CEEN 5820	Pavement Material and Design	3
CEEN 5836	Environmental Water Chemistry	3
CEEN 5837	Environmental Engineering Design	3
CEEN 5849	Structural Analysis 2	3
CEEN 5855	Reinforced Concrete Design	3
CEEN 5856	Steel Design	3
CEEN 5869	Design of Air Pollution Control Systems	3
CEEN 5880	Advanced Hydraulics	3
CEEN 5884	Solid and Hazardous Waste Management	3
CEEN 6910	Advanced Strength of Materials	3
CEEN 6923	Pavement Rehabilitation	3
CEEN 6932	Natural Systems Engineering	3
CEEN 6956	Advanced Soil Mechanics	3
CEEN 6958	Structural Dynamics	3
CEEN 6967	Biological Treatment Processes	3
CEEN 6973	Watershed Modeling	3
CEEN 6977	Hydrology	3
CEEN 6979	Water Quality Modeling	3
CEEN 6982	Foundation Engineering	3
CEEN 6983	Bridge Engineering	3
Outside CEEN (only 1 course)		
CHEN 5820	Industrial Pollution Control	3
ENST 5830	Toxicology and Risk Assessment	3
GIS 6901	Introduction to Geographic Information Science	3
GIS 6903	Advanced Geographic Information Science	3
MECH 5884	Finite Element Analysis	3

Accelerated 4+1 MSE PLAN

This plan is only available to students who are already in the Civil Engineering undergraduate program. A total of 30 semester hours of coursework is required for this plan. This generally consists of:

- 6 semester hours of core courses,
- 18-21 semester hours of technical courses, and
- 3 semester-hour graduate project or 6 semester-hour thesis

Undergraduate students can apply for admission into the accelerated program for the MSE in Civil and Environmental Engineering after completing

78 semester hours with a GPA of 3.3 or higher. After being admitted into the program, students can take a maximum of nine semester hours of graduate coursework that can count toward both the bachelor's and the master's degree. The courses chosen to count for both undergraduate and graduate coursework must be approved by the Graduate Program Director upon admission into the program. An additional three hours of graduate coursework at the 6000 level can be completed as an undergraduate student and used exclusively for graduate credit. This option is described in details in the accelerated 4+1 MSE program website.

Student Learning Outcomes (SLO): Civil and Environmental Engineering

At the time of graduation from the Civil and Environmental Engineering graduate program, students should be able to demonstrate:

- (a) advanced technical knowledge in one or more civil and environmental engineering subsdiscipline(s)
- (b) proficiency in scholarly research
- (c) effective oral and written communication skills

CEEN 5820 Pavement Material and Design 3 s.h.

Design methods for flexible, rigid and other wheel-supporting pavements to include investigation, testing and preparation of subgrade, base course and pavement materials, design of various pavement mixtures, stresses in pavements, pavement design, and strengthening existing pavements.

Prereq.: CEEN 3720 and CEEN 4881.

CEEN 5829 Civil Engineering Materials - Concrete 3 s.h.

A course designed to broaden the student's understanding of Portland Cement Concrete as a construction material. Topics include the study of cement, hydration of cement, aggregates, admixtures for concrete, mix design handling and placing, curing and properties of Portland Cement Concrete. Testing of Concrete, quality control and special concretes are also included. A library research paper on a concrete-related topic of the student's choice is required.

Prereq.: CEEN 3749 or permission of instructor.

CEEN 5832 Natural Systems Engineering 3 s.h.

Introduction to the features, functions and values of natural aquatic systems, and engineering approaches to analysis and restoration design. Focus on wetlands and streams. Topics include regulations, wetland delineation, constructed wetland design, basic stream geomorphology, and stream restoration design.

Prereq.: CEEN 3736 or permission of instructor.

CEEN 5836 Environmental Water Chemistry 3 s.h.

Fundamental principles and calculations of major chemical reactions and equilibria that occur in aquatic environments, and water/wastewater treatment processes.

Prereq.: CEEN 3736.

CEEN 5837 Environmental Engineering Design 3 s.h.

Theory and design of unit operations and processes for treatment of drinking water and municipal wastewater.

Prereq.: CEEN 3736.

CEEN 5849 Structural Analysis 2 3 s.h.

Analysis of statically indeterminate beams, trusses, bents and multistory frames, utilizing concepts of strain energy, virtual work, slope-deflection, and moment distribution. Introduction to matrix methods of analysis using force and displacement methods.

Prereq.: CEEN 3749.

CEEN 5855 Reinforced Concrete Design 3 s.h.

An introduction to the behavior, analysis, and design of reinforced concrete members. Included are singly and doubly reinforced beams, tee-beams, slabs, short and long columns.

Prereq.: CEEN 3749.

CEEN 5856 Steel Design 3 s.h.

An introduction to the behavior and design of steel structures. Included is the design of rolled and built-up tension members, beams, columns, beam-columns, welded and bolted connections.

Prereq.: CEEN 3749.

CEEN 5869 Design of Air Pollution Control Systems 3 s.h.

Engineering analysis, procedures, and techniques for the selection, applications and operation of air pollution control methods in various operational situations.

Prereq.: CEEN 3736.

CEEN 5877 Systems Engineering and Project Management 3 s.h.

Systems approach to engineering design; non-linear models; linear programming; dynamic programming; network analysis; project management.

Prereq.: MATH 3705.

CEEN 5879 Water Quality Modeling 3 s.h.

Mathematical modeling of physical, chemical, and biological processes in natural systems; development of computer models to simulate the fate and transport of pollutants in lakes, streams, and estuaries; application of models to evaluate water resource management options.

Prereq.: C or better in CEEN 3736.

CEEN 5880 Advanced Hydraulics 3 s.h.

Application of hydraulic principles for one dimensional river modeling; understanding the fundamental processes of open channel hydraulics; application of HEC-RAS/HEC-GeoRAS models for river system modeling.

Prereq.: A "C" or better in CEEN 3717.

CEEN 5882 Foundation Engineering 3 s.h.

Analysis and design of various foundations, including abutments, piers, piles, and footings; slope stability of embankments.

Prereq.: CEEN 4881 and CEEN 5855.

CEEN 5883 Bridge Engineering 3 s.h.

Analysis and design of concrete and steel bridges; specifications and code requirements; design detailing; effects of natural and man-made hazards on bridges; implications of bridge failures.

Prereq.: CEEN 5855 and CEEN 5856.

CEEN 5884 Solid and Hazardous Waste Management 3 s.h.

Sources, characteristics, handling and disposal options for solid waste and hazardous waste; topics include regulations, health effects, waste minimization, collection systems, landfill design, treatment and processing methods, and site assessment.

Prereq.: CEEN 3736.

CEEN 6910 Advanced Strength of Materials 3 s.h.

The basic methods of structural mechanics, such as conditions of equilibrium and compatibility, stress-strain relations. General treatment of energy principles including virtual work, minimum potential energy; applications to statically determinate and indeterminate systems such as rings, curved beams, plates, and other elastic systems.

CEEN 6920 Pavement Material & Design 3 s.h.

Design methods for flexible, rigid and other wheel-supporting pavements to include investigation, testing and preparation of subgrade, base course and pavement materials, design of various pavement mixtures, stresses in pavements, pavement design, and strengthening existing pavements.

Prereq.: CEEN 3720 and CEEN 4881.

Cross-Listed: CEEN 5820.

CEEN 6921 Groundwater and Surface Water Modeling 3 s.h.

Mathematical simulation of hydrodynamic processes and pollutant transport in subsurface and surface water environments.

Prereq.: CEEN 3716 Fluid Mechanics and CEEN 3736 Fundamentals of Environmental Engineering.

CEEN 6923 Pavement Rehabilitation 3 s.h.

Engineering concepts and information needed to maintain and rehabilitate pavements. Project evaluation, testing, and analysis. Design of rigid and flexible overlays and other methods of rehabilitation. Selection of rehabilitation alternatives. Analysis of the effects of maintenance activities on pavement performance. Initial and life cycle cost analysis of various rehabilitation alternatives.

Prereq.: CEEN 3720, CEEN 4881.

CEEN 6930 Sediment and Contaminant Transport 3 s.h.

Understanding of sediment and contaminant transport in fluvial environments. Topics include sediment characteristics, incipient motion, scour, bankfull discharge, advection, and mixing.

Prereq.: CEEN 3717 or equivalent.

CEEN 6932 Natural Systems Engineering 3 s.h.

Introduction to the features, functions and values of natural aquatic systems, and engineering approaches to analysis and restoration design. Focus on wetlands and streams. Topics include regulations, wetland delineation, constructed wetland design, basic stream geomorphology, and stream restoration design.

Prereq.: CEEN 3736 or permission of instructor.

Cross-Listed: CEEN 5832.

CEEN 6941 Structural Mechanics 3 s.h.

Study of beams under lateral load; beams with combined lateral load and thrust; buckling beams on elastic foundations; applications of Fourier series and virtual work principles to beam type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of engineering theory of plates.

CEEN 6947 Finite Element Analysis 3 s.h.

An introduction to finite element techniques as applied to problems in structural mechanics. Direct and variational methods of element formulation with application to beams, beam columns, frames, arches, thin plates, and shells.

CEEN 6951 Construction Project Management 3 s.h.

An integrated approach to construction project management. Advanced topics of Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) and its application in construction project scheduling. Resource allocation and leveling, construction cost control, computer simulation of construction operations, and expert systems construction.

CEEN 6952 Foundation Engineering 3 s.h.

Principles of mechanics of materials applied to foundation problems; stresses and deformations in soils, consolidation theory; shallow and deep foundation design.

CEEN 6953 Flow Through Porous Media 3 s.h.

Analysis of seepage volume and stresses due to flow of water through soils in connection with dams, slopes, excavations, subsurface drainage, and wells.

CEEN 6956 Advanced Soil Mechanics 3 s.h.

Development of shear strength theories, Mohr-Coulomb-Hvorslev equation, critical path concept, stability of slopes, lateral earth-pressure theories, development of bearing capacity equations.

Prereq.: CEEN 4881 or equivalent.

CEEN 6957 Structural Stability 3 s.h.

A study of the elastic stability of engineering structures, beam columns, static buckling of elastic beams, frames, plates, and shells, dynamic stability of beams and plates.

CEEN 6958 Structural Dynamics 3 s.h.

Analysis of the response of structures to air blasts and earthquake motions; development of both the normal mode and frequency response methods in dealing with periodic and nonperiodic excitations.

CEEN 6959 Advanced Steel Design 3 s.h.

Advanced topics in the structural design of girders, frames, and trusses. Light gauge metal structures. Use of modern alloys and hybrid systems.

CEEN 6961 Advanced Concrete Design 3 s.h.

Consideration of advanced design techniques for reinforced concrete members and structures such as composite and prestressed concrete beams, box girders, and slabs.

CEEN 6965 Special Topics 3 s.h.

The application, in civil engineering, of special topics selected by the faculty from fields of current research interest or special emphasis. May be repeated up to six semester hours.

CEEN 6967 Biological Treatment Processes 3 s.h.

Theory and design of biological processes used in the treatment of municipal and industrial wastewaters, and in the remediation of hazardous wastes.

Prereq.: CEEN 3736.

CEEN 6972 Advanced Topics in Environmental Engineering 3 s.h.

Advanced concepts related to the transport, reaction, phase distribution, and fate of pollutants in both the natural environment and treatment systems.

Prereq.: CEEN 3736.

CEEN 6973 Watershed Modeling 3 s.h.

Application of hydrologic principles for modeling point and non-point source pollution at the watershed scale; the nutrient and sediment transport simulation using SWAT model; understanding the fundamental processes of pollutant movement through the soils and overland flow; application of data driven modeling in Water Resources Engineering.

CEEN 6975 Physical and Chemical Treatment Processes 3 s.h.

Theory and design of physical and chemical processes used in the treatment of water supplies, wastewater, and hazardous wastes.

Prereq.: CEEN 3736.

CEEN 6976 Design of Small Dams 3 s.h.

Flood routing, reservoir engineering. Hydraulic design of small gravity, earth fill and rock fill dams, spillways, and energy dissipaters.

Prereq.: CEEN 3717 and CEEN 6977.

CEEN 6977 Hydrology 3 s.h.

Precipitation; hydrologic abstractions; runoff; urban and small watershed hydrology; frequency analysis; digital simulation.

CEEN 6978 Water Resources Policy and Management 3 s.h.

International, national, and local water resources case studies, laws, policies, and management strategies are discussed. The need and demand for water; technical, economic, financial, social, environmental, and political considerations; data requirements; multipurpose projects.

CEEN 6979 Water Quality Modeling 3 s.h.

Mathematical modeling of physical, chemical, and biological processes in natural systems; development of computer models to simulate the fate and transport of pollutants in lakes, streams, and estuaries; application of models to evaluate water resource management options.

Prereq.: CEEN 3736 Fundamentals of Environmental Engineering.

Cross-Listed: CEEN 5879.

CEEN 6982 Foundation Engineering 3 s.h.

Analysis and design of various foundations, including abutments, piers, piles, and footings; slope stability of embankments.

Prereq.: CEEN 4881 and CEEN 5855.

CEEN 6983 Bridge Engineering 3 s.h.

Analysis and design of concrete and steel bridges; specifications and code requirements; design detailing; effects of natural and man-made hazards on bridges; implications of bridge failures.

Prereq.: CEEN 5855 and CEEN 5856.

CEEN 6989 Graduate Projects 1-3 s.h.

Special projects involving research, analysis, design, or other independent investigation, undertaken by the M.S. student under the direction of a graduate faculty member with the approval of the department chair. Credit will be determined in each case based on the nature and extent of the project.

CEEN 6990 Thesis 1-9 s.h.

Hours arranged. May be repeated.