Civil and Environmental Engineering

Chair

- Michelle Scherer

Undergraduate major: civil engineering (B.S.E.)
Graduate degrees: M.S. in civil and environmental engineering; Ph.D. in civil and environmental engineering
Faculty: http://www.engineering.uiowa.edu/cee/people/faculty-kee
Web site: http://www.engineering.uiowa.edu/cee/

Civil engineering is one of the three largest fields of engineering. It traditionally has been concerned with infrastructure facilities that are both large in scale and essential to modern life. Civil and environmental engineering projects include transportation systems and their components, such as bridges, highways, public transit systems, railways, harbors, airports, and seaports; large-scale structures and office buildings that provide enclosed working and living space; environmental and hydraulic systems that provide clean water and air, including filtration plants and distribution systems for municipal and industrial water supplies, wastewater treatment plants, dams, levees, and irrigation systems.

Growth areas of civil and environmental engineering include water sustainability, infrastructure development, construction management, computer-aided design, hazardous waste management, and engineered environmental systems. In the future, civil and environmental engineers will be called upon to design structures for earth, prevent erosion and sedimentation of our rivers, predict effects of global climate change on the environment, provide modern and efficient transportation systems, and ensure the quality of our air and our surface waters and groundwaters.

In planning and design, civil and environmental engineers work with other engineers, architects, landscape architects, planners, economists, financiers, sociologists, lawyers, and other specialists as members of the design team. Some civil engineers work in engineering offices; others may be called upon to construct or supervise outdoor projects they have designed. These field assignments, many of which are in remote and fascinating parts of the world, are particularly appealing to many civil and environmental engineers. There also is significant potential for entrepreneurial work by civil and environmental engineers as they start their own companies.

Undergraduate Program of Study

- Major in civil engineering (Bachelor of Science in Engineering)
Within a few years of graduation, graduates of the program are expected to:
- be productive and contributing members of the civil and environmental engineering profession as practitioners, entrepreneurs, researchers or teachers, and be engaged in learning, understanding, and applying new ideas as the field develops;
- pursue advanced studies if qualified and interested; and
- promote the safety, health, and welfare of the public and environmental through professional practice and civic leadership.

Bachelor of Science in Engineering

The Bachelor of Science in Engineering requires a minimum of 131 s.h. Students majoring in civil engineering choose one of two subtracks: civil, which provides breadth in the discipline; or environmental, which provides for a concentration.

All engineering students complete the B.S.E. core requirements, which include RHET:1030 Rhetoric; ENGR:1100 Engineering Problem Solving I and ENGR:1300 Engineering Problem Solving II; and courses in chemistry, engineering mathematics and fundamentals, and physics. They must earn a grade of C-minus or higher in the core requirements MATH:1550 Engineering Mathematics I: Single Variable Calculus and MATH:1560 Engineering Mathematics II: Multivariable Calculus.

They also complete the curriculum designed for their major program, which covers four major stems: mathematics and basic sciences, engineering topics, an elective focus area, and the general education component (15 s.h. of humanities and social science courses). For information about the curriculum stems, see Bachelor of Science in Engineering in the Catalog.

Civil subtrack and environmental subtrack requirements are the same for the first semester of the first year but are different after that.

Students must select elective focus area courses according to guidelines established by the Department of Civil and Environmental Engineering. See “Elective Focus Area” after the following curriculum list.

The following study plan includes the B.S.E. core requirements and the curriculum for the civil engineering major. Some courses in the curriculum are prerequisites for others. Students must complete a course’s prerequisites before they may register for the course. Those who take courses in the order below satisfy the prerequisite requirements automatically.

Civil Subtrack

FIRST YEAR

First Semester

- ENGR:1000 Engineering Success for First-Year Students (credit does not count toward B.S.E. degree) 1 s.h.
- ENGR:1100 Engineering Problem Solving I 3 s.h.
- CHEM:1110 Principles of Chemistry I 4 s.h.
- MATH:1550 Engineering Mathematics I: Single Variable Calculus 4 s.h.
- RHET:1030 Rhetoric 4-5 s.h.

Second Semester

- ENGR:1300 Engineering Problem Solving II 3 s.h.
- MATH:1560 Engineering Mathematics II: Multivariable Calculus 4 s.h.
Second Semester

CEE:2015 Civil and Environmental Engineering Practice 2 s.h.
ENGR:2110 Engineering Fundamentals I: Statics 2 s.h.
ENGR:2120 Engineering Fundamentals II: Electrical Circuits 3 s.h.
ENGR:2130 Engineering Fundamentals III: Thermodynamics 3 s.h.
MATH:2560 Engineering Mathematics IV: Differential Equations 3 s.h.
PHYS:1612 Introductory Physics II 3-4 s.h.

Third Semester

CEE:1030 Introduction to Earth Science 3-4 s.h.
CEE:2000 CEE Sophomore Seminar 0 s.h.
CEE:2150 Natural Environmental Systems 3 s.h.
ENGR:2710 Dynamics 3 s.h.
ENGR:2750 Mechanics of Deformable Bodies 3 s.h.
STAT:2020 Probability and Statistics for the Engineering and Physical Sciences 3 s.h.
General education component course 3 s.h.

Fourth Semester

CEE:3001 Leadership Seminar 1 s.h.
CEE:3530 Soil Mechanics 3 s.h.
CEE:3533 Principles of Structural Engineering 3 s.h.
CEE:3763 Principles of Transportation Engineering 3 s.h.
ENGR:2510 Fluid Mechanics 4 s.h.
Elective focus area course 3 s.h.

Second Semester

CEE:3002 Professional Skills Seminar 1 s.h.
CEE:3155 Principles of Environmental Engineering 4 s.h.
CEE:3371 Principles of Hydraulics and Hydrology 3 s.h.
CEE:3586 Civil Engineering Materials 3 s.h.
General education component course 3 s.h.
Elective focus area course 3 s.h.

Third Semester

CEE:3003 Senior Design Seminar 1 s.h.
General education component course 3 s.h.
Two elective focus area courses 6 s.h.
Two of these, each from a different technical area:
CEE:3136 Design of Concrete Structures 3 s.h.
CEE:4157 Environmental Engineering Design 3 s.h.
CEE:4374 Water Resource Design 3 s.h.
**Joint B.S.E./M.S.**

The College of Engineering offers a joint (fast-track) Bachelor of Science in Engineering/Master of Science for civil engineering undergraduate students who intend to earn an M.S. in civil and environmental engineering. B.S.E./M.S. students may attend the departmental graduate seminar and work on a master's thesis or research project while they are still undergraduates. They may count a limited amount of course work toward both degrees. Once students complete the requirements for the bachelor's degree, they are granted the B.S.E., and they normally complete the M.S. one year later.

To be admitted to the joint degree program, students must have completed at least 80 s.h. and must have a cumulative g.p.a. of at least 3.25. They must submit an application form to the Department of Civil and Environmental Engineering, along with a letter stating their proposed area of specialization and the name of a department faculty member willing to be their primary M.S. advisor. They also must identify a faculty sponsor who can guide them from at least the second semester of their senior year until they complete the M.S.

Applications are due by March 1.

**Graduate Programs of Study**

- **Master of Science in civil and environmental engineering**
- **Doctor of Philosophy in civil and environmental engineering**

Graduate study in civil and environmental engineering prepares students for professional careers and further study. The principal concentration areas are environmental engineering and environmental science; hydraulics, hydrology, and water resources; structures, mechanics, and materials; and transportation.

The department also participates in two Graduate College programs: Applied Mathematical and Computational Sciences, an interdisciplinary doctoral program; and Transportation Studies, a graduate certificate program (see "Related Certificate: Transportation Studies" below).

**Research and Study Areas**

**ENVIRONMENTAL ENGINEERING AND SCIENCE**

The environmental engineering and science curriculum provides a comprehensive base of course work and research in the areas of air- and water-quality management, environmental chemistry and microbiology, natural systems modeling, and processes for water supply, pollution control, and solid and hazardous waste management. Interdisciplinary specialization and study are conducted with programs including IIHR—Hydroscience & Engineering, the Center for Global and Regional Environmental Research, the Center for Health Effects of Environmental Contamination, the Hazardous Substances Research Center, the Center for Biocatalysis and Bioprocessing; the Departments of Chemical and Biochemical Engineering, Earth and Environmental Sciences, Geographical and Sustainability Sciences, Microbiology, Occupational and Environmental Health; and the School of Urban and Regional Planning. New areas of interdisciplinary focus include groundwater contamination, biotechnology, global climate change, and hazardous substances.
HYDRAULICS, HYDROLOGY, AND WATER RESOURCES

The hydraulics, hydrology, and water resources curriculum is associated with IIHR—Hydroscience & Engineering, a world-renowned research institute. Senior staff members of the institute are professors in the program; they devote about half of their time to teaching.

IIHR offers unique opportunities for students to participate actively in the research, analysis, and design aspects of real-world problems. Considerable attention is given to the use of computers in mathematical modeling and in data acquisition and processing. IIHR high-speed computer facilities and advanced graphics and communication software complement the hydrology, hydraulics, and water resources curriculum.

STRUCTURES, MECHANICS, AND MATERIALS

The structures, mechanics, and materials curriculum is designed for students who wish to gain knowledge and skill in the mechanics of solids and structures that they can apply to civil infrastructure systems and other fields. The program concentrates on developing appropriate methodologies for tackling broad, complex issues related to civil infrastructure systems, and on educating engineers in the implementation and application of methodologies to actual engineering projects. Faculty members have expertise in structural engineering, design optimization, solid mechanics, and computational methods.

TRANSPORTATION ENGINEERING

The transportation engineering curriculum aims at graduating students interested in developing specialized knowledge and skills applicable to the diverse set of issues associated with transportation. Faculty members have expertise in traffic engineering, infrastructure management systems, pavement engineering, advanced construction materials, dynamic load and pavement simulation, optimal design, winter highway maintenance, real-time simulation, human factors, intelligent sensors, nondestructive testing, transportation planning, and travel demand modeling.

Master of Science

The Master of Science program in civil and environmental engineering requires a minimum of 30 s.h. of graduate credit, with or without thesis. The program enables students to concentrate in one or more areas of their choice. Graduates are placed in advanced technical positions in industry, consulting firms, or government, or they may continue their graduate study. Current and projected demand for M.S. graduates is excellent. Students who choose the thesis program may earn up to 6 s.h. for the thesis.

With the approval of their advisor, students develop a study plan that satisfies the requirements of their chosen curriculum. All M.S. students must maintain a g.p.a. of at least 2.75, pass an oral examination, and in some program options, a written examination.

Consult the department’s Graduate Student Manual for more detailed information about the M.S. program in civil and environmental engineering.

Doctor of Philosophy

The Doctor of Philosophy program in civil and environmental engineering requires a minimum of 72 s.h. of graduate credit. The doctoral degree is granted primarily on the basis of achievement rather than on a prescribed course of study.

Students usually need at least three years of full-time graduate study to complete the degree. All students must pass a qualifying examination. Students also must pass a written and oral comprehensive examination before they may be formally admitted to Ph.D. candidacy; the comprehensive examination usually is taken after all required course work has been completed. Students devote one year to the preparation of a dissertation that contributes to knowledge in the field; they must defend their dissertation successfully in a final examination. Ph.D. students must maintain a g.p.a. of at least 3.00 throughout the program.

Consult the department’s Graduate Student Manual for more detailed information about the Ph.D. program in civil and environmental engineering.

Related Certificate: Transportation Studies

The Transportation Studies Program offers the Certificate in Transportation Studies, which requires 18 s.h. of graduate credit. The program focuses on the varied and complex problems of transportation and on interdisciplinary approaches to addressing them. The Departments of Civil and Environmental Engineering, Mechanical and Industrial Engineering, and Geographical and Sustainability Sciences and the School of Urban and Regional Planning participate in the program, which is administered by the Graduate College and the University’s Public Policy Center. See Transportation Studies (Graduate College) in the Catalog for more information about the certificate.

Admission

Applicants must meet the admission requirements of the Graduate College; see the Manual of Rules and Regulations of the Graduate College.

Each of the program’s curricula is flexible; students may be admitted from all disciplines of engineering as well as from the mathematical and basic sciences.

Applicants to the M.S. program should have a cumulative undergraduate g.p.a. of at least 3.00. Ph.D. applicants should have a graduate g.p.a. of at least 3.00. Applicants whose grade-point average is slightly lower should contact the department.

Applicants should have a combined verbal and quantitative score of at least 301 on the Graduate Record Examination (GRE) General Test. Lower scores are considered with other evidence of academic promise (recommendation letters, grade-point average). GRE General Test scores also are used in financial aid decisions.

Financial Support

A significant number of research assistantships are available on a variety of research projects, as are a limited number of teaching assistantships. Selection of recipients usually is based on scholastic achievement and research interest.
Facilities and Laboratories

Undergraduate Core

The first-year engineering course ENGR:1100 Engineering Problem Solving I includes an introduction to the college's Engineering Computer Services. Students in the course use computer-aided design tools on engineering workstations. All civil engineering courses require knowledge of personal computers and contain significant computer content.

For information about laboratories affiliated with core courses coordinated by other engineering departments, see the Catalog section for each of the departments.

Required and Elective Undergraduate Laboratories

CEE:2015 Civil and Environmental Engineering Practice (2 s.h.), CEE:3763 Principles of Transportation Engineering (3 s.h.), and CEE:3084 Project Design and Management in Civil Engineering (3 s.h.): use of a state-of-the-art laboratory for computer-aided design and drawing.

CEE:3530 Soil Mechanics (3 s.h.): equipped for determining the classification, seepage characteristics, stress-strain properties, and strength of soils.

CEE:3155 Principles of Environmental Engineering (4 s.h.): conducted at the University Water Treatment Plant and Iowa City Wastewater Plant for demonstrations of unit operations and processes of water and wastewater treatment, and applications in environmental chemistry and microbiology.

CEE:3371 Principles of Hydraulics and Hydrology (3 s.h.): hydraulics of pressure conduits and open channels, dimensional analysis, flow measurements, hydraulic machinery, with laboratory.

CEE:3586 Civil Engineering Materials (3 s.h.): structure, strength and failure, durability, deformation, practice, and processing for primary construction materials systems, including steel, aluminum, concrete, asphalt, fiber-reinforced composites, masonry, timber.

CEE:4153 Environmental Chemistry Laboratory (3 s.h.): experiments to demonstrate fundamental principles of aquatic chemistry and chemical analyses for characterization of water and wastewater quality, conducted in the Environmental Engineering Laboratories.

CEE:5154 Environmental Microbiology (3 s.h.): typical microorganisms isolated and their physiology and metabolic characteristics studied in the Environmental Engineering Laboratories.

CEE:5156 Physical-Chemical Process Fundamentals (3 s.h.): unit operations, processes studied in bench scale experiments; use of typical process analytical parameters; experiments conducted in the Environmental Engineering Laboratories, University Water Plant, and Iowa City Wastewater Treatment Plant.

Graduate Laboratories

ENVIRONMENTAL ENGINEERING AND SCIENCE

The Environmental Engineering and Science Laboratories provide state-of-the-art facilities, equipment, and expertise to support both undergraduate and graduate-level instruction and research. The laboratories support research in contaminant fate and transport in various media (air, water, soil, plants, and microbes), drinking water disinfection and distribution, wastewater treatment, geochemical-contaminant interactions, bioremediation, and phytoremediation. They also provide resources for analytical chemistry, electrochemistry, molecular biology, microscopy, computer modeling, and simulated environments on the bench- and pilot-scale levels.

The Environmental Engineering and Science Laboratories are affiliated with the University's Center for Health Effects of Environmental Contamination and Its Center for Global and Regional Environmental Research, and with the UI Environmental Health Sciences Research Center, an affiliate of the National Institute of Environmental Health Sciences (NIEHS).

HYDRAULICS, HYDROLOGY, AND WATER RESOURCES

The teaching and research functions of the department are closely connected to the research activities of IIHR—Hydroscience & Engineering. The institute houses some of the most modern research facilities in the world, including a 100-meter towing tank, a wave basin facility for ship hydrodynamics research, several flumes, an array of field instrumentation for hydrologic experiments, extensive laboratory space for hydraulic modeling, state-of-the-art instrumentation for flow measurements and visualization, and comprehensive computational facilities.

Research related to ecohydrology and the environment takes place at the Lucille A. Carver Mississippi Riverside Environmental Research Station. IIHR—Hydroscience & Engineering operates the 250-square-foot facility, which is located on the Mississippi River near Muscatine, Iowa. The station provides engineers and biological scientists with an ideal facility in which to examine the multifaceted ecohydrologic processes of the upper Mississippi. It is equipped with water quality laboratories, research boats, and a seminar room.

STRUCTURES, MECHANICS, AND MATERIALS

Facilities for computations, materials testing, geotechnical experiments, and small-scale structural testing are available for research and teaching. Faculty, staff, and students in structures, mechanics, and materials (SMM) have access to the computing resources of Engineering Computer Services and the Center for Computer-Aided Design (CCAD). Both centers continuously update their computing facilities to maintain pace with the rapidly changing field.

A wide range of experimental facilities is available for testing structural materials such as Portland cement concrete, asphalt, metals, timber, and composites. These facilities include several loading frames (purely uniaxial, purely torsional, and axial-torsional) that are available with computer-based control and data collection systems. Facilities for creep testing, triaxial soil testing, and high-cycle fatigue testing also are available. The laboratories have a variety of ovens and other facilities for preparation and treatment of test specimens.

Four well-equipped physical testing laboratories are dedicated to SMM teaching and research: the Civil Materials Laboratory, Soil Mechanics Laboratory, Plasticity Laboratory, and the Asphalt Laboratory. The Civil Materials Laboratory currently has a small-scale single-degree-of-freedom shaker table. Faculty, staff, and students have access through CCAD to a six-degree-of-freedom man-
rated shaker table with 4000-pound payload and a 12-camera Vicon motion-capture system.

TRANSPORTATION ENGINEERING

The department's Asphalt Laboratory is equipped with a set of SuperPave testing equipment and asphalt mixture performance testing equipment, which can measure dynamic modulus and flow number of asphalt mixtures. The laboratory has a Hamburg Wheel Tracking Device for measuring the moisture sensitivity of asphalt mixtures; asphalt foaming equipment for mix design of cold in-place recycled asphalt using foamed asphalt; and equipment for Marshall mix design, indirect tensile strength test, and volumetric analysis of asphalt mixtures. The Asphalt Laboratory is one of the department's group of laboratories for testing the strength behavior of other materials.

Courses

Special Topics

CEE:0000 Cooperative Education Training Assignment: Civil Engineering
Civil engineering students participating in the Cooperative Education Program register in this course during work assignment periods; registration provides a record of participation in the program on the student's permanent record card. Requirements: admission to the Cooperative Education Program.

CEE:0002 Half-time Cooperative Education Training Assignment: Civil and Environmental Engineering
Registration for work assignment periods; for students participating in the Cooperative Education Program.

CEE:2000 CEE Sophomore Seminar
Introduction to civil and environmental engineering curriculum and profession; presentations by senior undergraduate students, faculty, and professionals; lifelong learning skills and requirements for professional licensure in civil engineering. Requirements: sophomore standing.

CEE:2015 Civil and Environmental Engineering Practice
Concepts of the built environment and the natural environment; infrastructure life cycle; engineering communication (plans, engineering drawings and information systems, computer-aided drafting); field trip to major city.

CEE:2240 Digital Drafting with AutoCAD
Basic principles of 2-D and 3-D computer-aided drafting; use of AutoCAD software to draw plans, elevations, and sections for objects and interior spaces. Prerequisites: (ARTS:1510 and ARTS:1520) and (TDSN:2210 or CERM:2010 or MTLS:2910 or SCLP:2810). Same as TDSN:2240.

CEE:3001 Leadership Seminar
Survey of leadership ideas and principles as applied to situations commonly encountered in civil engineering practice, especially as they relate to challenges that beginning engineers face; speakers in selected engineering professions provide context and examples; exercises on leadership principles. Requirements: junior standing in civil and environmental engineering.

CEE:3002 Professional Skills Seminar
Development of communication skills through writing and oral presentations; impact of engineering solutions in a global, economic, environmental, and societal context; writings and presentations on current or historical engineering solutions; exposure to professionals with significant experiences to share in these areas. Requirements: junior standing.

CEE:3003 Senior Design Seminar
Review and extension of civil and environmental engineering project management skills in preparation for capstone senior design course; project scheduling, cost estimating, contract types, construction phasing; review for Fundamentals of Engineering Exam (FE) and practice tests in four subdisciplinary areas. Requirements: senior standing.

CEE:3084 Project Design and Management in Civil Engineering
Design of civil engineering systems, individual and team design projects oriented toward the solution of local problems, project management, construction management, contracts, budgeting, bidding. Prerequisites: CEE:3003 and CEE:3533 and CEE:3763 and CEE:3371. Requirements: senior standing.

CEE:3783 Surveying and Remote Sensing
Engineering surveying measurements, methods, computations. Prerequisites: ENGR:1100.

CEE:3998 Individual Investigations: Civil Engineering
Individual projects for civil engineering undergraduate students: laboratory study, engineering design project, analysis and simulation of an engineering system, computer software development, research.

CEE:4107 Sustainable Systems
New and emerging concepts in sustainable systems design and assessment. Same as CBE:4410.

CEE:4116 Computer-Aided Design for Civil and Environmental Engineering
Introduction to engineering design process and graphical communications tools used by civil engineers; fundamentals of engineering drawing, descriptive geometry, multiview projection, graphical analysis, coordinate systems, database manipulation, building information modeling (BIM); AutoCAD. Prerequisites: CEE:2015. Requirements: civil and environmental engineering major.
**CEE:4511 Numerical Calculations** 3 s.h.
Development of algorithms for functional approximations, numerical differentiation and integration; solution of algebraic and differential equations, with emphasis on digital computations; initial and boundary value problems. Prerequisites: MATH:2560. Same as ME:4111.

**CEE:4512 Engineering Design Optimization** 3 s.h.
Engineering design projects involving modeling, formulation, and analysis using optimization concepts and principles; linear and nonlinear models, optimality conditions, numerical methods. Prerequisites: ENGR:2110 and MATH:2550. Requirements: Prerequisite: junior standing. Same as ME:4112.

**CEE:4515 Computer-Aided Engineering** 3 s.h.
Computational engineering modeling and simulation, geometric modeling, grid generation, finite-element and finite-volume methods, uncertainty analysis, optimization, engineering applications. Prerequisites: ENGR:2750 and ME:3052. Same as ME:4110.

**CEE:4187 Statistics for Experimenters** 3 s.h.
Application of statistical techniques to evaluate data derived from experimental samples designs; use of spreadsheets, statistical software; design and analysis of experiments; regression analysis; model building; practical applications. Same as OEH:4540.

**CEE:4568 Civil Infrastructure** 3 s.h.
Analytical methods for developing Infrastructure Management Systems (IMS); evaluation of infrastructure condition, performance modeling, rehabilitation optimization, development of the IMS; basic concepts of information technology applied in solving civil infrastructure management problems. Prerequisites: CEE:2015.

**CEE:4788 International Perspectives: Xicotepec** 3 s.h.
Introduction to providing service to a community in a less developed country; student projects intended to improve quality of life in Xicotepec. Requirements: P3 standing. Same as PHAR:8788, GHS:4126.

**CEE:5129 Information Systems for Resource Management** 3 s.h.
Understanding and managing natural and engineered resources requiring data/reach foundation; management of data; complex data-driven technologies integrated into data and information systems (DIS); hands-on opportunity to develop or use capabilities of DIS for study or research area of interest (science, engineering, industrial operation); wind power generation, an emerging field in Iowa, used as a case study for illustrating key DIS components, links, and functionalities. Same as IE:5129, ME:5129, ECE:5129, GEOG:5129.

**CEE:5210 Developing Professional Service Business** 2-3 s.h.
Use of professional skills and functional knowledge in creating a specialized service business. Same as ENTR:9000.

**CEE:5513 Mathematical Methods in Engineering** 3 s.h.

**CEE:6310 Analytical Methods in Mechanical Systems** 3 s.h.
Vector and function spaces; functionals and operators in Hilbert spaces; calculus of variations and functional analysis with application to mechanics; Ritz and Galerkin methods. Prerequisites: ME:5113. Same as ME:6214.

**CEE:7197 Teaching Undergraduate Science and Engineering** arr.
Basic skills to be a successful undergraduate instructor; teaching of technical subjects and solving problems; emphasis on practical applications of lesson material and class demonstrations; techniques for teaching effective classes; opportunity for students to teach; intended for graduating Ph.D. students with a career interest in a university environment.

**Structures, Mechanics, and Transportation**

**CEE:3135 Structural Modeling and Health Monitoring** 3 s.h.
Measurements, structural modeling, structural analysis, stiffness method, trusses and frames, structural testing, modal analysis. Prerequisites: CEE:3533 and ENGR:2750.

**CEE:3136 Design of Concrete Structures** 3 s.h.
Fundamental analysis and design of reinforced concrete members and structures, flexure, shear, bond, continuity, beams, one-way slab system; columns. Corequisites: CEE:3533.

**CEE:3142 Quality Control** 3 s.h.
Basic techniques of statistical quality control; application of control charts for process control variables; design of inspection plans and industrial experimentation; modern management aspects of quality assurance systems. Offered fall semesters. Prerequisites: STAT:2020. Same as IE:3600, STAT:3620.

**CEE:3179 Continuum Mechanics** arr.
Mechanics of continuous media; kinematics of deformation, concepts of stress and strain; conservation laws of mass, momentum and energy; constitutive theories; boundary and initial value problems. Prerequisites: ENGR:2510 or ENGR:2750. Same as ME:3179.

**CEE:3530 Soil Mechanics** 3 s.h.
Identification and classification of earth materials; hydraulic and mechanical properties of soils; soil improvement; laboratory testing. Prerequisites: ENGR:2750.

**CEE:3533 Principles of Structural Engineering** 3 s.h.
Fundamental principles of structural analysis applied to statically determinate and indeterminate structures, continuous beams, trusses, and frames; external and internal equilibrium; compatibility of deformation, influence lines, virtual work; parallel use of classical and matrix formulation; slope deflection, flexibility and stiffness methods; use of computers. Prerequisites: ENGR:2750.

CEE:3586 Civil Engineering Materials 3 s.h.
Structure, strength and failure, durability, deformation, practice, and processing for primary construction materials systems, including steel, aluminum, concrete, asphalt, fiber-reinforced composites, masonry, timber. Prerequisites: ENGR:2750.

CEE:3763 Principles of Transportation Engineering 3 s.h.
History of transportation modes, new transport technologies, traffic operations and control, economic evaluation of transport alternatives, transportation planning, roadway design and construction, route location, preventive maintenance strategies. Corequisites: CEE:2015.

CEE:4131 Impacts of Technological Singularity 3 s.h.
Technological singularity—what it is, its current standing, impacts, implications; bio-, nano-, and information technologies; how new technologies affect sustainability; ethical issues raised by technologies.

CEE:4160 Introduction to Bridge Engineering 3 s.h.
Bridge engineering and design; history of the bridge; factors that affect bridge design; bridges according to use (e.g., road, rail, pedestrian and bicycle) and type (e.g., suspension, cable stay, truss); how sustainability concepts may impact bridge design; substantial design exercise. Prerequisites: CEE:3533.

CEE:4167 Public Transit Operations and Planning 3 s.h.
Bus, light and heavy rail, and paratransit modes; transit operations, planning, modeling and optimization, transit agency economics, transit finance, and evolving transportation policy; skills essential to planners and engineers who intend to work for a either planning agency, transportation provider, or a transportation or engineering. Requirements: undergraduate or graduate standing in engineering, or graduate standing in urban and regional planning. Same as URP:4195.

CEE:4176 Transportation Demand Analysis 3 s.h.
City planning procedures and traffic engineering techniques applied to transportation problems; trip generation, distribution, assignment, mode choice models; travel surveys, data collection techniques; arterial flow, intersection performance, parking; transit system analysis. Same as URP:4262.

CEE:4352 Fundamentals of Vibrations 3 s.h.
Vibration of linear discrete and continuous mechanical and structural systems; harmonic, periodic, and arbitrary excitation; modal analysis; applications. Prerequisites: ENGR:2750. Same as ME:4153.

CEE:4353 Finite Element I 3 s.h.
One- and two-dimensional boundary value problems; heat flow, fluid flow, torsion of bars; trusses and frames; isoparametric mapping; higher order elements; elasticity problems; use of commercial software. Prerequisites: ENGR:2750. Same as ME:4115.

CEE:4353 Design of Steel Structures 3 s.h.
Concepts and procedures in steel design; LRFD (load and resistance factor design) methodology for beams/columns; analysis and design of indeterminate structures. Prerequisites: CEE:3533.

CEE:4359 Foundations of Structures 3 s.h.
Application of soil mechanics to analysis of structural foundations; slope stability analysis; bearing capacity and settlement of shallow and deep foundations; retaining structures, braced cuts, reinforced earth structures; usage of computational models; subsurface exploration methods. Prerequisites: CEE:3530.

CEE:4354 Computational Inelasticity 3 s.h.
Computational techniques and implementations for elastic, hyperelastic, elasto-plastic, visco-elastic, and visco-plastic material models; development of sound numerical integration algorithms from rate constitutive equations. Recommendations: CEE:3179.

CEE:4360 Pavement Engineering 3 s.h.
Fundamental design principles; characterization and testing of asphalt and concrete paving materials; stresses and stain development within pavement structure; basic principles of mechanistic-empirical pavement design procedures. Prerequisites: CEE:3763.

CEE:4362 Design of Transportation Systems 3 s.h.
Overview of different modes within transportation systems; concepts of sustainability and livability in transportation system design; derivation of standards for geometric design of highways; roundabout design; cross-sectional and longitudinal geometric design of highways. Prerequisites: CEE:3763.

CEE:4376 Traffic Engineering 3 s.h.
Design of traffic control devices; evaluation and analysis of intersections and transportation networks using appropriate computer software. Prerequisites: CEE:3763 and STAT:2020.

CEE:4376 Winter Highway Maintenance 3 s.h.
Aspects of winter highway maintenance; current and innovative practices and the theory that underpins them.

CEE:5094 Graduate Seminar: Transportation 0 s.h.
Recent advances and research in transportation engineering. Requirements: senior or graduate standing.
CEE:5137 Composite Materials 3 s.h.
Mechanical behavior of composite materials and their engineering applications; composite constituents (fibers, particles, matrices) and their properties and behavior; macromechanical behavior of composite laminae; micromechanical predictions of composite overall properties; classical lamination theory; composite beams and plates. Prerequisites: ENGR:2750. Same as ME:5167.

CEE:5236 Optimization of Structural Systems 3 s.h.
Advanced topics; optimization of structural topology, shape, and material; finite dimensional dynamic response optimization, sensitivity analysis, distributed parameter systems; projects.

CEE:5540 Intermediate Mechanics of Deformable Bodies 3 s.h.
Application of equilibrium analyses, strain-displacement relations, and constitutive relationships to practical structural systems and elementary plane elasticity problems. Prerequisites: ENGR:2750. Same as ME:5150, BME:5660.

CEE:5549 Fracture Mechanics 3 s.h.
3-D stress states, definition and criteria for failure, nominal and local yield phenomena, linear elastic and elastic plastic fracture mechanics, plane stress and plane strain fracture toughness, J-Integral, crack opening displacement, environmental assisted cracking, fatigue crack growth, fall safe, and damage tolerant design. Prerequisites: BME:4910 or ME:4055 or ME:5150. Same as ME:5159.

CEE:6532 Finite Element II 3 s.h.
Computer implementation; plate and shell elements; mixed and hybrid formulations; nonlinear analysis; recent development; introduction to boundary element method. Prerequisites: CEE:4533. Same as ME:6215.

CEE:6534 Applied Optimal Design 3 s.h.
Optimal design problem formulation; optimality conditions; linear, quadratic, convex, and nonlinear programming; Lagrangian duality; numerical algorithms for unconstrained and constrained design problems, design sensitivity analysis, engineering applications. Prerequisites: CEE:5513. Same as ME:6534.

CEE:6763 Application Simulation to Transportation 3 s.h.
Transportation system management and traffic engineering; application of real-time simulation and visualization. Prerequisites: CEE:3763 or CEE:4763. Same as URP:6063.

CEE:7250 Advanced Fracture Mechanics 3 s.h.
Fracture of modern engineering materials; linear-elastic fracture; computational methods; functionally graded materials; elastic-plastic fracture; multiscale fracture and fatigue crack initiation. Prerequisites: ME:5113 and (ME:4115 or ME:5159). Same as ME:7250.

CEE:7549 Multiscale Modeling 3 s.h.
Computational modeling of engineering materials ranging from molecular to continuum scales, molecular dynamics and Monte Carlo methods, nanoscale continuum modeling, scale-coupling methods. Prerequisites: ME:4115 or ME:5143. Same as ME:6255.

Environmental Engineering and Science

CEE:1030 Introduction to Earth Science 3-4 s.h.
Relationships between plate tectonics, geologic time, and the rock cycle with volcanoes and igneous, sedimentary, metamorphic rocks; fossils; radioactive isotopes; landscape evolution; mountain building; natural resources; their impacts on civilization. GE: Natural Sciences without Lab; Natural Sciences with Lab. Same as EES:1030.

CEE:2150 Natural Environmental Systems 3-4 s.h.
Environmental chemistry and biology of air, water, and soil quality, air and water pollution, limnology, global atmospheric change, fate and transport of pollutants; hazardous substances, risk analysis, standard setting. Prerequisites: CHEM:1110. Same as GHS:2150.

CEE:3141 Design With the Developing World 3 s.h.
Experience working on interdisciplinary teams to solve problems of the developing world; technologies for improving water and sanitation, energy, housing, and health; community building strategies, participatory methods, other techniques essential to good design; service-learning component. Recommendations: junior or higher standing. Same as GHS:3141.

CEE:3155 Principles of Environmental Engineering 4 s.h.
Water supply and treatment processes; wastewater treatment processes; processes for air pollution control, groundwater remediation; solid and hazardous waste management. Corequisites: CEE:2150.

CEE:4102 Groundwater 3 s.h.
Groundwater quality and quantity; Darcy's Law, 2-D flow equation, unsaturated zone, contaminant transport, redox reactions, drinking water quality, bioremediation; laboratories in permeameter testing, porous media grain size analysis, pump testing, monitoring well installation.

CEE:4104 Groundwater Modeling 3 s.h.
Groundwater flow and contaminant transport modeling; numerical methods, applications of groundwater modeling to water supply, groundwater resources evaluation, remediation design using software; GMS (MODFLOW, MODPATH, and MT3D). Prerequisites: (EES:4630 or CEE:4103) and MATH:1860. Same as EES:4660.

CEE:4147 Decentralized Wastewater Treatment 3 s.h.
Established and innovative technologies used in decentralized wastewater treatment; lagoons, constructed wetlands, sand filters, and other ecological technologies appropriate for small wastewater flows; need for more sustainable treatment of small wastewater flows; Iowa's approximately 739 unsewered communities throughout the state, high-growth areas surrounding Des Moines and Cedar Rapids-Iowa City corridor with small developments in need of wastewater treatment, developing countries. Prerequisites: CEE:2150 and CEE:3155 and CEE:3371.

CEE:4151 Biological Treatment Processes 3 s.h.  

CEE:4153 Environmental Chemistry Laboratory 3 s.h.  
Laboratory experiments to demonstrate important concepts in environmental chemistry and to familiarize students with procedures used to characterize water and wastewater and evaluate certain treatment processes. Prerequisites: CHEM:1120. Corequisites: CEE:5152.

CEE:4157 Environmental Engineering Design 3 s.h.  
Application of physical, chemical, and biological operations and processes to the design of water and wastewater treatment systems; applications in solid and hazardous waste treatment. Prerequisites: CEE:3155.

CEE:4158 Solid and Hazardous Wastes 3 s.h.  

CEE:4159 Air Pollution Control Technology 3 s.h.  
Sources, environmental and health impacts, regulations, modeling of air pollution; processes and alternative strategies for control; global climate considerations. Prerequisites: CEE:2150. Same as CEE:4459.

CEE:4180 Fundamentals of Atmospheric Science 3 s.h.  
Review of fundamental principles in atmospheric sciences needed for study of interdisciplinary topics involving the Earth's atmosphere; understanding weather and climate processes to address problems in engineering; hydrometeorology of rainfall and its measurement by remote sensing; impact of climate anomalies and climate change on water resources; exchange of water, energy, and chemicals at the land-atmosphere boundary; forecasting of atmospheric chemistry and air quality. Prerequisites: ENGR:2510.

CEE:4220 U.S. and Global Environmental Health Policy 3 s.h.  
Major concerns in environment and human health, legislation enacted to deal with these concerns; emphasis on contemporary issues. Offered fall semesters of odd years. Requirements: for OEH:4220 — OEH:4240; for CEE:4220 — CEE:2150. Same as GHS:4220, OEH:4220.

CEE:5115 Atmospheric Chemistry and Physics 3 s.h.  
Principal chemical and physical processes affecting atmospheric trace gas and pollutant cycles; emphasis on atmospheric photochemistry, aerosol science, major sources and removal processes. Corequisites: CBE:3120. Same as CBE:5425.

CEE:5152 Environmental Chemistry I 3 s.h.  
Principles of general, physical, organic chemistry applied in water and air systems; emphasis on qualitative and quantitative understanding of chemical kinetics and equilibrium; acid-base reactions, complex formation, precipitation, dissolution, and oxidation-reduction reactions; organic nomenclature. Prerequisites: CHEM:1120. Same as CBE:5152.

CEE:5154 Environmental Microbiology 3 s.h.  
Fundamentals of microbiology and microbial ecology with application in water quality and biodegradation of priority pollutants; lectures and laboratory. Corequisites: CEE:5152.

CEE:5156 Physical-Chemical Process Fundamentals 3 s.h.  
Theory of physical and chemical operations and processes in water and wastewater treatment, including fundamental aspects of process dynamics; lectures, laboratory. Prerequisites: CEE:2150 and CEE:5152. Corequisites: CEE:3155.

CEE:5875 Perspectives in Biocatalysis 1-3 s.h.  
Applied enzymology, protein design, structure-activity relationships, biosensor technology, microbial transformations, biodegradation of environmental pollutants. Requirements: graduate standing in a participating department supported by the Predoctoral Training Program in Biotechnology. Same as CHEM:5875, PHAR:5875, CBE:5875, MIRC:5875, BIOC:5875.

CEE:6151 Environmental Systems Modeling 3 s.h.  
Mathematical modeling of environmental systems, including rivers, lakes, estuaries, treatment systems for conventional and toxic pollutants. Prerequisites: CEE:2150 and CEE:3155 and CEE:5152.

CEE:6223 Environmental Boundary Layers 4 s.h.  
Fundamentals of environmental boundary layer dynamics and thermodynamics of natural and engineered systems; atmospheric boundary layers and aquatic surface layer dynamics; land-atmosphere interaction, air-water exchange, and turbulent transport in aquatic ecosystems; turbulence, surface energy balance, spectral analysis, similarity theory; flow over homogeneous and heterogeneous surfaces, thermal stratification effects, measurement, simulation of turbulent and surface fluxes; applications to environmental modeling, urban meteorology, ecosystem dynamics, renewable energy; recent and current research topics. Prerequisites: ENGR:2510.
Hydraulics, Hydrology, and Water Resources

CEE:6253 Environmental Chemistry II 3 s.h.
Solid-liquid interface problems, heterogeneous equilibria, environmental organic chemistry, modeling chemical equilibrium and kinetics, redox chemistry, atmospheric chemistry. Prerequisites: CEE:5152.

CEE:6255 Environmental Biotechnology and Bioremediation 3 s.h.
Concepts in molecular microbial ecology and bioremediation; microbial diversity and genetics, evolution of biodegradation pathways, application of quantitative PCR, high-throughput amplicon and metagenomic and transcriptomic sequencing, proteomics, stable isotopes; bioremediation research and practice. Prerequisites: CEE:5154.

CEE:3328 Fluvial Geomorphology 3 s.h.
Hydrologic principles, stream channel processes, and fluvial geomorphology within drainage basin systems; spatial and temporal variations in water distribution, analysis of hydrological data, flow mechanisms, sediment transport, forecasting procedures, hydrograph construction, modeling. Requirements: EES:3020 or another 3000-level geology or hydrology course. Same as EES:3380.

CEE:3371 Principles of Hydraulics and Hydrology 3 s.h.
Hydraulics of pressure conduits and open channels, dimensional analysis, flow measurements, hydraulic machinery, laboratory. Prerequisites: ENGR:2510.

CEE:4103 Water Quality 3 s.h.
Sources, availability, uses, characteristics, criteria, best management practices for surface waters; protection of waters impaired by eutrophication, soil erosion and sedimentation; pathogenic organisms, habitat destruction, wastewater discharges, contaminated sediments, atmospheric deposition, watershed development, invasive species, irrigation return flows, stormwater discharges, nonpoint sources, agricultural runoff; laboratory component, measurement of water quality characteristics in the field. Requirements: junior or higher standing.

CEE:4118 Probabilistic Methods in Hydroscience 3 s.h.
Common probabilistic models used in hydrology, hydraulics, and water resources; derived distributions; multivariate models and estimation of model parameters; analysis of data and model building; uncertainty analysis. Prerequisites: MATH:2560 and STAT:2020.

CEE:4119 Hydrology 3 s.h.
Overview of fundamental processes in water cycle, including precipitation, evaporation, infiltration, and runoff; quantitative approaches for predicting streamflow and design discharges; applications to flood hazard assessment and stormwater management. Prerequisites: ENGR:2510.

CEE:4120 Water Resources Sustainability 3 s.h.
Effect of human impact on hydrologic ecosystems (aquifers, watersheds, coastal zones, lakes, and wetlands); quantitative measures of impact and mitigation/attenuation efforts; key questions addressed (What does water resources sustainability mean? How can it be measured? How can it be implemented?); worldwide case studies that illustrate the detrimental effects of unsustainable resource utilization and the benefits of implementing sustainable resource management strategies.

CEE:4123 Hydroclimatology 3 s.h.
Introduction to fundamental processes governing climate system and hydrological cycle, links between them; measurements of atmospheric and terrestrial components; atmosphere-ocean interactions (e.g., El Nino, Pacific Decadal Oscillation); teleconnections; climatology of atmospheric storms and impacts (e.g., atmospheric rivers, tropical cyclones, floods, droughts); climate change and variability; tools for analysis of climate data. Recommendations: CEE:4118 and CEE:4119 and CEE:4180 and CEE:4378.

CEE:4146 Multiscale Hydrology: Introduction to Multiscale Hydrologic Phenomena 3 s.h.
Hydrologic principles over the last century developed from experimentation at laboratory and small plot scales; major scientific and engineering challenges, including links between statistical fluctuations that data exhibits; physical, chemical, and biological principles through appropriate mathematical theories, numerical models, and field observations; coupled hydrologic processes at larger scales using newly built on abstraction; observations used in hydrologic engineering at larger scales for several decades and missing a coherent theory that ties them together. Prerequisites: ENGR:2510 and MATH:6600. Requirements: three semesters of calculus and college physics, an introductory hydrology course, and a probability and statistics course.

CEE:4317 Remote Sensing 3 s.h.
Fundamentals of electromagnetic waves, atmospheric radiative transfer, passive remote sensing, weather radar, hydrologic application of remote sensing.

CEE:4370 Flow in Open Channels 3 s.h.
In-depth analysis of governing flow equations; steady uniform flow in channels of different resistance and cross section; flow control sections; specific energy considerations; analysis and computation of gradually varied profiles and spatially varied flow effected by lateral outflow and inflow; unsteady flow; flood routing. Prerequisites: CEE:3371.

CEE:4371 Water Resources Engineering 3 s.h.
Planning and economics of varied water resources projects; stochastic basis for design; flood damage mitigation, reservoirs, river morphology, economic analysis of water projects, urban water requirements, water supply, hydroelectric power systems, river navigation; contemporary civil-engineering problems and issues associated with water infrastructure development. Corequisites: CEE:3371.
CEE:4373 River Mechanics 3 s.h.  
Laws governing fall velocity, applications to particle-size analysis; incipient motion, bed forms, bed load, suspended load, natural river processes; theory and practice of movable-bed model experiments. Prerequisites: CEE:4370.

CEE:4374 Water Resource Design 3 s.h.  
Prerequisites to storm water management systems design, including design flows and rates; analysis and design of storm sewers, detention basins, street and highway drainage facilities, culverts, dams, spillways, measures for energy dissipation; review of wastewater transfer systems and design. Prerequisites: CEE:3371.

CEE:4378 Hydrometeorology 3 s.h.  
Atmospheric thermodynamics; precipitation processes; evaporation; infiltration; surface runoff; hydrographs, runoff relations; runoff hydrography; storage problems; frequency, intensity, duration studies of storms, floods, droughts; hydrometeorological observations and network design; watershed modeling; urban hydrology climate.

CEE:4385 International Perspectives in Water Sciences and Management 3 s.h.  
Internationalization and water, with focus on a country or a world region; intensive, in-depth exposure to complex issues that affect planning and execution of water projects in large-scale watersheds.

CEE:5083 Introduction to Comp Flow in Pipes and Channels 3 s.h.  
General review of numerical methods in hydraulics (finite-difference, finite-element, and method of characteristics); stability and accuracy of numerical schemes; steady free surface flows; flow transients in pipelines and channels. Prerequisites: CEE:5369.

CEE:5184 The Fate and Transport of Contaminated Sediments 3 s.h.  
Rich and complex field of sediment and contaminant transportation; involves physical, chemical, biological processes as well as mathematical modeling of these processes; recently investigated topics not covered elsewhere; physical processes affecting stability/mobility, transport, and fate of contaminants in sediments; lack of general understanding of development of fine-scale sedimentary structure in different systems, particularly contamination and contamination release; issue of suspension effects on turbulent flows; flow dynamics. Prerequisites: CEE:3530 and CEE:4370 and CEE:4373.

CEE:5188 Computational Methods in Water Resources 3 s.h.  
Computational methods for solution of problems; emphasis on problems in water resources; standard methods for problem solutions using computers; problems of interest in hydraulics/hydrology. Recommendations: some programming ability.

CEE:5216 Coherent Structures in Environmental Hydraulics 3 s.h.  
Introduction to coherent structures and their role in explaining the physics of several important categories of environmental flows; focus on examples related to hydraulics, river engineering, stratified flows, and geosciences; turbulence modeling using eddy resolving techniques that can capture the dynamics of coherent structures; no prior experience in coding or numerical methods is expected. Prerequisites: CEE:5369. Requirements: M.S. or Ph.D. standing.

CEE:5369 Intermediate Mechanics of Fluids 3 s.h.  
Basic concepts and definitions; pressure distribution in a fluid; governing equations and boundary conditions; integral and differential analysis; dimensional analysis and similarity; experimental analysis; laminar and turbulent internal and external flows; potential flows; engineering applications. Prerequisites: ENGR:2510. Same as ME:5160.

CEE:5372 Experimental Methods in Fluid Mechanics and Heat Transfer 3 s.h.  
Hands-on experience in methodology of conducting experiments in fluid mechanics and heat transfer from design to data acquisition and processing; essential theoretical elements, experimental methodologies, data acquisition systems, uncertainty analysis; wide variety of instruments for fundamental and applied experimentation; work in small groups; design, implement, test, and report an experiment in area of interest. Same as ME:5162.

CEE:6372 Environmental Dispersion Processes 3 s.h.  
Review of classical diffusion theories; longitudinal dispersion, transverse and vertical mixing in free-surface turbulent shear flow; application to natural channels; selected topics including stream-tube models, mixing and dispersion of heated effluents. Corequisites: CEE:5369.

CEE:6376 Viscous Flow 3 s.h.  
Equations of viscous flow; classical analytical and numerical solutions; flow regimes and approximations; laminar boundary layers—equations, solution methods, applications; stability theory and transition; incompressible turbulent flow—mean-flow and Reynolds-stress equations, modeling, turbulent boundary layers and free shear flows. Requirements: for ME:6260 — ME:5160; for CEE:6376 — CEE:5369. Same as ME:6260.

CEE:6520 Watershed Sedimentation 3 s.h.  
Exploration of rich and complex field of sediment transport, geomorphology, and contaminant transport; associated physical, chemical, and biological processes with associated mathematical modeling; investigation of current topics not covered elsewhere, including physical processes affecting stability/mobility, transport, and fate of soil/sediments; lack of general understanding in development of fine-scale sedimentary structure in different systems, particularly contamination and contamination release; suspension effects on turbulent flows. Prerequisites: CEE:4370 and CEE:4373.
Graduate Seminars, Advanced Topics, Research

CEE:4097 Topics in Teaching and Learning 1 s.h.
Overview of Iowa's hydroclimate; emphasis on discharge, rainfall, and temperature; how to address basic research questions related to Iowa's climate and extreme events; hands-on exercises.

CEE:4995 Contemporary Topics in Civil and Environmental Engineering arr.
New topics or areas of study not formally offered in other civil and environmental courses; ice engineering, chaos and strange attractors, remote sensing, nonlinear dynamics of hydrologic processes, advanced water and wastewater treatment processes, hazardous waste control, global climate change, damage mechanics; based on faculty/student interest.

CEE:5091 Graduate Seminar: Structure, Mechanics, Materials 0 s.h.
Presentation and discussions of recent advances and research in structures, mechanics, and materials engineering by guest lecturers, faculty, students. Requirements: senior or graduate standing.

CEE:5092 Graduate Seminar: Environmental Engineering Seminar 0 s.h.
Presentation and discussion of current topics, case studies, and research in environmental science and engineering by students, guest lecturers, faculty. Requirements: senior or graduate standing.

CEE:5093 Graduate Seminar: Hydraulics, Hydrology, and Water Resources 0 s.h.
Presentation and discussions of recent advances and research in hydraulics, hydrology, and water resources by guest lecturers, faculty, students. Requirements: senior or graduate standing.

CEE:5998 Individual Investigations: Civil and Environmental Engineering arr.
Individual projects for civil and environmental engineering graduate students: laboratory study, engineering design project, analysis and simulation of an engineering system, computer software development, research. Requirements: graduate standing.

CEE:5999 Research: Civil and Environmental Engineering M.S. Thesis arr.
Experimental and/or analytical investigation of an approved topic for partial fulfillment of requirements for the M.S. with thesis in civil and environmental engineering. Requirements: graduate standing.

Experimental and/or analytical investigation of an approved topic for partial fulfillment of requirements for the Ph.D. in civil and environmental engineering.