

CIVIL AND ENVIRONMENTAL ENGINEERING

<https://ceps.unh.edu/civil-environmental-engineering>

Overview

Civil and Environmental Engineering involves the sustainable planning, design, and construction of public works for the benefit of society while minimizing environmental impact. Civil Engineering concerns the design of buildings, bridges, roads, dams, water transmission systems, water treatment systems, tunnels, and more. Environmental Engineering specializes in environmental cleanup, drinking water systems, wastewater treatment systems, and solid and hazardous waste disposal systems, environmental remediation, all with consideration of people, planet, and profits - known as the triple bottom line. Resulting infrastructure facilities must provide efficient service, be cost effective, and be compatible with the environment. Moreover, civil and environmental engineers work under a code of ethics in which their primary, overriding responsibility, is to uphold the public's trust by working to plan, design, build, and restore safe, sustainable, and environmentally responsible public works.

As civil engineering is such a broad field, it is traditionally divided into sub-disciplines. At the University of New Hampshire, multiple courses are offered in six: transportation, environmental engineering, geotechnical engineering, structural engineering, sustainable engineering, and water resources engineering.

Environmental engineering focuses on environmental pollution and public health protection; water, wastewater, reuse and stormwater technology; solid and hazardous waste engineering and remediation; engineering sustainability; environmental microbiology and chemistry; contaminant transport and fate, hydraulics, and hydrology.

Students may readily transfer between the BSCIVE and BSENVE programs within the first three semesters. Transferring between the two programs is also possible later on in the programs, but additional courses may result.

Both engineering degrees provide a firm base in mathematics and engineering, and all majors are expected to develop excellent communication and computer skills. Graduates are prepared to enter the profession and to pursue advanced study. Because of the broad technical background attained, some graduates also successfully pursue further education in business, architecture, education, and law.

Mission

The mission of the Department of Civil and Environmental Engineering at the University of New Hampshire is fourfold:

- To pursue and disseminate knowledge through teaching, scholarship, outreach and public service.
- To provide excellent undergraduate and graduate education.
- To advance the state-of-the-art in science and engineering by conducting research.
- To enhance the quality of life for people in New Hampshire, New England, and beyond.

BSCIVE Program Overview

Civil engineers work as private consultants, for large contracting firms, and for government agencies in a wide variety of indoor and outdoor settings around the world. There is a strong and constant market for civil engineers due to the demands placed on the profession to design, construct, maintain, and repair the infrastructure.

Educational Objectives

In accordance with its University, College, and Department missions, the faculty of the Department of Civil & Environmental Engineering has established clear educational objectives for our BSCIVE graduates, five years after obtaining the degree:

1. Professional employment, primarily in the civil and environmental engineering disciplines.
2. Commitment to continuous learning through graduate and post-graduate education, coursework, and research.
3. Being resourceful in finding solutions, and retaining ownership and accountability for their work.
4. Positions of leadership, directing the work of others.
5. Professional licensure or certification in civil and environmental engineering disciplines and other professions.
6. Positions and active participation in community, public, and professional service.

Student Outcomes

To enable our graduates to achieve our educational objectives, the BSCIVE program is designed to provide the following student outcomes at the time of graduation:

1. To have obtained an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. To have obtained an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. To have obtained an ability to communicate effectively with a range of audiences.
4. To have obtained an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. To have obtained an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. To have obtained an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. To have obtained an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

BSENVE Program Overview

Environmental engineers work as private consultants, in industry and for government agencies in a wide variety of indoor and outdoor settings around the world. There is a strong and constant market for environmental engineers due to the demands placed on the profession to construct, maintain, and repair the drinking water, wastewater, water reuse and stormwater, and solid and hazardous waste management

infrastructure. The curriculum prepares students to plan, using triple bottom line considerations, and design systems to minimize the impact of human activity on the environment and protect human health.

Educational Objectives

In accordance with its University, College, and Department missions, the faculty of the Department of Civil & Environmental Engineering has established clear educational objectives for our BSENVE graduates, five years after obtaining the degree:

1. Professional employment, primarily in the environmental engineering disciplines.
2. Commitment to continuous learning through graduate and post-graduate education, coursework, and research.
3. Being resourceful in finding solutions and retaining ownership and accountability for their work.
4. Positions of leadership, directing the work of others.
5. Professional licensure or certification in environmental engineering discipline and other professions.
6. Positions and active participation in community, public, and professional service.

Student Outcomes

To enable our graduates to achieve our educational objectives, the BSENVE program is designed to provide the following student outcomes at the time of graduation:

1. To have obtained an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. To have obtained an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. To have obtained an ability to communicate effectively with a range of audiences.
4. To have obtained an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. To have obtained an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. To have obtained an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. To have obtained an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Programs

- [Civil Engineering Major \(B.S.\)](#)
- [Environmental Engineering Major \(B.S.\)](#)
- [Environmental Engineering Minor](#)

Courses

CEE 400 - Introduction to Civil Engineering

Credits: 0 or 4

Introduction to the civil engineering profession: structural, geotechnical, water resources, materials, and environmental. Overviews the civil project process including the creative design process, teamwork, bidding and construction. The relationship between civil engineering works and society including ethics, earthquakes, failures, successful signature structures, current events, and professional licensure. The production of professional engineering documents including writing tasks and calculations sets. Campus resources, the University system, and relationship between required curriculum, student objectives, and the civil engineering profession. Introduction to spreadsheet software, data analysis, and probability and statistics.

Attributes: Environment, TechSociety(Disc); Inquiry (Discovery)

Equivalent(s): CIE 402

Grade Mode: Letter Grading

CEE 402 - 2D Computer Aided Design

Credits: 3

This course will serve as an introduction to some of the fundamental principles of building design and land planning. You will prepare plans representative of building construction and land development commonly used in the architectural, engineering, surveying and construction fields. The emphasis will be on the end result: Preparing complete and professional plans. Through this, you will acquire basic skills in designing and plan layout required by these industries. We will approach this material by designing and drafting using computer software (AutoCAD). Another end outcome is that you will gain a certain level of competency with this AutoCAD software, a program used by the majority of the firms in these professions.

Equivalent(s): TECH 564

Grade Mode: Letter Grading

Special Fee: Yes

CEE 403 - GIS for Civil and Environmental Engineering

Credits: 3

This course will serve as an introduction to some of the fundamental principles of Geographic Information Systems integral to Civil and Environmental Engineering. Students will develop an understanding of imagery and data acquisition; develop skills in identification, interpretation, and mapping of civil and land features, terrain analysis, and achieve an understanding of map projections; gain experience in GIS software to perform fundamental geoprocessing and mapping techniques.

Grade Mode: Letter Grading

Special Fee: Yes

CEE 404 - Surveying and Mapping

Credits: 0 or 4

Principles of land measurements by ground, photogrammetric and satellite methods to model the environment. Application of theory of measurements to perform and adjust engineering survey. Conformal mapping and its application to state plane coordinates. Digital mapping and Geographic Information Systems. Construction and cadastral surveying. Lab.

Attributes: Writing Intensive Course

Prerequisite(s): MATH 425 (may be taken concurrently) with a minimum grade of D-.

Equivalent(s): CIE 505

Grade Mode: Letter Grading

CEE 420 - Environmental Engineering Lectures I**Credits:** 3

Introduces the profession, the environmental engineer as planner, designer, problem solver, and interdisciplinary team player; and the goals of the environmental engineering curriculum. Lectures by faculty and practitioners. Introduction to computer skills required for environmental engineering. Engineering ethics.

Equivalent(s): ENCV 400, ENE 400**Grade Mode:** Letter Grading**CEE 500 - Statics for Civil Engineers****Credits:** 3

Introduction to statics with emphasis on civil engineering topics; two and three dimensional force systems; static equilibrium; friction; analysis of trusses and beams; centroids; and moment and shear diagrams for flexural members.

Prerequisite(s): PHYS 407 with a minimum grade of D- and MATH 426 (may be taken concurrently) with a minimum grade of D-**Equivalent(s):** CIE 525, CIE 528, ME 525**Grade Mode:** Letter Grading**CEE 501 - Strength of Materials****Credits:** 3

Strength of materials with emphasis on civil engineering applications. Virtual work; work and energy relationships; analysis of members subjected to flexure, torsion, and axial loads; stresses and strains; and stability of columns.

Prerequisite(s): CEE 500 with a minimum grade of D- or ME 525 with a minimum grade of D-**Equivalent(s):** CIE 526, CIE 529, ME 526**Grade Mode:** Letter Grading**CEE 502 - Project Engineering****Credits:** 3

Techniques for financial analysis, and operation and management of engineering systems, engineering economics, material take-offs, estimating, scheduling, modeling physical systems, and decision-making. CEE major or permission.

Equivalent(s): CIE 533, CIE 633, CIE 733**Grade Mode:** Letter Grading**CEE 505 - Introduction to Sustainable Engineering****Credits:** 3

This course begins with exploration of the precept that we live in, and must design engineering works for, a world with a finite supply of natural resources and with limited life support capacity. Tools for sustainability engineering are the focus of the course, which includes life cycle analysis and life cycle impact analysis, the metrics and mass and energy flow analyses used in the field of industrial ecology, and environmental management systems.

Grade Mode: Letter Grading**CEE 520 - Environmental Pollution and Protection: A Global Context****Credits:** 0 or 4

Introduces environmental science and engineering and the anthropogenic causes of environmental change. Emphasizes the causes, effects, and controls of air, water, and land pollution. The political, ecological, economic, ethical, and engineering aspects of environmental pollution and control are discussed. Field trips.

Attributes: Environment, TechSociety(Disc); Writing Intensive Course**Equivalent(s):** BIOL 520, ENCV 520, ENE 520**Grade Mode:** Letter Grading**CEE 620 - Fundamental Aspects of Environmental Engineering****Credits:** 4

Application of fundamental concepts of mass balance in treatment processes. Physical, chemical, and biological aspects of pollution control, and design concepts for operations and processes used in environmental engineering are discussed. Concepts of engineering ethics are presented. Students participate in a design project that involves an oral presentation and written report.

Attributes: Writing Intensive Course**Prerequisite(s):** (CHEM 404 with a minimum grade of D- or CHEM 405 with a minimum grade of D-) and CEE 650 with a minimum grade of D- and CEE 520 with a minimum grade of D-**Equivalent(s):** ENCV 645, ENE 645**Grade Mode:** Letter Grading**CEE 635 - Engineering Materials****Credits:** 0 or 4

Structural properties and applications of the various materials used in civil engineering projects, including steel, cement, mineral aggregates, concrete, timber, and bituminous materials. Microstructure and properties of common metals, plastics, and ceramics. Lab.

Attributes: Writing Intensive Course**Prerequisite(s):** CEE 501 with a minimum grade of D- or ME 526 with a minimum grade of D-**Equivalent(s):** CIE 622**Grade Mode:** Letter Grading**CEE 650 - Fluid Mechanics****Credits:** 0 or 4

Properties of fluids, fluid statics, continuity, momentum and energy equations, resistance to flow, boundary layer theory, flow in open channels and piping systems, dimensional analysis, similitude, drag, and lift. Laboratory exercises on measurement of fluid properties, energy principles, flow resistance, discharge measurements, momentum, hydropower, groundwater flow, and settling of spheres. Lab.

Attributes: Writing Intensive Course**Prerequisite(s):** PHYS 407 with a minimum grade of D-**Equivalent(s):** CIE 642**Grade Mode:** Letter Grading**CEE 665 - Soil Mechanics****Credits:** 0 or 4

Soil classification and physical properties. Permeability, compressibility, consolidation, and shearing resistance are related to the behavior of soils subjected to various loading conditions. Lab.

Prerequisite(s): CEE 635 with a minimum grade of D- and CEE 650 with a minimum grade of D-**Equivalent(s):** CIE 665**Grade Mode:** Letter Grading**CEE 680 - Classical Structural Analysis****Credits:** 3

Analytical stress and deflection analysis of determinate and indeterminate structures under static and moving loads by classical methods.

Prerequisite(s): CEE 501 with a minimum grade of D-**Equivalent(s):** CIE 681**Grade Mode:** Letter Grading

CEE 700 - Building Information Modeling**Credits:** 3

Building Information Modeling (BIM) is the process of generating and managing project data during its life cycle by integrating 3D multidisciplinary drawings with dynamic scheduling and visualization. BIM provides a digital representation of project data to facilitate the exchange of information beyond the standard two dimensional plan set. This course introduces students to the fundamentals of model creation, scheduling, material take-offs, visualizations, and animations that improve the communication of information to potential clients.

Prerequisite(s): CEE 402 (may be taken concurrently) with a minimum grade of D-.

Equivalent(s): CIE 780

Grade Mode: Letter Grading

CEE 703 - Site Design and Project Development**Credits:** 3

Provides an in-depth introduction to the various design activities undertaken for Land Development (Site Design) projects. Investigates aspects of site design: parking, grading, drainage, traffic, due diligence, permitting, cost estimating, and financing. Introduces concepts of Project Development process including project management, financing, delivery methods, design development, client relations, and construction administration. Course format will include lectures, guest presenters, and site visits. Grading based upon writing examination, assignments, group project, and professional development activities.

Prerequisite(s): CEE 502 with a minimum grade of D-.

Equivalent(s): CIE 753

Grade Mode: Letter Grading

CEE 704 - Transportation Eng & Planning**Credits:** 3

Fundamental relationships of traffic speed, density, and flow applied to public and private modes of transport. Principles of demand forecasting and urban systems planning.

Equivalent(s): CIE 751, CIE 754

Grade Mode: Letter Grading

CEE 705 - Introduction to Sustainable Engineering**Credits:** 3

This course begins with exploration of the precept that we live in, and must design engineering works for, a world with a finite supply of natural resources and with limited life support capacity. Tools for sustainability engineering are the focus of the course, which includes life cycle analysis and life cycle impact analysis, the metrics and mass and energy flow analyses used in the field of industrial ecology, and environmental management systems.

Grade Mode: Letter Grading

CEE 706 - Environmental Life Cycle Assessment**Credits:** 3

This course teaches knowledge and hands-on-skills in conducting environmental life cycle assessment (LCA), which is a widely used technique by industries, academics, and governments. Students will learn to use popular LCA software (e.g. SimaPro), apply proper LCA techniques, critically analyze LCA results, and provide client-oriented suggestions during this course. Class time is primarily devoted to a combination of lectures and computer labs.

Grade Mode: Letter Grading

CEE 719 - Green Building Design**Credits:** 3

This course gives an overview of green designs and sustainable practices in building construction. We will cover technical topics and requirements of a nationally recognized rating system (LEED), with a specific focus on Green Building Design and Construction. Students are introduced to basic building designs and systems related to sustainability. Additionally, they learn about green design topics such as site plans, water and energy efficiency, material and resources usage, environmental quality and renewable energy source. As an outcome of the course, students are able to assess and incorporate green technologies and designs into building projects.

Equivalent(s): CIE 781

Grade Mode: Letter Grading

CEE 720 - Solid and Hazardous Waste Engineering**Credits:** 3

A thorough examination of the problems that exist in hazardous and solid waste management are presented in terms of the current regulations and engineering approaches used to develop solutions. Topics include risk-based decision making, transport and fate of contaminants, and the fundamental physical, chemical, and biological concepts, which make up the basis for technological solutions to these waste management problems. Case studies are used throughout the course to highlight key concepts and provide real-world examples.

Equivalent(s): ENCV 742, ENE 742

Grade Mode: Letter Grading

CEE 721 - Environmental Sampling and Analysis**Credits:** 4

Theory of analytical and sampling techniques used in environmental engineering. Topics include potentiometry, spectroscopy, chromatography, automated analysis, quality control, sampling design, and collection methods. Methods discussed in lecture are demonstrated in labs. Lab.

Prerequisite(s): (CHEM 404 with a minimum grade of D- or CHEM 405 with a minimum grade of D-) and CEE 620 with a minimum grade of D-.

Equivalent(s): CEE 721W, ENCV 643, ENE 643, ENE 743, ENE 743W

Grade Mode: Letter Grading

CEE 722 - Introduction to Marine Pollution and Control**Credits:** 4

Introduces the sources, effects, and control of pollutants in the marine environment. Dynamic and kinetic modeling; ocean disposal of on-shore wastes, shipboard wastes, solid wastes, dredge spoils, and radioactive wastes; and oil spills.

Prerequisite(s): CEE 620 with a minimum grade of D-.

Equivalent(s): ENCV 747, ENE 747

Grade Mode: Letter Grading

CEE 723 - Environmental Water Chemistry**Credits:** 4

Emphasizes the use of chemical equilibrium principles and theory, calculations, and applications of ionic equilibrium stresses. Topics include thermodynamics, kinetics, acid/base, complexation, precipitation/dissolution, and redox equilibria. Computer equilibrium modeling is presented.

Prerequisite(s): CHEM 404 with a minimum grade of D- or CHEM 405 with a minimum grade of D-.

Equivalent(s): ENCV 749, ENE 749

Grade Mode: Letter Grading

CEE 724 - Environmental Engineering Microbiology**Credits:** 4

Concepts of environmental engineering microbiology. Topics include taxonomy of species important in environmental engineering processes; microbial metabolism, interaction, and growth kinetics in environmental treatment processes; biogeochemical cycling in water; and effects of environmental parameters on environmental engineering microbial processes. Laboratories focus on microbiological methods and laboratory-scale biological treatment experiments. Lab.

Attributes: Writing Intensive Course**Prerequisite(s):** CEE 520 with a minimum grade of D- and CEE 650 with a minimum grade of D-.**Equivalent(s):** ENCV 656, ENE 656, ENE 756**Grade Mode:** Letter Grading**CEE 729 - Sources, Control, and Stewardship of Air Pollution****Credits:** 4

Sources and fate of air pollutants from natural and engineered systems. Fundamentals of pollutant chemistry, atmospheric dispersion, and engineering controls. Includes regulatory policy, environmental, and social justice issues.

Prerequisite(s): CEE 720 with a minimum grade of D-.**Grade Mode:** Letter Grading**CEE 730 - Public Health Engineering for Rural and Developing Communities****Credits:** 3

The application of environmental health engineering and sanitation principles in disease prevention and control are discussed. Special emphasis is given to areas of the world where communicable and related diseases have not yet been brought under control and to what can happen in more advanced countries when basic sanitary safeguards are relaxed. The following topics are covered: water-related diseases to include their transmission and control; safe water development, treatment, distribution and storage; and on-site wastewater treatment and disposal system.

Equivalent(s): ENCV 740, ENE 740**Grade Mode:** Letter Grading**CEE 731 - Advanced Water Treatment Processes****Credits:** 4

The primary objective of this course is to provide the environmental engineer with an overview of physical-chemical and biological unit water treatment processes. Major emphasis is placed on the analysis and design of both conventional and advanced water treatment unit processes/operations.

Equivalent(s): ENCV 744, ENE 744**Grade Mode:** Letter Grading**CEE 732 - Solid and Hazardous Waste Design****Credits:** 4

Selection, design, and evaluation of unit processes employed in the treatment of solid wastes and hazardous wastes will be studied. Topics include design of materials recovery facilities, landfills, waste-to-energy facilities and hazardous waste site remedial technologies. A group term project taken from a real-world project will be required. An oral presentation by the group and preparation of a final written engineering report including alternative evaluation, permits, scheduling and economic analysis will be required from each group.

Attributes: Writing Intensive Course**Prerequisite(s):** CEE 720 with a minimum grade of D-.**Equivalent(s):** ENCV 748, ENE 748**Grade Mode:** Letter Grading**CEE 733 - Public Infrastructure Asset Management****Credits:** 4

The course provides a thorough examination of the growing engineering field of Public Infrastructure Assess Management (IAM). The course enables the student to design an IAM system. It touches upon all types of public infrastructure with a particular focus on water infrastructure for the semester design project. Students build upon their engineering economics and project engineering skills and use simple IAM software along with GIS applications. Practice leaders from the industry provide guest lectures throughout the semester. A focus on triple bottom line or the Societal, Environmental and Economic aspects of IAM are included. The format is a modified team base design learning experience providing practice in processing of technical lecture material, personal performance evaluation (frequent quizzes) and team based performance evaluation. Student groups will present their design to the class and provide a written engineering report.

Prerequisite(s): CEE 502 (may be taken concurrently) with a minimum grade of D- and CEE 620 (may be taken concurrently) with a minimum grade of D-.**Equivalent(s):** ENE 739**Grade Mode:** Letter Grading**CEE 735 - Properties and Production of Concrete****Credits:** 3

Basic properties of hydraulic cements and mineral aggregates, and their interactions in the properties of plastic and hardened concrete; modifications through admixtures; production handling and placement problems; specifications; quality control and acceptance testing; lightweight, heavyweight, and other special concretes.

Prerequisite(s): CEE 635 with a minimum grade of D-.**Equivalent(s):** CIE 722**Grade Mode:** Letter Grading**CEE 736 - Asphalt Mixtures and Construction****Credits:** 3

Specification of asphalt cements, aggregates and proportioning of mixture constituents for paving applications. Asphalt mixture design methods, production, construction, and quality control are discussed. Current new material production and construction technologies are introduced.

Prerequisite(s): CEE 635 with a minimum grade of D-.**Equivalent(s):** CIE 723**Grade Mode:** Letter Grading**CEE 737 - Pavement Rehabilitation, Maintenance, and Management****Credits:** 3

This course covers the technical and financial strategies to extend the life of highway and airfield pavements. The course topics will include: Assessment of pavement functional and structural condition, suitability of pavement maintenance and repair techniques, use of pavement preservation processes, and application of asset management to extend the life of pavement infrastructure.

Prerequisite(s): CEE 635 with a minimum grade of D-.**Grade Mode:** Letter Grading

CEE 748 - Pavement Design Project**Credits:** 1

Semester long design project accompanying CEE 749 Pavement Design Analysis. The design project will require weekly meetings (either online or in person) for the duration of the semester. Meeting times will be arranged based on student schedules. This course, in combination with the 3-credit CEE 749 Pavement Design Analysis, will satisfy a senior level materials principal design elective in the CEE department.

Co-requisite: CEE 749**Grade Mode:** Letter Grading**CEE 749 - Pavement Design and Analysis****Credits:** 3

Introduction to flexible and rigid pavement design and analysis for highways and airports. Examines design inputs, materials, analysis methods, design tools, and maintenance treatments. This course satisfies a senior level materials design elective in the CEE department. This course, in combination with the 1-credit CEE 748 Pavement Design Project, will satisfy a senior level materials principal design elective in the CEE department.

Prerequisite(s): CEE 635 with a minimum grade of D- and CEE 665 with a minimum grade of D-.**Equivalent(s):** CIE 721**Grade Mode:** Letter Grading**CEE 751 - Open Channel Flow****Credits:** 3

Energy and momentum principles in open channel flow; flow resistance; channel controls and transitions; unsteady flow concepts and dam failure studies. Modeling with HEC programs.

Prerequisite(s): CEE 650 with a minimum grade of D-.**Equivalent(s):** CIE 741**Grade Mode:** Letter Grading**CEE 753 - Snow Hydrology****Credits:** 3

Snow is a significant component of the hydrologic cycle in high latitude and high elevation environments. It is also a part of engineering design and practice that is frequently overlooked. In this course, we will examine spatial controls on snow accumulation and the dynamics of snowmelt processes through readings in snow hydrology, field assays of snow distribution, and analytical exercises. Of particular interest will be the role of snow in water resource engineering.

Prerequisite(s): CEE 650 with a minimum grade of D- and (MATH 539 with a minimum grade of D- or MATH 644 with a minimum grade of D-).**Grade Mode:** Letter Grading**CEE 754 - Engineering Hydrology****Credits:** 3

Hydrologic cycle, probability theory related to hydrology and the design of water resources structures, water law, flood discharge prediction, hydrograph development, hydraulic and hydrologic river routing, reservoir routing, theory of storage, reservoir operations, hydropower development, modeling of watershed hydrology with program HEC-1, HEC-HMS, multipurpose projects.

Equivalent(s): CIE 745**Grade Mode:** Letter Grading**CEE 755 - Design of Pressurized Water Transmission Systems****Credits:** 4

Theory developed for individual components to large complex systems. Analysis and designs of components and systems. Topics include: steady and unsteady closed conduit flow, valves and meters, pump requirements, pump selection, system planning and layout, water hammer, and system operation and maintenance. Pressure system modeling with program EPANET.

Prerequisite(s): CEE 650 with a minimum grade of D-.**Equivalent(s):** CIE 755**Grade Mode:** Letter Grading**CEE 758 - Stormwater Management Designs****Credits:** 3

Historic review of stormwater management leading up to the current regulatory framework. Overview of stormwater management strategies, strategy selection, and the targeting of specific contaminants, contaminant removal efficiencies, construction and site selection, and system maintenance. Hydrologic concepts including watershed and storm characteristics, design hydrology (peak flows, storm and treatment volumes), hydrograph routing, and critical review of hydrology and drainage reports. Design and sizing of treatment systems including: conventional, BMPs, low impact development, and manufactured devices. Rainfall runoff calculations with US SCS TR55 model.

Prerequisite(s): CEE 650 with a minimum grade of D-.**Equivalent(s):** CIE 758**Grade Mode:** Letter Grading**CEE 759 - Stream Restoration****Credits:** 4

The assessment, planning, design, engineering, and monitoring of stream and watershed practices intended to protect and restore the quality and quantity of flowing surface waters and stream corridors. Lecture material covers hydrology, geomorphology, and ecosystems, with the intent of understanding the variables associated with stream systems and their interplay. Students measure field variables and then are challenged with actual designs. Examples of stream restoration issues include: in-stream flow, dam removal, induced recharge, improvements to fish habitat, and channel stabilization.

Prerequisite(s): CEE 650 with a minimum grade of D-.**Equivalent(s):** CIE 759**Grade Mode:** Letter Grading**CEE 765 - Engineering Behavior of Soils****Credits:** 4

Review of stress and strain in soil. Introduction to continuum mechanics. Development of engineering soil properties. Application of soil mechanics to shear strength and stress-strain behaviors of soils. Failure states and residual strength. Application of stress paths in engineering problems. Unstaturated soil mechanics. Laboratory exercises using direct shear test, triaxial test, and soil-water retention measurements.

Equivalent(s): CIE 767**Grade Mode:** Letter Grading**CEE 766 - Introduction to Geotechnical Earthquake Engineering****Credits:** 3

Overviews earthquake source mechanisms; magnitude and intensity; seismicity of the United States. Dynamics of simple structures; response spectra. Selection of design parameters; source, magnitude, input records. Measurement of dynamic characteristics of soils; site response, liquefaction, and ground deformation.

Prerequisite(s): CEE 778 with a minimum grade of D-.**Equivalent(s):** CIE 762**Grade Mode:** Letter Grading

CEE #767 - Geological Engineering**Credits:** 3

Functional classification of rocks and rock masses, stereographic projection, engineering properties of rocks, and rock mechanics. The influence of geology in the design of underground excavations, tunneling, foundations, and rock slope engineering.

Prerequisite(s): ESCI 401 with a minimum grade of D-.**Equivalent(s):** CIE 763**Grade Mode:** Letter Grading**CEE 768 - Geo-Environmental Engineering****Credits:** 3

Soil composition and structure; contaminant fate and transport; containment design including landfills, geo-synthetics for liners and covers, and leachate collection systems; vertical cutoff walls and slope stability analyses; geo-environmental site characterization and investigation using geotechnical and geophysical methods; ground water, soil and gas monitoring and sampling; remediation including in situ and ex situ techniques and treatment methods.

Equivalent(s): CIE 766**Grade Mode:** Letter Grading**CEE 778 - Foundation Design I****Credits:** 4

Foundation design based on subsurface investigation and characterization using current methods of laboratory and in situ testing. Use of consolidation theory and bearing capacity theory for the design of shallow foundations including footings and rafts. Basic design of pile foundations. Earth pressure theory applied to design of retaining walls. Slope stability theory and applications.

Prerequisite(s): CEE 665 with a minimum grade of D-.**Equivalent(s):** CIE 760**Grade Mode:** Letter Grading**CEE 779 - Foundation Design II****Credits:** 3

Advanced pile and pier design under vertical and lateral loads. Slope stability by circular and noncircular arc methods. Design of flexible bulkhead walls and mechanically stabilized walls. Excavation and dewatering. Soil and site improvement.

Prerequisite(s): CEE 778 with a minimum grade of D-.**Equivalent(s):** CIE 761**Grade Mode:** Letter Grading**CEE 780 - Matrix Structural Analysis and Modeling****Credits:** 3

Modeling and analysis of determinate and indeterminate structures by matrix computer methods. Creation of matrix elements using compatibility, equilibrium, and constitutive relationships. Plane trusses, beams, frames, and space trusses.

Prerequisite(s): CEE 680 with a minimum grade of D-.**Equivalent(s):** CIE 685, CIE 783**Grade Mode:** Letter Grading**CEE 781 - Dynamics of Structures****Credits:** 3

Dynamics of single- and multi-story buildings. Response due to earthquakes, blasting, traffic, and mechanical equipment. Analysis in the time domain and through the Fourier Transform. Fundamentals of structural vibration measurement.

Prerequisite(s): CEE 780 with a minimum grade of D-.**Equivalent(s):** CIE 787**Grade Mode:** Letter Grading**CEE 789 - Timber Design****Credits:** 3

Introduces the design of timber structures. Structural properties of wood, determination of horizontal and vertical loads, horizontal and vertical load-resisting systems, and design of horizontal diaphragms, shear walls, beams, and columns. Bolted, screwed, and nailed connections.

Prerequisite(s): CEE 680 with a minimum grade of D-.**Equivalent(s):** CIE 782**Grade Mode:** Letter Grading**CEE 790 - Structural Design in Masonry****Credits:** 3

Introduces the design of reinforced masonry structural members by the stress and strength method and considering deflection and other serviceability performance criteria. Includes development of wind and seismic load, curtain wall, shear wall, lintels and columns. Prereq: CEE 635, CEE 680; or permission.

Prerequisite(s): CEE 635 with a minimum grade of D- and CEE 680 with a minimum grade of D-.**Equivalent(s):** CIE 776**Grade Mode:** Letter Grading**CEE 791 - Reinforced Concrete Design****Credits:** 0 or 4

Introduces the design of reinforced concrete structural members by the strength method and considering deflection performance. Includes loads, approximate analyses, slabs, beams, and columns.

Prerequisite(s): CEE 635 with a minimum grade of D- and CEE 680 with a minimum grade of D-.**Equivalent(s):** CIE 774**Grade Mode:** Letter Grading**CEE #792 - Pre-stressed Concrete****Credits:** 3

Analysis and design of prestressed and post-tensioned concrete sections in flexure and shear. Strength, deflection, and losses in flexural members. Optimization of section and prestressing force selection.

Prerequisite(s): CEE 791 with a minimum grade of D-.**Equivalent(s):** CIE 791**Grade Mode:** Letter Grading**CEE 793 - Structural Design in Steel****Credits:** 4

Introduction to steel member design, including horizontal and vertical members for design and analysis of buildings. Examines design inputs, material choice, analysis methods and design and construction methodologies.

Prerequisite(s): CEE 635 with a minimum grade of D- and CEE 680 with a minimum grade of D-.**Equivalent(s):** CIE 793**Grade Mode:** Letter Grading**CEE 794 - Bridge Design****Credits:** 3

Analysis of two-span, continuous, slab and beam bridges using the AASHTO LRFD Bridge Design Specifications. Use of influence lines, load distribution, load factoring, deck design, analysis and design of composite beams and plate girders. Bridge aesthetics.

Prerequisite(s): CEE 791 with a minimum grade of D- and CEE 793 (may be taken concurrently) with a minimum grade of D-.**Equivalent(s):** CIE 792**Grade Mode:** Letter Grading

CEE 795 - Independent Study**Credits:** 1-4

Seniors in good standing may pursue independent studies under faculty guidance. A written culminating report is required.

Repeat Rule: May be repeated up to unlimited times.**Equivalent(s):** CIE 795**Grade Mode:** Letter Grading**CEE 796 - Special Topics****Credits:** 1-4

Advanced or specialized topics not normally covered in regular course offerings. May be repeated, but not in duplicate areas.

Repeat Rule: May be repeated up to unlimited times.**Equivalent(s):** CIE 795**Grade Mode:** Letter Grading**CEE 797 - Introduction to Project Planning and Design****Credits:** 2

Part one of a two-part sequence. Student groups develop a project statement to address a large-scale civil engineering system design. Each team prepares a project plan to be executed in CEE 798, part two of this sequence.

Equivalent(s): CIE 784**Grade Mode:** Letter Grading**CEE 798 - Project Planning and Design****Credits:** 2

Student groups are formed into design teams to prepare a design plan for a large-scale civil engineering system including consideration of budgetary constraints, building code criteria, and environmental impacts. Each team prepares a final written report and gives a formal presentation.

Attributes: Writing Intensive Course**Prerequisite(s):** CEE 797 with a minimum grade of D-**Equivalent(s):** CIE 682, CIE 788**Grade Mode:** Letter Grading**CEE 799H - Senior Honors Thesis****Credits:** 4

Students in the honors program in civil engineering complete a project under the direction of a faculty sponsor resulting in a written thesis which must be accepted by the sponsor by the end of the second semester, senior year. Four credits total during senior year; 3 of which may be used to fulfill a CEE non-design elective.

Attributes: Honors course**Equivalent(s):** CIE 799H**Grade Mode:** Letter Grading**CEE 804 - Transportation Engineering and Planning****Credits:** 3

Fundamental relationships of traffic speed, density, and flow applied to public and private modes of transport. Principles of demand forecasting and urban systems planning.

Equivalent(s): CIE 854**Grade Mode:** Letter Grading**CEE 805 - Introduction to Sustainable Engineering****Credits:** 3

Course begins with exploration of the precept that we live in, and must design engineering works for, a world with a finite supply of natural resources and with limited life support capacity. Tools for sustainability engineering are the major focus of the course, which include life cycle, analysis and life cycle impact analysis, the metrics and mass and energy flow analyses used in the field of industrial ecology, and environmental management systems.

Equivalent(s): CIE 851**Grade Mode:** Letter Grading**CEE 806 - Environmental Life Cycle Assessment****Credits:** 3

This course teaches knowledge and hands-on skills in conducting environmental life cycle assessment (LCA), which is a widely used technique by industries, academics, and governments. Students will learn to use popular LCA software (e.g., SimaPro), apply proper LCA techniques, critically analyze LCA results, and provide client-oriented suggestions during this course. Class time is primarily devoted to a combination of lectures and computer labs.

Grade Mode: Letter Grading**CEE 820 - Solid and Hazardous Waste Engineering****Credits:** 3

A thorough examination of the problems which exist in hazardous and solid waste management will be presented in terms of the current regulations and engineering approaches used to develop solutions. Topics will include risk-based decision making, transport and fate of contaminants, and the fundamental physical, chemical and biological concepts which make up the basis for technological solutions to these waste management problems. Case studies will be used throughout the course to highlight key concepts and provide real-world examples.

Equivalent(s): CIE 842**Grade Mode:** Letter Grading**CEE 821 - Environmental Sampling and Analysis****Credits:** 4

Theory of analytical and sampling techniques used in environmental engineering. Topics include potentiometry, spectroscopy, chromatography, automated analysis, quality control, sampling design, and collection methods. Methods discussed in lecture are demonstrated in labs.

Grade Mode: Letter Grading**CEE 822 - Introduction to Marine Pollution and Control****Credits:** 4

Introduction to the sources, effects, and control of pollutants in the marine environment. Dynamic and kinetic modeling; ocean disposal of on-shore wastes, shipboard wastes, solid wastes, dredge spoils, and radioactive wastes; and oil spills. Prior coursework in fundamental aspects of environmental engineering required.

Equivalent(s): CIE 847**Grade Mode:** Letter Grading**CEE 823 - Environmental Water Chemistry****Credits:** 4

Emphasizes the use of chemical equilibrium principles and theory, calculations, and applications of ionic equilibrium stresses. Topics include thermodynamics, kinetics, acid/base, complexation, precipitation/dissolution, and redox equilibria. Computer equilibrium modeling is presented. General chemistry knowledge required.

Equivalent(s): CIE 849**Grade Mode:** Letter Grading

CEE 824 - Environmental Engineering Microbiology**Credits:** 4

Concepts of environmental engineering microbiology including microbial metabolism, growth kinetics, bioremediation applications, mass transfer kinetics and effects of environmental parameters. Coursework includes reading and discussion of the microbial literature. Laboratories cover microbiological monitoring and biological treatment experiments. Lab. Prior coursework in fundamental aspects of environmental engineering required.

Equivalent(s): CIE 856**Grade Mode:** Letter Grading**CEE 829 - Sources, Control, and Stewardship of Air Pollution****Credits:** 4

Sources and fate of air pollutants from natural and engineered systems. Fundamentals of pollutant chemistry, atmospheric dispersion, and engineering controls. Includes regulatory policy, environmental, and social justice issues. Prior coursework in solid and hazardous waste engineering or permission required.

Grade Mode: Letter Grading**CEE 830 - Public Health Engineering for Rural and Developing Communities****Credits:** 3

The design principles are to impart to the student specific information that can be used to design public health control facilities such as small water treatment systems and on-site wastewater disposal systems. The engineering control methods taught are particularly applicable to rural areas and developing countries.

Equivalent(s): CIE 840**Grade Mode:** Letter Grading**CEE 831 - Advanced Water Treatment Design****Credits:** 4

Selection, design, and evaluation of advanced unit processes employed in the treatment of water, wastewater, and hazardous wastes. Emphasis given on treatment schemes based on experimental laboratory or pilot studies.

Grade Mode: Letter Grading**CEE 832 - Solid and Hazardous Waste Design****Credits:** 4

Selection, design, and evaluation of unit processes employed in the treatment of solid wastes and hazardous wastes will be studied. Topics include design of materials recovery facilities, landfills, waste-to-energy facilities and hazardous waste site remedial technologies. A group term project taken from a real-world project will be required. An oral presentation by the group and preparation of a final written engineering report including alternative evaluation, permits, scheduling and economic analysis will be required from each group. Prior coursework in fundamental aspects of environmental engineering required.

Equivalent(s): CIE 848**Grade Mode:** Letter Grading**CEE 833 - Public Infrastructure Asset Management****Credits:** 4

The course provides a thorough examination of the growing engineering field of Public Infrastructure Assess Management (IAM). The course enables the student to design an IAM system. It touches upon all types of public infrastructure with a particular focus on water infrastructure for the semester design project. Students build upon their engineering economics and project engineering skills and use simple IAM software along with GIS applications. Practice leaders from the industry provide guest lectures throughout the semester. A focus on triple bottom line or the Societal, Environmental and Economic aspects of IAM are included. The format is a modified team base design learning experience providing practice in processing of technical lecture material, personal performance evaluation (frequent quizzes) and team based performance evaluation. Student groups will present their design to the class and provide a written engineering report. Prior coursework in fundamental aspects of environmental engineering required.

Equivalent(s): CIE 839**Grade Mode:** Letter Grading**CEE 835 - Properties and Production of Concrete****Credits:** 3

Basic properties of hydraulic cements and mineral aggregates and their interactions in the properties of plastic and hardened concrete; modifications through admixtures; production handling and placement problems; specifications; quality control and acceptance testing; lightweight, heavyweight, and other special concretes. Prior coursework in fundamental aspects of materials engineering required.

Equivalent(s): CIE 822**Grade Mode:** Letter Grading**CEE 836 - Asphalt Mixtures and Construction****Credits:** 3

Specification of asphalt cements, aggregates and proportioning of mixture constituents for paving applications. Asphalt mixture design methods, production, construction, and quality control are discussed. Current and new material production and construction technologies are introduced. Prior coursework in fundamental aspects of materials engineering required.

Equivalent(s): CIE 823**Grade Mode:** Letter Grading**CEE 837 - Pavement Rehabilitation, Maintenance, and Management****Credits:** 3

This course covers the technical and financial strategies to extend the life of highway and airfield pavements. The course topics will include: Assessment of pavement functional and structural condition, suitability of pavement maintenance and repair techniques, use of pavement preservation processes, and application of asset management to extend the life of pavement infrastructure.

Grade Mode: Letter Grading**CEE #848 - Pavement Design Project****Credits:** 1

Semester long design project accompanying CEE 849 Pavement Design Analysis. The design project will require weekly meetings (either online or in person) for the duration of the semester. Meeting times will be arranged based on student schedules.

Co-requisite: CEE 849**Grade Mode:** Letter Grading

CEE 849 - Pavement Design Analysis**Credits:** 3

Introduction to flexible and rigid pavement design and analysis for highways and airports. Examines design inputs, materials, analysis methods, design tools, and maintenance treatments. Prior coursework in fundamental aspects of material and geotechnical engineering required.

Equivalent(s): CIE 821**Grade Mode:** Letter Grading**CEE 851 - Open Channel Flow****Credits:** 3

Energy and momentum principles in open channel flow; flow resistance; channel controls and transitions; unsteady flow concepts and dam failure studies. Modeling with HEC programs. Prior coursework in fundamental aspects of environmental engineering required.

Equivalent(s): CIE 841**Grade Mode:** Letter Grading**CEE 853 - Snow Hydrology****Credits:** 3

Snow is a significant component of the hydrologic cycle in high latitude and high elevation environments. It is also a part of engineering design and practice that is frequently overlooked. In this course, we will examine spatial controls on snow accumulation and the dynamics of snowmelt processes through readings in snow hydrology, field assays of snow distribution, and analytical exercises. Of particular interest will be the role of snow in water resource engineering.

Grade Mode: Letter Grading**CEE 854 - Engineering Hydrology****Credits:** 3

Hydrologic cycle, probability theory related to hydrology and the design of water resources structures, water flow, flood discharge prediction, hydrograph development, hydraulic and hydrologic river routing, reservoir routing, theory of storage, reservoir operations, hydropower development, modeling of watershed hydrology with program HEC-1, HEC-HMS, multipurpose projects.

Equivalent(s): CIE 845**Grade Mode:** Letter Grading**CEE 855 - Design of Pressurized Water Transmission Systems****Credits:** 4

Theory developed for individual components to large complex systems. Analysis and designs of components and systems. Topics include steady and unsteady closed conduit flow, valves and meters, pump requirements, pump selection, system planning and layout, water hammer, and system operation and maintenance. Pressure system modeling with program EPANET. Coursework in fluid mechanics required.

Equivalent(s): CIE 855**Grade Mode:** Letter Grading**CEE 858 - Stormwater Management Designs****Credits:** 3

Historic review of stormwater management leading up to the current regulatory framework. Overview of stormwater management strategies, strategy selection and the targeting of specific contaminants, contaminant removal efficiencies, construction and site selection, and system maintenance. Hydrologic concepts including watershed and storm characteristics, design hydrology (peak flows, storm and treatment volumes), hydrograph routing, and critical review of hydrology and drainage reports. Design and sizing of treatment systems including conventional BMPs, low impact development, and manufactured devices. Rainfall runoff calculations with US SCS TR55 model. Coursework in fluid mechanics required.

Equivalent(s): CIE 858**Grade Mode:** Letter Grading**CEE 859 - Stream Restoration****Credits:** 4

Explores the assessment, planning, design, engineering, and monitoring of stream and watershed practices intended to protect and restore the quality and quantity of flowing and surface waters and stream corridors. Lecture material covers hydrology, geomorphology, and ecosystems, with the intent of understanding the variables associated with stream systems and their interplay. Students measure field variables and then are challenged with actual designs. Examples of stream restoration issues include in-stream flow, dam removal, induced recharge, improvements to fish habitat, and channel stabilization. Coursework in fluid mechanics required.

Equivalent(s): CIE 859**Grade Mode:** Letter Grading**CEE 865 - Engineering Behavior of Soils****Credits:** 4

Review of stress and strain in soil. Introduction to continuum mechanics. Development of engineering soil properties. Application of soil mechanics to shear strength and stress-strain behavior of soils. Failure states and residual strength. Application of stress paths in engineering problems. Unsaturated soil mechanics. Laboratory exercises using the direct shear test, triaxial test, and soil-water retention measurements. Coursework in foundation design required.

Equivalent(s): CIE 867**Grade Mode:** Letter Grading**CEE 866 - Introduction to Geotechnical Earthquake Engineering****Credits:** 3

Overview of earthquake source mechanisms; magnitude and intensity; seismicity of the U.S.A. Dynamics of simple structures; response spectra. Selection of design parameters; source, magnitude, input records. Measurement of dynamic characteristics of soils; site response, liquefaction, and ground deformation.

Prerequisite(s): CEE 878 with a minimum grade of D-**Equivalent(s):** CIE 862**Grade Mode:** Letter Grading**CEE #867 - Geological Engineering****Credits:** 3

Functional classification of rocks and rock masses. Stereographic projection. Engineering properties of rocks. Rock mechanics. The influence of geology in the design of underground excavations, tunneling, foundations, and rock slope engineering. Prereq: ESCI 401 or permission.

Equivalent(s): CIE 863**Grade Mode:** Letter Grading

CEE 868 - Geo-Environmental Engineering**Credits:** 3

Soil composition and structure; hydrogeology; attenuation and contaminant transport; containment design including landfills, geosynthetics for liners and covers, leachate collection systems, vertical cutoff walls, and stability analyses; geo-environmental site characterization and investigation using geotechnical and geophysical methods; ground water, soil and gas monitoring, and sampling; remediation including in-situ and ex-situ techniques and treatment methods. Prior coursework in fundamental aspects of geotechnical engineering required.

Equivalent(s): CIE 866**Grade Mode:** Letter Grading**CEE 878 - Foundation Design I****Credits:** 4

Foundation design based on subsurface investigation and characterization using current methods of laboratory and in situ testing. Use of consolidation theory and bearing capacity theory for the design of shallow foundations, including footings and rafts. Basic design of pile foundations. Earth pressure theory applied to design of retaining walls. Slope stability theory and applications. Prior coursework in fundamental aspects of geotechnical engineering required.

Equivalent(s): CIE 860**Grade Mode:** Letter Grading**CEE 879 - Foundation Design II****Credits:** 3

Advanced pile and pier design under vertical and lateral loads. Slope stability by circular and noncircular arc methods. Design of flexible bulkhead walls and mechanically stabilized walls. Excavation and dewatering. Soil and site improvement.

Prerequisite(s): CEE 878 with a minimum grade of D-.**Equivalent(s):** CIE 861**Grade Mode:** Letter Grading**CEE 880 - Matrix Structural Analysis and Modeling****Credits:** 3

Modeling and analysis of determinate and indeterminate structures by matrix computer methods. Creation of matrix elements using compatibility, equilibrium, and consecutive relationships. Plane trusses, beams, frames, and space trusses. Prior coursework in fundamental aspects of structural engineering required.

Equivalent(s): CIE 883**Grade Mode:** Letter Grading**CEE 881 - Dynamics of Structures****Credits:** 3

Dynamics of single- and multi-story buildings. Response due to earthquakes, blasting, traffic, and mechanical equipment. Analysis in the time domain and through the Fourier Transform. Fundamentals of structural vibration measurement.

Prerequisite(s): CEE 880 with a minimum grade of D-.**Equivalent(s):** CIE 887**Grade Mode:** Letter Grading**CEE 889 - Timber Design****Credits:** 3

Introduction to the design of timber structures. Structural properties of wood. Determination of horizontal and vertical loads. Horizontal and vertical load-resisting systems. Design of horizontal diaphragms, shear walls, beams, and columns. Bolted, screwed, and nailed connections. Prior coursework in fundamental aspects of structural engineering required.

Equivalent(s): CIE 882**Grade Mode:** Letter Grading**CEE 890 - Structural Design in Masonry****Credits:** 3

Introduces the design of reinforced masonry structural members by the stress and strength method and considering deflection and other serviceability performance criteria. Includes development of wind and seismic load, curtain wall, shear wall, lintels and columns. Prior coursework in fundamental aspects of materials and structural engineering required.

Equivalent(s): CIE 876**Grade Mode:** Letter Grading**CEE 891 - Reinforced Concrete Design****Credits:** 0 or 4

Introduction to the design of reinforced concrete structural members by the strength method and considering deflection performance. Includes loads, approximate analysis, slabs, beams, and columns. Prior coursework in fundamental aspects of materials and structural engineering required.

Equivalent(s): CIE 874**Grade Mode:** Letter Grading**CEE 892 - Pre-stressed Concrete****Credits:** 3

Analysis and design of pre-stressed and post-tensioned concrete sections in flexure and shear. Strength, deflection, and losses in flexural members. Optimization of section and pre-stressing force selection.

Prerequisite(s): CEE 891 with a minimum grade of D-.**Equivalent(s):** CIE 891**Grade Mode:** Letter Grading**CEE 893 - Structural Design in Steel****Credits:** 4

Introduction to steel member design, including horizontal and vertical members for design and analysis of buildings. Examines design inputs, material choice, analysis methods and design and construction methodologies. Prior coursework in fundamental aspects of materials and structural engineering required.

Equivalent(s): CIE 893**Grade Mode:** Letter Grading**CEE 894 - LRFD Bridge Design****Credits:** 3

AASHTO LRFD Bridge Design Specifications using SI units. Design objectives, loads, load case analysis and selection, load distributions, static analysis, and design for axial loads, flexure, and shear. Design of slender columns, composite beams, and plate girders. Senior-level structural design course required prior to taking this course.

Equivalent(s): CIE 892**Grade Mode:** Letter Grading

CEE 895 - Independent Study**Credits:** 1-4

A limited number of qualified graduate students will be permitted to pursue independent studies under faculty guidance. May be repeated.

Equivalent(s): CIE 895**Grade Mode:** Letter Grading**CEE 896 - Special Topics****Credits:** 1-4

Advanced or specialized topics not normally covered in regular course offerings. May be repeated, but not in duplicate areas.

Equivalent(s): CIE 896**Grade Mode:** Letter Grading**Special Fee:** Yes**CEE 897 - Masters Student Seminar****Credits:** 1

Topics of interest to graduate students and staff; reports of research ideas, progress, and results; lectures by outside speakers. Requires one presentation from students on their research, self-assessment, and a minimum attendance level. Continuing course: instructor may assign IA grade (continuous grading) at the end of one semester. Course held simultaneously with 897/997.

Equivalent(s): CIE 900**Grade Mode:** Graduate Credit/Fail grading**CEE 898 - Master's Project Paper****Credits:** 3

Concluding project paper required of Master's level students who utilize the non-thesis option.

Equivalent(s): CIE 888**Grade Mode:** Letter Grading**CEE 899 - Master's Thesis****Credits:** 1-6

Master's Thesis.

Repeat Rule: May be repeated for a maximum of 6 credits.

Equivalent(s): CIE 899**Grade Mode:** Graduate Credit/Fail grading**CEE #907 - Systems Analysis of the Environment****Credits:** 3

This course teaches knowledge and hands-on skills in system dynamics modeling, which is one of the most commonly used tools in analyzing the mechanisms, tradeoffs, and feedbacks in environmental, social, and economic procedures and systems. Students will also be trained with the ability of systems thinking during this course. Class time is primarily devoted to a combination of lectures and computer labs.

Grade Mode: Letter Grading**CEE 936 - Advanced Asphalt Materials****Credits:** 3

Examination of chemical composition of asphalt cements, current technologies for modification, and inclusion of recycled materials to meet desired physical properties. Advanced characterization of asphalt materials, modelling, advanced mixture design tools.

Prerequisite(s): CEE 836 with a minimum grade of D-**Equivalent(s):** CEE 923**Grade Mode:** Letter Grading**CEE 949 - Advanced Pavement Design and Analysis****Credits:** 3

Advanced flexible pavement design and analysis including rehabilitation/overlay design. Includes development of mechanistic-empirical methods, advanced pavement structural analysis, and advanced material characterization.

Prerequisite(s): CEE 849 with a minimum grade of D-**Equivalent(s):** CEE 921**Grade Mode:** Letter Grading**CEE 951 - Statistical Hydrology****Credits:** 3

Course examines statistical methods used to address water resources planning and management problems involving uncertainty objectives and hydrologic inputs. Application of statistics and probability to uncertainty in the description, measurement, and analysis of hydrologic variables and processes, including extreme events, error models, simulation, and sampling. A hydrology course and basic statistics required prior to taking this course.

Equivalent(s): CIE 951**Grade Mode:** Letter Grading**CEE 954 - Advanced Groundwater Topics****Credits:** 3

Review of Darcy's Law for confined and unconfined aquifers, linearization techniques, draw down computations under varying boundary conditions, solutions to the inverse problem, drainage theory, recharge theory, two-phase flow, succession of steady states modeling, and borehole geophysics.

Prerequisite(s): ESCI 810 with a minimum grade of D-**Equivalent(s):** CIE 945**Grade Mode:** Letter Grading**CEE #955 - Advanced Surface Water Hydrology****Credits:** 3

Occurrence and distribution of water by natural processes including atmospheric thermodynamics, precipitation, runoff, infiltration, water losses, flood routing and catchment characteristics, analysis, and methods of runoff prediction. This course builds from a foundation of fluid mechanics in the environment to address essentials of modern hydrology. An emphasis is placed on fundamental concepts, first principles, and the scientific basis of approximations. Knowledge of calculus and fluid mechanics required for this course.

Equivalent(s): CIE 955**Grade Mode:** Letter Grading**CEE 959 - Advanced Stream Restoration Topics****Credits:** 3

Course focuses on: stream crossing analysis and design, dam removal, and designs for aquatic species passage. Prior coursework in fundamental aspects of stream restoration required.

Equivalent(s): CIE 959**Grade Mode:** Letter Grading**CEE 966 - Geotechnical Modeling****Credits:** 4

Introduction to geotechnical modeling, soil constitutive modeling, introduction to numerical modeling and applications, physical modeling, centrifuge modeling, and theoretical modeling. Prior coursework in fundamental aspects of geotechnical engineering required.

Equivalent(s): CIE 962**Grade Mode:** Letter Grading

CEE 967 - In Situ Geotechnical Testing**Credits:** 3

In situ geotechnical testing methods for site characterization; theory and practice. Geotechnical testing methods include the piezocone, the pressuremeter, the flat plate dilatometer, the field vane, and the standard penetration test. Includes sampling techniques, geophysical exploration, and recent innovations in site and soil characterization.

Prerequisite(s): CEE 965 with a minimum grade of D-**Equivalent(s):** CIE 961**Grade Mode:** Letter Grading**CEE 968 - Soil-Structure-Interaction****Credits:** 3

Introduction to soil-structure-interaction, elastic and plastic analyses, serviceability calculations, relative foundation stiffness, Pile-soil-interaction, flexible retaining walls, tunnel lining, bridge abutments, dynamic soil-structure-interaction, case studies, and modeling techniques. Prior coursework in fundamental aspects of geotechnical engineering required.

Equivalent(s): CIE 963**Grade Mode:** Letter Grading**CEE 993 - Advanced Structural Steel Design****Credits:** 3

Advanced design of structural steel elements according to the AISC Load and Resistance Factor Method as applied to advanced topics in steel design. Emphasis will be placed on theory involved in the development of the design code requirements. Course design project will expand on these topics and include experimental work as appropriate. Prior coursework in fundamental aspects of structural steel design engineering required.

Equivalent(s): CIE 993**Grade Mode:** Letter Grading**CEE 995 - Problems****Credits:** 2-4

The study and investigation of problems selected to meet the needs of the students.

Equivalent(s): CIE 995**Grade Mode:** Letter Grading**CEE 997 - Doctoral Student Seminar****Credits:** 1

Topics of interest to graduate students and staff; reports of research ideas, progress, and results; lectures by outside speakers. Requires one presentation from students on their research, self-assessment, and a minimum attendance level. Continuing course: instructor may assign IA grade (continuous grading) at the end of one semester. Course help simultaneously with 897/997.

Equivalent(s): CIE 901**Grade Mode:** Graduate Credit/Fail grading**CEE 999 - Doctoral Research****Credits:** 0

Doctoral Research.

Equivalent(s): CIE 999**Grade Mode:** Graduate Credit/Fail grading

Faculty

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