CIVIL AND ENVIRONMENTAL ENGINEERING (CEE)

Degrees Offered: Ph.D., M.Eng., M.S.

This program is offered in Durham.

The Department of Civil and Environmental Engineering offers the master of engineering degree in civil engineering, the master of science degree in civil engineering, and a Ph.D. degree in civil engineering with the following areas of specialization: structural, materials, geotechnical, water resources, and environmental engineering. Interested applicants are encouraged to visit the department website for information on current research in the department and to contact faculty members in their area of interest directly. The department website has information on program requirements and frequently asked questions. Applicants with questions not answered by the department or graduate school website should write to the graduate program coordinator for specific information.

Admission Requirements

An applicant must have completed a baccalaureate science degree in engineering, mathematics, or science at an accredited college or university. If coursework or laboratory experience is deficient, an admitted student will be required to fulfill, without graduate credit, all undergraduate prerequisites for graduate courses. In some cases, the student’s adviser may require additional undergraduate courses in order to achieve a well-integrated program of study. Applicants must submit current scores (within five years) from the general test of the GRE, unless waived by the graduate coordinator (for current UNH CEE undergraduates CIVE - civil engineering or ENVE - environmental engineering).

For more information on the Civil and Environmental Engineering Graduate Program, please email CEE.Graduate@unh.edu.

https://ceps.unh.edu/cee/graduate-programs

Courses

Civil and Environmental Engineering (CEE)

CEE 800 - 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. Prereq: AUTOCAD Experience or by permission.

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. Prereq: permission.

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.

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.

CEE 819 - Green Building Design
Credits: 3
This course gives an overview of green designs and sustainable practices in building construction. We 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. They are prepared to contribute in building projects that target LEED certifications. Students are also capable to engage in green practices within their existing built environments.

Programs

- Civil and Environmental Engineering (Ph.D.) (http://catalog.unh.edu/graduate/programs-study/civil-environmental-engineering/civil-environmental-engineering-phd)
- Civil and Environmental Engineering (M.Eng.) (http://catalog.unh.edu/graduate/programs-study/civil-environmental-engineering/civil-environmental-engineering-meng)
- Civil and Environmental Engineering (M.S.) (http://catalog.unh.edu/graduate/programs-study/civil-environmental-engineering/civil-environmental-engineering-ms)
CxEE 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.

CxEE 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. Prereq: CxEE 620 or permission.

CxEE 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. Prereq: general chemistry or equivalent.

CxEE 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. Prereq: CxEE 620 or permission.

CxEE 830 - Public Health Engineering for Rural and Developing Communities  
Credits: 3  
The design principles are 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. Prereq: permission.

CxEE 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. Prereq: CxEE 720. permission.

CxEE 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. Pre- or Coreq: CxEE 502 and CxEE 620.

CxEE 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. Prereq: CxEE 635 or permission.

CxEE 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. Prereq: CxEE 635 or permission.

CxEE 848 - Pavement Design Project  
Credits: 1  
Semester long design project accompanying CxEE 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: CxEE 849

CxEE 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. Prereq: CxEE 635 and CxEE 665.

CxEE 850 - Echhydrology  
Credits: 3  
Introduction to ecohydrological concepts in terrestrial and riverine systems. Topics include the historical practices, resources management impacts, hydrologic variability and the relationships among water and ecology, vegetation, biology, geomorphology, and water quality. Prereq: CxEE 854 or ESCI 805; or permission.

CxEE 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. Prereq: CxEE 650 or permission.
**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.

**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. Prereq: Fluid mechanics, or permission.

**CEE 857 - Coastal Engineering and Processes**  
Credits: 3  
Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave-structure interaction. Design of coastal structures. Introduction to mathematical and physical modeling. Prereq: CEE 650 or permission. (Also offered as ME 857 and OE 857.)

**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. Prereq: Fluid mechanics or permission.

**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. Prereq: CEE 650.

**CEE 865 - Engineering Behavior of Soils**  
Credits: 4  

**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. Prereq: CEE 878 or permission.

**CEE 867 - Geological Engineering**  
Credits: 3  

**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. Prereq: CEE 665 or permission.

**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. Prereq: CEE 665 or permission.

**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. Prereq: CEE 878 or permission.

**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. Prereq: CEE 680 or permission.

**CEE 881 - Dynamics of Structures**  
Credits: 3  

**CEE 889 - Timber Design**  
Credits: 3  
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. Prereq: CIE 635, 680; or permission.

CEE 891 - Reinforced Concrete Design  
Credits: 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. Prereq: CEE 635, 680; or permission.

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. Prereq: CEE 891 or permission.

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. Prereq: CEE 635 and CEE 680.

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. Prereq: senior-level structural design course or permission.

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.

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. Prereq: permission. Special Fee.

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. Continuing course: instructor may assign IA grade (continuous grading) at the end of one semester. Course held simultaneously with CEE 997.

CEE 898 - Master's Project Paper  
Credits: 3  
Concluding project paper required of Master's level students who utilize the non-thesis option. Prereq: permission. CEE majors only.

CEE 899 - Master's Thesis  
Credits: 1-6  
May be repeated up to maximum of 6 credits. Cr/F.

CEE 931 - Advanced Physicochemical Treatment Design  
Credits: 4  
Selection, design, and evaluation of advanced unit processes employed in physicochemical treatment of waters, wastewaters, and hazardous wastes. Discussion on preparation of alternative designs and economic analysis. Emphasis on treatment schemes based on experimental laboratory or pilot studies. Prereq: undergraduate-level course in water and waste water engineering or water chemistry, or permission. Lab.

CEE 934 - Advanced Bioenvironmental Engineering Design  
Credits: 4  
Theoretical and experimental examination of the fundamental parameters used in selection, design, and operation of biological treatment processes for waters, wastewaters, and hazardous wastes. Topics include design and evaluation of aerobic and anaerobic processes, suspended and fixed-film processes, and advanced biological water and wastewater treatment processes. Prereq: environmental engineering microbiology course, or permission.

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. Prereq: CEE 836 or permission.

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. Prereq: CEE 849 or permission.

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. Prereq: A hydrology course, basic statistics, or permission.

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. Prereq: ESCI 810.

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. Prereq: Calculus and Fluid Mechanics.
CEE 959 - Advanced Stream Restoration Topics
Credits: 3
Course focuses on: stream crossing analysis and design, dam removal, and designs for aquatic species passage. Pre- or Coreq: CEE 759 or equivalent.

CEE 965 - Advanced Soil Mechanics
Credits: 4
Numerical and physical modeling of the mechanical behavior of soils. Cam-clay and other predictive models. Laboratory studies of mechanical behavior and measurement of input parameters to soil models. Prediction of soil behavior based on laboratory results. Applications to numerical modeling of soil masses. Prereq: soil mechanics, and foundation design, or permission.

CEE 966 - Laboratory Geotechnical Testing
Credits: 4
Introduction to geotechnical modeling, soil constitutive modeling, introduction to numerical modeling and applications, physical modeling, centrifuge modeling, and theoretical modeling. Prereq: CEE 665, CEE 778, or equivalent, or permission.

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. Prereq: CEE 965 or equivalent.

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. Prereq: CEE 665 and 778; or permission.

CEE 980 - Nonlinear Structural Analysis
Credits: 3
This course deals with the theory, implementation, and application of methods of geometric and material nonlinear analysis. Geometric nonlinear analysis entails solving for equilibrium on the deformed configuration on the structure. Material nonlinear analysis involves inelastic behavior of materials. Practical design implications include problems of structural stability and inelastic static/dynamic analysis. Emphasis is on methods applied to frame structures comprised of line-type elements; however, the basic concepts also apply to general finite element methods. Prereq: CEE 780/CEE 880 or equivalent.

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. Prereq: CEE 793/CEE 893 or permission.

CEE 995 - Problems
Credits: 2-4
The study and investigation of problems selected to meet the needs of the students.

CEE 997 - Doctoral Student Seminar
Credits: 1
Topics of interest to graduate students, faculty, and staff; requires two presentations from doctoral students on their research ideas, progress, and results; lectures by outside speakers. Continuing course: instructor may assign IA grade (continuous grading) at the end of one semester. Course held simultaneously with CEE 897.

CEE 999 - Doctoral Research
Credits: 0
Cr/F.

Faculty

See http://ceps.unh.edu/faculty/cee for faculty.