OVERVIEW

Graduate programs in Civil and Environmental Engineering (CEE) that lead to the master of science and doctor of philosophy degrees are offered. The curricular and research programs emphasize engineering related to environmental and hydrological processes, sustainable transportation systems, materials, and geotechnical, geo-environmental and structural engineering.

Research in the department addresses critical issues facing the world related to sustainability and energy; infrastructure systems; climate change, hazard mitigation and adaptation; and environmental and public health. A wide range of research methods are employed from state-of-the-art laboratory and field testing to sensing to computational modeling to artificial intelligence. Example projects include groundwater contamination modeling and remediation, environmental restoration and ecological engineering, hydrological processes, air pollution related health effects, sustainable materials, soil and structural dynamics, geo-energy, and sustainable transportation systems.

CEE graduate students can concurrently pursue certificates of graduate study in Complex Systems, Ecological Economics, and Community Resilience & Planning, among others.

DEGREES

- Civil and Environmental Engineering AMP (http://catalogue.uvm.edu/graduate/civilenvironengineering/civilandenvironmentalengineeringamp/)
- Civil and Environmental Engineering M.S. (http://catalogue.uvm.edu/graduate/civilenvironengineering/civilandenvironmentalengineersms/)
- Civil and Environmental Engineering Ph.D. (http://catalogue.uvm.edu/graduate/civilenvironengineering/civilandenvironmentalengineeringphd/)

FACULTY

- Hamshaw, Scott; Research Assistant Professor, Department of Civil and Environmental Engineering; Ph.D, University of Vermont
- Hernandez, Eric M.; Associate Professor, Department of Civil and Environmental Engineering; PHD, Northeastern University
- Holmén, Britt A.; Professor, Department of Civil and Environmental Engineering; PHD, Massachusetts Institute of Technology
- Marti, Clelia Luisa; Assistant Professor, Department of Civil and Environmental Engineering; PHD, The University of Western Australia
- Rizzo, Donna Marie; Professor, Department of Civil and Environmental Engineering; PHD, University of Illinois Urbana-Champaign
- Scarborough, Matthew; Assistant Professor, Department of Civil and Environmental Engineering; PHD, University of California, Davis
- Tan, Ting; Associate Professor, Department of Civil and Environmental Engineering; PHD, University of Wisconsin-Madison
- Underwood, Kristen L.; Research Assistant Professor, Department of Civil and Environmental Engineering; PHD, University of Vermont

Courses

- **CE 201. Sustainable Eng Materials. 3 Credits.**
  Introduces the fundamentals of materials with a focus on sustainable engineering, including structure and bond, interatomic potential, metals, fracture, strength testing, cement chemistry, aggregates, composites, reinforced concrete, asphalt, bamboo and wood. Prerequisite: CE 100, ME 014, or Instructor permission.

- **CE 211. Sustainable Eng. Materials. 3 Credits.**
  Introduces the fundamentals of materials with a focus on sustainable engineering, including structural bonding, metals, fracture, strength testing, cement chemistry, aggregates, composites, reinforced concrete, asphalt, bamboo, wood, and bio-inspired materials and structures. Prerequisites: CE 100 or ME 014 or Instructor permission.

- **CE 218. Numerical Methods for Engineer. 3 Credits.**
  Foundational concepts of numerical integration, numerical differentiation, and numerical approximation and solution of differential and partial differential equations of the type encountered in the analysis of engineering problems and data processing; project-based. Prerequisites: MATH 271, CS 020; MATH 122 or MATH 124; Cross-listed with: ME 218.

- **CE 241. Traffic Operations & Design. 3 Credits.**
  Advanced concepts of traffic engineering and safety; human, vehicle and environment factors; simulation and statistical analysis software; transportation design manuals; project-based. Prerequisite: CE 133.
CE 243. Transportation Demand Models. 3 Credits.
Study of specific methods used to analyze travel demand, travel behavior and network flows; process of travel demand modeling; collection, analysis and expansion of survey data and travel data; mathematical methods common to travel modeling. Prerequisite: CE 133.

CE 250. Fate/Transport Organic Chem. 3 Credits.
Chemical transfers between environmental media; molecular structure-reactivity models; chemical, photochemical and biochemical transformation rates; emphasis on predicting environmental concentrations and risk. Project-based. Prerequisites: CHEM 031, CHEM 032, CE 132.

CE 253. Transportation & Air Quality. 3 Credits.
Air pollution sources, measurement methods, legislation, vehicle emissions formation, control and transport processes. Emphasis on emission factor and dispersion multi-scale modeling using latest modeling tools. Project-based. Prerequisites: CE 132, CE 133.

CE 254. Environmental Quantitive Anyl. 0 or 4 Credits.
Course focuses on chemical, biochemical and physical processes; diffusion, equilibria, reaction kinetics, acids/bases, colloids, air/water exchange; laboratories demonstrate standard environmental engineering techniques; project-based. Prerequisites: CHEM 032, CE 132, STAT 143.

CE 255. Phys/Chem Proc Water/Wstwater. 0 or 3 Credits.
Theory of physical/chemical processes for treating waters and wastewaters; reactor dynamics, mass transfer, adsorption, ion exchange, precipitation; project-based. Prerequisite: CE 151.

CE 256. Biol Proc Water/Wastewater Tr. 0 or 3 Credits.
Theory and application of biological processes for treating industrial and domestic wastewaters and contaminated ground water; microbiological considerations; aerobic and anaerobic processes; reactor design, in-situ bioremediation; bench-scale and pilot-scale experimentation. Prerequisite: CE 151.

CE 260. Hydrology. 3 Credits.
Theory of precipitation, run-off, infiltration, and ground water; precipitation and run-off data; and application of data for use in development of water resources. Pre/Co-requisite: CE 160.

CE 262. Advanced Hydrology. 3 Credits.
Introduces computer modeling of hydrological systems. Project-based. Simple overland flow, flood routing, water quality, and groundwater models are developed using finite difference techniques. Stochastic hydrology and hydrologic time series analysis are also introduced. Prerequisite: CE 260.

CE 265. Ground Water Hydrology. 3 Credits.
Principles of ground water hydraulics, well characteristics, aquifers, and use of numerical methods to solve ground water flow problems. Project-based. Prerequisite: CE 160.

CE 271. Advanced Structural Analysis. 3 Credits.
Virtual work, energy theorems, analysis of structures by the displacement method and the finite element method, non-linear structural analysis. Project-based. Prerequisite: CE 170.

CE 272. Structural Dynamics. 3 Credits.
Vibrations, matrices, earthquake engineering, stability and wave propagation. Project-based. Prerequisites: Senior standing in Engineering or Physical Sciences or Instructor permission. Cross-listed with: ME 270.

CE 273. Structural Design - Wood. 3 Credits.
Analysis and design of solid and glue laminated timber members and structural systems including tension members, beams, columns, beam-columns, diaphragms, shear walls, and connections; LRFD and ASD design methods; application of IBC for timber systems; current developments in wood design/construction; project-based. Prerequisite: CE 170.

CE 285. Geo-energy Systems. 3 Credits.
An introduction to Geoenrgy technologies for subsurface energy extraction (shallow and deep geothermal systems, enhanced oil recovery, shale gas extraction) and secure storage of byproducts of energy production (carbon dioxide and nuclear wastes); project-based. Prerequisite: CE 180.

CE 286. Foundation Design. 3 Credits.
Subsurface explorations; geotechnical analysis, design, construction, preservation, remediation, and monitoring aspects of shallow and deep foundations. Prerequisite: CE 180.

CE 290. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CE 312. Sustainability & Transportatn. 3 Credits.
Introduction to the complex interconnection of engineering, policy, science and social science that characterize transportation systems, mobility problems and solutions. Interdisciplinary teams conduct case studies. Prerequisite: Instructor permission required.

CE 359. Appld Artificial Neural Ntwrks. 1-3 Credits.
Introduction to artificial neural networks. A broad range of example algorithms are implemented in MATLAB. Research applications to real data are emphasized. Prerequisites: CS 020, STAT 223 or equivalent.

CE 367. Phys Flow&Trs thru Porous Mdia. 3 Credits.
The fundamental equations describing fluid flow and mass transport in subsurface systems are developed from first principles. Prerequisite: CE 265.

CE 369. Applied Geostatistics. 3 Credits.
Introduction to the theory of regionalized variables, geostatistics (kriging techniques): special topics in multivariate analysis; Applications to real data subject to spatial variation are emphasized. Prerequisites: STAT 223; CS 020 or CS 021; or Instructor permission. Cross-listed with: CSYS 369, STAT 369.
CE 370. Reliability of Eng. Systems. 3 Credits.
Modeling and simulation of functions of random variables and random processes, propagation of uncertainties in engineering systems, analytical and computational methods for reliability analysis of engineering systems and components, Bayesian methods to update reliability estimates based on operational data. Prerequisite: STAT 151 or equivalent.

CE 380. Advanced Soil Mechanics. 3 Credits.
Stress-strain-strength of soils, introduction to constitutive modeling, critical state concepts, applications of limit analysis and limit equilibrium methods in analyzing stability problems in geotechnical engineering, such as foundations, slopes and embankments and retaining structures. Prerequisite: CE 180.

CE 391. Master’s Thesis Research. 1-12 Credits.

CE 392. Master’s Project. 1-6 Credits.
Independent project related to civil and environmental engineering under the supervision of a Civil & Environmental Engineering faculty member, concluding with a written technical report and an oral presentation to a committee of two Civil & Environmental Engineering faculty members. Prerequisite: Permission of Civil & Environmental Engineering Graduate Coordinator or Civil & Environmental Engineering Department Chair.

CE 393. CEE Graduate Seminar. 0 Credits.
Presentation and discussion of advanced problems, research, and current topics in Civil & Environmental Engineering by faculty, graduate students, and outside guest speakers. Prerequisite: Graduate student in Civil & Environmental Engineering.

CE 395. Advanced Special Topics. 1-18 Credits.
Advanced topics in recently developed technical areas. Hours and credits as arranged.

CE 491. Doctoral Dissertation Research. 1-18 Credits.

CE 496. Advanced Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.