CIVIL AND ENVIRONMENTAL ENGINEERING

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, geoenvironmental and structural engineering.

Research includes: groundwater contamination modeling and remediation including optimal remediation design; environmental restoration and ecological engineering; hydrological processes; air pollution and related health effects; modeling of contaminant fate and transport in the environment; materials; geotechnical and geoenvironmental engineering; dynamic behavior of soils, structures and structural health monitoring; geo-energy; and sustainable transportation systems.

Graduate students of CEE can concurrently pursue certificates of graduate study in, for example, complex systems and ecological economics.

DEGREES

- Civil and Environmental Engineering AMP
- Civil and Environmental Engineering M.S.
- Civil and Environmental Engineering Ph.D.

FACULTY

Aultman-Hall, Lisa M.; Professor, Civil and Environmental Engineering; PHD, McMaster University  
Badireddy, Appala Raju; Assistant Professor, Civil and Environmental Engineering; PHD, University of Houston, TX  
Bomblies, Arne; Associate Professor, Civil and Environmental Engineering; PHD, Massachusetts Institute of Technology  
Dewoolkar, Mandar M; Professor, Civil and Environmental Engineering; PHD, University of Colorado Boulder  
Garcia, Luis; Professor, Civil and Environmental Engineering; PHD, University of Colorado  
Ghazanfari, Ehsan; Assistant Professor, Civil and Environmental Engineering; PHD, Lehigh University  
Hernandez, Eric M.; Associate Professor, Civil and Environmental Engineering; PHD, Northeastern University  
Holmen, Britt A.; Professor, Civil and Environmental Engineering; PHD, Massachusetts Institute of Technology  
Pinder, George Francis; Professor, Civil and Environmental Engineering; PHD, University of Illinois Urbana-Champaign  
Rizzo, Donna Marie; Professor, Civil and Environmental Engineering; PHD, University of Vermont  
Rosowsky, David; Professor, Civil and Environmental Engineering; PHD, Johns Hopkins University  
Tan, Ting; Assistant Professor, Civil and Environmental Engineering; PHD, Princeton University

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. Prerequisites: MATH 271, CS 020; MATH 122 or MATH 124. Cross-listed with: ME 218.

CE 220. Intro to Finite Element Anyl. 3 Credits.
Introduction to finite element analysis: applications in solid mechanics, hydrodynamics, and transport: analysis of model behavior: Fourier analysis. Computer project required. Prerequisites: CS 020; MATH 122 or MATH 124.

CE 226. Civil Engineering Systems Anyl. 3 Credits.
Linear programming, dynamic programming, network analysis, simulation; applications to scheduling, resource allocation, routing, and a variety of civil engineering problems. Prerequisites: Minimum Senior standing in Civil & Environmental Engineering. Cross-listed with: CSYS 226.

CE 238. Design/Planning for Bikes/Peds. 3 Credits.
Interdisciplinary introduction to design/planning concepts for bikes/ pedestrians from a systems view. Examines current best practices on how effectively they address social, environmental, economic, and health related transportation issues. Prerequisite: Minimum Senior standing.

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. Prerequisite: CE 133.

CE 245. Intelligent Transportation Sys. 3 Credits.
Introduction to Intelligent Transportation Systems (ITS), ITS user services, ITS applications, the National ITS architecture, ITS evaluation, and ITS standards. Prerequisite: CE 133. Cross-listed with: CSYS 245.
CE 248. Hazardous Waste Mgmt Engr. 3 Credits.
Management of hazardous and industrial waste from generation to
disposal; emphasis on pollution prevention within industry; waste
minimization, recovery, reuse, treatment technologies; environmental
regulations, risk assessment, costs and public policy; group projects.
Prerequisite: Senior standing in engineering or sciences.

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. Graduate student
independent modeling project. Prerequisites: CHEM 031,
CHEM 032, CE 132.

CE 251. Envir Facility Dsgn/Wastewater. 3 Credits.
Design of wastewater conveyance and treatment facilities; sewage
treatment plant design; equipment selection. Prerequisite: CE 151.

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. 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. 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. 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 259. Msmt of Airborne Contaminants. 3 Credits.
Quantifying airborne contaminants from processes and ambient
levels. Laboratories demonstrate calibration and measurement, stack
sampling and ambient air monitoring, and specific contaminant
generation and measurement. Prerequisite: CE 132.

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

CE 261. Open Channel Flow. 3 Credits.
Application of the laws of fluid mechanics to flow in open channels,
design of channels and transition structures, modeling, uniform and
gradually-varied flows. Prerequisite: CE 160.

CE 262. Advanced Hydrology. 3 Credits.
Introduces computer modeling of hydrological systems and involves
a semester-long design project. 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.
Prerequisite: CE 160.

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

CE 272. Structural Dynamics. 3 Credits.
Vibrations, matrices, earthquake engineering, stability and wave
propagation. 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. Prerequisite: CE 170.

CE 281. Geotechnical Design. 3 Credits.
Subsurface explorations; bearing capacity, lateral earth pressures,
slope stability; analysis and design of shallow and deep foundations,
retaining structures, and slopes. Prerequisite: CE 180.

CE 283. Designing with Geosynthetics. 3 Credits.
Geotextiles, geogrids, geonets, geomembranes, geocomposites,
geopipes. Design for separation, reinforcement, filtration, drainage,
erosion, control, liners. Applications in transportation, drainage, solid
waste containment. Material testing, behavior. Prerequisite: CE 180.

CE 284. Site Characterization. 3 Credits.
A comprehensive approach to subsurface site characterization for
gotechnical and environmental designs and a systems approach for
integrating the two. Prerequisites: CE 160, CE 180.

CE 285. Geo-energy Systems. 3 Credits.
An introduction to Geoenergy 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). 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 287. Design of Earth Structures. 3 Credits.
Soil and rock properties using laboratory, field and in-situ testing; analysis and design of slopes, embankments and retaining structures. 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 295. Special Topics. 1-18 Credits.
Content is dictated by expanding professional interest in newly developing, or recently developed, technical areas in which there is particular need or opportunity. Prerequisite: Minimum Senior standing.

CE 304. Adv Engineering Analysis I. 3 Credits.
Analytical methods for the solution of partial differential equations in engineering mechanics and physics, including: eigenfunction expansions; Fourier series; Sturm-Liouville theory and special functions. Prerequisites: Graduate standing in engineering, mathematics, or physical sciences. Cross-listed with: ME 304.

CE 305. Adv Engineering Analysis II. 3 Credits.
Advanced analytical techniques for problems in engineering mechanics and physics, including: integral transform methods, Green's functions, perturbation methods, and variational calculus. Prerequisites: ME 304; Graduate standing in engineering, mathematics, or physical science. Cross-listed with: ME 305.

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. Cross-listed with: PA 342, TRC 312.

CE 314. Risk/Behavior in Transportatn. 3 Credits.
In-depth examination of human, environmental and vehicle factors in transportation crashes. Students develop safety research proposals and statistical measurements of risk and rates. Prerequisite: Instructor permission.

CE 321. Engr Computations on Adv Arch. 3 Credits.
Engineering computations using multiprocessing computers, concurrent processing, algorithms for numerical approximation of differential equations, linear systems. Programming projects required. Prerequisites: Graduate standing in engineering, mathematics or physical science.

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. Cross-listed with: CSYS 359.

CE 360. Advanced Hydrology. 3 Credits.
Application of statistics to engineering hydrology; concept, use of instantaneous unit hydrograph; study of runoff models; flow through porous media; design techniques for water resources projects. Prerequisites: CE 260, MATH 271. Offered as occasion warrants.

CE 361. Fluvial Forms & Processes. 3 Credits.
Advanced topics in fluvial forms and processes; focus on river and stream restoration and design; includes journal readings, discussion, field trips and group design project. Prerequisite: CE 160.

CE 365. Contaminant Hydrogeol&Remediat. 3 Credits.
Practical, theoretical aspects of contaminant hydrogeology, advances in technologies, mass transport and transformation in saturated and vadose zones; movement, distribution, and remediation of nonaqueous-phase liquids. Prerequisite: CE 265.

CE 366. Numerical Method/Surface Water. 3 Credits.
Development of the governing equations for geophysical hydrodynamics/transport, shallow water equations, analysis and implementation of finite element/finite difference computational algorithms. Prerequisite: CE 218 or CE 220.

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 368. Groundwater Modeling. 3 Credits.
The fundamental theory of groundwater hydrology is combined with concepts in numerical methods to provide the technology needed to study a real-world groundwater problem. Prerequisites: CE 265, and CE 218 or CE 220.

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: CS 020, STAT 223 or equivalent. Cross-listed with: CSYS 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 390. Adv Topics in Civil & Envir Eng. 1-6 Credits.
Special topics to intensify the programs of graduate students in civil and environmental engineering. Hours and credits to be arranged.
CE 391. Master Thesis Rsch. 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 394. Independent Study. 1-18 Credits.

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 494. Independent Study. 1-18 Credits.

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