
280 Principles of Environmental Engineering and Science
Fall, Spring. 3(3-0) P: (CEM 141 or CEM 151 or LBS 171) and ((MTH 132 or concurrently) or (MTH 152H or concurrently) or (LBS 118 or concurrently))
Physical, chemical and biological processes related to environmental science and engineering. Environmental systems analysis with application to air, water and soil. Analysis of environmental problems and development of engineering solutions.

305 Introduction to Structural Analysis and Design
Spring. 4(3-2) P: (ME 222 and CE 271 or concurrently) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering.

312 Soil Mechanics
Fall, Spring. 4(3-3) P: ME 222 and (CE 271 or concurrently) R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering. Engineering properties of soil and their measurement. Effective-stress concept. Permeability and seepage. Compaction. Consolidation, shear strength, and stress-strain behavior.

321 Introduction to Fluid Mechanics
Fall, Spring. 4(3-2) P: (MTH 234 or MTH 254H or LB 220) and CE 221 and (IBE 230 or concurrently) R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering or in the Biosystems Engineering major. Not open to students with credit in ME 332. Fluid properties, fluid statics, fluids in motion. Conservation of mass, energy, and momentum. Dimensional analysis and similarity. Internal and external flows. Applications.

337 Civil Engineering Materials I
Fall, Spring. 4(3-3) P: (ME 222 or concurrently) and (CE 271 or concurrently) R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering. Common civil engineering construction and paving materials: aggregates, inorganic cements, asphalts, concretes, wood, and steel. Composition, structure, physical and mechanical properties, tests, and production mix design.

341 Transportation Engineering
Fall, Spring. 3(3-0) P: ((MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently)) and ((CE 271 or concurrently) and completion of Tier I writing requirement) R: STT 351 R: Open to juniors or seniors in the Department of Civil and Environmental Engineering or in the Urban and Regional Planning major. SA: CE 346
Overview of transportation system issues and problems. Fundamentals of highway design and operations. Planning and evaluation of transportation system alternatives. }

400 Structural Mechanics
Spring. 3(3-0) P: CE 305 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Matrix methods of structural analysis. Flexibility method. Direct stiffness method for plane structures. Elastic supports, inclined supports, member releases and non-prismatic members. Application software.

405 Design of Steel Structures
Fall. 3(3-0) P: CE 305 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Design of steel beams, columns, tension members and connections. Stability and plastic strength.

406 Design of Concrete Structures
Spring. 3(3-0) P: CE 305 and CE 337 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Design of reinforced concrete beams, slabs, columns and footings.

418 Geotechnical Engineering
Fall, Spring. 3(3-0) P: CE 312 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Shallow foundation design: bearing capacity, stress distribution, and settlement analysis. Pile foundations. Design of retaining structures, including rigid walls, braced excavations, and sheet-pile walls. Stability of slopes and embankments.

421 Engineering Hydrology
Fall. 3(2-2) P: CE 321 RB: STT 351 R: Open only to juniors or seniors or graduate students in the College of Engineering or College of Natural Science or Department of Crop and Soil Sciences. Hydrologic design of stormwater systems. Equilibrium hydログram analysis, unit hydrographs, infiltration, hydrograph synthesis, and reservoir routing. Groundwater: Darcy's law, flow nets, well hydraulics, design of capture wells.
449 Highway Design
Fall, Spring. 3(3-0): CE 341 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Geometric design of highways. Operation, capacity, safety, and geometric features. Alignment, drainage and pavement design. Use of CAD systems in preparing contract plans.

461 Computational Methods in Civil Engineering
Fall, 3(3-2): CSE 131 and CE 221 and MTH 235 R: Open to juniors or seniors or graduate students in the Civil Engineering major. SA: CE 390 Not open to students with credit in ME 361. Theoretical, numerical, and computational methods for civil engineering problems. Physical modeling, numerical techniques, and programming methods. Focus on civil engineering dynamics, solving systems of differential equations, and visualizing the results.

462 Technical Communication
Spring. 3(3-0) RB: Junior status in a degree program in the College of Engineering. Major modes of technical communication such as letters, memoranda, research reports, analysis/decision papers, presentations, information graphics, procedures. Communication planning, audience analysis, and information design. Case studies, exercises and writing workshops.

471 Construction Engineering - Equipment, Methods and Planning
Spring, 3(3-0) RB: Junior status in a degree program in the College of Engineering. Engineering and construction fundamentals of earthwork operations, moving of materials, concrete construction, formwork, false work, and other temporary structures. Relationship to a construction project's constructability, cost, and schedule.

480 Water and Wastewater Analysis Laboratory
Fall. 1(1-0) C: CE 802 concurrently. 1(1-0) P: CE 390. Chemical and microbial analysis of water and wastewater.

481 Environmental Engineering Chemistry
Fall. 3(3-0) P: {CE 151 and CEM 152} or (CEM 151H and CEM 152H) or (LBS 171 and LBS 172) and (CE 481 or concurrently) R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Chemical and microbial analysis of water and wastewater.

483 Unit Operations and Processes in Environmental Engineering
Fall, 3(3-0) P: CE 280 and (CE 321 or concurrently) R: Open to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering or in the College of Engineering. Scientific basis and design of physical, chemical and biological treatment methods for the control of water and air pollution. Operation and process selection.

485 Landfill Design
Spring. 3(3-0) P: CE 280 and CE 312 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering. Geotechnical and environmental design issues for solid waste landfills.

487 Microbiology for Environmental Health Engineering
Spring. 3(3-0) P: CHE 201 R: Open only to juniors or seniors or graduate students in the College of Engineering or graduate students in the College of Natural Science. Use and control of microorganisms for the protection of public health and the environment. Thermodynamics of microbial populations and microbial transformations.

490 Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering. Approval of department. Civil engineering problem of specific interest to the student and a faculty member. May be analysis or design.

491 Civil Engineering Design Project
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering. Approval of department. Planning, specification, and design of a civil engineering project or facility.

492 Selected Topics in Civil Engineering
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Approval of department. Selected topics related to construction engineering, environmental engineering, fluid mechanics, geotechnical engineering, hydrology, pavements, structural engineering, or transportation engineering.

495 Senior Design in Civil Engineering
Fall, Spring. 3(1-3) R: Approval of department. Preliminary design. Application of design concepts in civil engineering. Integrated design solutions for situations with geotechnical, hydrological, pavement, structural, environmental, and transportation considerations. Planning the design process. Design specifications. Cost. Written and oral presentations.

801 Nonlinear Structural Mechanics
Spring of odd years. 3(3-0) RB: Basic knowledge of the design of steel (CE405) and concrete structures (CE406), matrix methods of structural analysis (CE400), background in differential equations. Theory and methods related to the nonlinear behavior and analysis of structures with focus on line-type elements in two dimensions. Inelastic behavior of structural materials. Stability of structures. Nonlinear behavior and analysis of members and structural systems. Methods for iterative solution strategies and use of special computer software.

802 Introduction to Dynamics and Earthquake Engineering
Fall. 2 credits. RB: MSM 306 Not open to students with credit in ME 461. Dynamic response of single degree-of-freedom systems. Damping in structures and soils. Time domain and frequency domain methods. Analytical and numerical solution techniques. Earthquake response spectra.

803 Structural Dynamics

804 Advanced Mechanics for Civil Infrastructure
Spring, 3(3-0) R: CE 400 or matrix structural analysis R: Open only to graduate students in the College of Engineering. Advanced linear mechanics. Potential energy principles. Finite element formulations. Applications to problems in structural, geotechnical and pavement engineering.

805 Advanced Design of Steel Structures
Spring, 3(3-0) Flexural and torsional instability of columns and beams. Slender cross-sectional elements, design of beam-columns. Torsion, plastic design, plate girders, composite steel-concrete construction, connections.

806 Advanced Structural Concrete Design
Fall. 3(3-0) SA: CE 808 Analysis and design of prestressed and conventionally reinforced concrete structures.

807 Seismic Structural Design
Spring of even years. 3(3-0) RB: CE 400 and CE 405 and CE 406 Theory and methods for the seismic design of buildings, bridges, and other structures. Emphasis on fundamental factors influencing and controlling structural response. Philosophies for ductile design, capacity design and performance-based design. Analysis of structural systems under seismic demands for design and assessment. Introduction to retrofit strategies.

808 Structural Fire Engineering
Spring of even years. 3(3-0) RB: CE 400 and CE 405 and CE 406. Fire safety, fire codes, and fire engineering design methods. High temperature material properties, and behavior of materials and structures exposed to fires. Fire resistance design of steel, concrete, composite and timber structures. Use of the computer program for thermal and structural analysis.
809 Advanced Composite Materials and Structures
Spring of even years. 3(3-0) P: CE 222 and CE 490 and CSE 231 and MTH 235 and MTH 314
Mechanics and design of advanced composite materials and structures and their use for civil infra-
structure. Elastic anisotropy and failure theories. Micro- and macro-mechanical analysis of fiber-
reinforced polymer composites, particulate composites, and nanocomposites. Analysis and behavior of 
laminated plates and shells. Design applications to civil and mechanical structures.

810 Reliability-Based Design in Civil Engineering
Fall. 3(3-0)
Probabilistic treatment of live and dead loads: earthquakes, floods, material properties, and capacity. 
Reliability basis of design specifications, reliability index, probability of failure, design for reliability. 
Reliability of engineering systems.

811 Advanced Hydrogeology
Spring. 3(3-0) Interdepartmental with Geological Sciences. Administered by Geologi-
cal Sciences. RB: CE 821
Processes influencing groundwater flow and solute transport. Mathematical equations and numerical 
methods to describe these processes.

812 Properties of Soils
Fall of odd years. 3(2-3)
Saturated and unsaturated hydraulic properties, consolidation and shear strength properties, thermal 
properties, and numerical modeling. Laboratory determination of soil properties including, interpreta-
tion of experimental data.

813 Soil Dynamics
Fall. 1(1-0) SA: CE 803B C: CE 802 concur-
rently.
Wave propagation in visco-elastic media. Seismic site response analysis. Foundation vibrations. Dy-
namic soil properties. Soil liquefaction. Dynamic earth pressures. Computing dynamic response of 
continuous medium using a finite element program and the complex response method.

815 Selected Topics in Geotechnical Engineering
Spring. 3(3-0) A student may earn a maxi-
mum of 6 credits in all enrollments for this course.
Selected topics related to soil stabilization, highway and airport soils, and frozen ground engineering.

818 Advanced Geotechnical Design
Spring. 3(3-0)
Foundations and earth retaining structures. Bearing capacity, settlement, and lateral resistance of deep 
foundations. Advanced design of retaining structures using in-situ test data. Numerical solution of geo-
technical problems.

821 Groundwater Hydraulics
Fall. 3(3-0)
Physical properties of porous media. Equations of flow in saturated media. Flow nets, well flow and 
parameter measurement. Transport processes and the advective-dispersion equation for conservative 
contaminants.

822 Groundwater Modeling
Spring of even years. 3(3-0) P: CE 821
Analysis and modeling of groundwater flow, surface water and groundwater interaction, and reactive 
contaminant transport. Applied numerical methods for solving groundwater flow and contaminant trans-
port equations. Case studies.

823 Stochastic Groundwater Modeling
Spring of odd years. 3(3-0) P: CE 821 RB: 
Groundwater Hydrology, groundwater mod-
eling Analysis and modeling of flow and solute transport in heterogeneous aquifers, Geostatistics and vari-
ogram modeling, Upscaling and effective models. Uncertainty modeling, Perturbation methods and 
Monte Carlo simulation.

829 Mixing and Transport in Surface Waters
Fall of odd years. 3(3-0) P: ENE 801
Waves, tides and shallow-water processes. Numeri-
cal solutions and applications of shallow-water equations to lakes, rivers and estuaries. Principles and 
processes of sediment transport, and dispersion of materials in surface waters. Wind-driven circula-
tion in Lake Michigan.

831 Advanced Concrete Pavement Analysis 
and Design
Spring of odd years. 3(3-0) RB: CE 312 and 
CE 337 and CE 431
Theoretical models for analysis of concrete pave-
ment systems. Impact of concrete material on pavement response and performance. Formulation of 
improved mechanistic structural design proce-
dures.

832 Advanced Asphalt Pavement Analysis 
and Design
Spring of even years. 3(3-0) RB: CE 312 
and CE 337 and CE 431
Mechanistic approach to asphalt pavement design. Analysis of asphalt pavement systems using theo-
retical models, asphalt material modeling, prediction, and performance. Formulation of improved mecha-
nistic structural and mix design procedures.

835 Engineering Management of Pavement 
Networks
Spring of even years. 3(3-0)
Theoretical and statistical analysis of pavement networks. Engineering monitoring. Determination of 
distress mechanisms and engineering solutions. Assignment of priorities to engineering actions.

836 Materials Science for Civil Engineers
Spring. 3(3-0) RB: CE 337 or equivalent 
Structure of materials and structure-property rela-
tionships. Principles and theories governing me-
chanical, physical, and durability characteristics of civil engineering materials. Material selection, pro-
duction, and quality control.

837 Advanced Concrete Materials
Fall of odd years. 3(3-0)
Microstructure, engineering characteristics and 
modeling of concrete materials. Structure-property 
relationships in concrete materials. Control of con-
crete structure and properties for different infrastruc-
ture applications.

841 Traffic Flow Theory
Spring. 3(3-0)
Microscopic and macroscopic traffic flow models, 
Queueing theory. Gap acceptance. Simulation mod-
els for network analysis. Intelligent vehicle highway systems.

843 Simulation and Optimization of Urban 
Traffic Flow
Fall of even years. 3(3-0) RB: CE 444 and 
CE 841
Assumptions behind and use of traffic signal optimi-
ization models as tools for the development of signal 
timing plans for isolated intersections and coordi-
nated networks. Principles of vehicle actuation and 
design of actuated timing plans using signal optimi-
ization models. Simulation studies. Calibration issues with the use of microscopic traffic simulation 
models.

844 Highway and Traffic Safety
Fall of odd years. 3(3-0)
Analysis of highway geometric design alternatives and operational-control strategies with respect to 
accident probabilities. Statistical methods of pattern 
identification. Countermeasure selection and evalua-
tion methodology. Risk management.

846 Transportation Policies and Decision-
Making
Fall of even years. 3(3-0)
National transportation issues, policy formulation, and decision-making. Highway finance, 
assessment, urban and statewide planning, revenue sources, cost allocation, and transportation funding programs.

847 Traffic Analysis and Control
Spring of odd years. 3(3-0) P: CE 444 RB: 
Graduate student in transportation engineer-
ing
Modern traffic control and traffic modeling using state-of-the-art algorithms and computer models. 
Practical implications.

849 Transportation Research Methods
Spring. 3(3-0)
Application and interpretation of quantitative me-
thods and design of experiments for transportation research; ANOVA, non-parametric, discriminant 
analysis, factor analysis, multivariate regression, SPSS.

850 Intelligent Transportation Systems (ITS)
Fall of odd years. 3(3-0) RB: Traffic and 
Transportation engineering
Technical and policy aspects emerging from the application of advanced technologies to transporta-
tion problems. Intelligent Transportation Systems (ITS) user services requirements, available and 
emerging technologies, case studies of ongoing operational tests, legal institutional and planning 
issues related to ITS development and deployment.

851 Transportation and the Environment
Spring of even years. 3(3-0) RB: B.S. in Civ-
il Engineering with emphasis on transporta-
tion or environmental engineering R: Open 
only to graduate students in the College of 
Engineering.
The impact of transportation systems on the envi-
ronment. Elements of Environmental Impact State-
ments. Policy options and their consequences. 
Alternatives for reducing environmental impact.

852 Analysis and Optimization of Civil 
Engineering Systems with Soft Computing
Spring of odd years. 3(3-0) R: Open to stu-
dents in the College of Engineering.
Introduction to soft component techniques including 
networks, genetic algorithms, fuzzy logic, and 
neuro-fuzzy systems. Application to modeling analy-
sis, and optimization of complex civil engineering 
problems. Theory, selection of suitable soft compu-
ting technique, and proper application.
Civil Engineering—CE

860  Advanced Computational Methods for Engineers  
Fall of even years. 3(3-0) RB: Computer Programming Course  
Advanced computational techniques for engineering applications using Matlab, including robust and fast mechanics based computational methods, appropriate numerical methods, large data file manipulation and computation, and advanced data visualization techniques.

872  Finite Element Method  
Fall, Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Mechanical Engineering. SA: AE 809, MSM 809  
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.

890  Independent Study in Civil Engineering  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to master's students in the Civil Engineering major. Approval of department. Research problems of limited scope not pertaining to thesis accomplished under CE 899 or CE 999.

891  Selected Topics in Civil Engineering  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. Selected topics in new or developing areas of civil engineering.

892  Master's Research Project  
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 5 credits in all enrollments for this course. R: Open only to master's students in the Civil Engineering major. Approval of department. Master's degree Plan B individual student research project. Original research, research replication, or survey and reporting on a research topic.

893  Master's Design Project  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. R: Open only to master's students in the Civil Engineering major. Approval of department. Master's degree Plan B individual student civil engineering design project.

899  Master's Thesis Research  
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course. Master's thesis research.

900  Independent Study in Civil Engineering  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to doctoral students in the Civil Engineering major. Research problems of limited scope not pertaining to thesis accomplished under CE 999.

999  Doctoral Dissertation Research  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course. Doctoral dissertation research.