337 Civil Engineering Materials I
Fall, Spring. 4(3-3) P:M: (ME 222 or concurrently) and (CE 271 or concurrently) R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering.

341 Transportation Engineering
Fall, Spring. 3(3-0) P:M: (CE 234 or concurrently) or (CE 254H or concurrently) or (LBS 220 or concurrently) or (LBS 254H or concurrently) and (CE 271 or concurrently) and completion of Tier I writing requirement. RB: STT 351 R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering or in the Urban and Regional Planning major. SA: CE 346


417 Elementary Mechanics
Fall, Spring. 3(3-0) P:M: CE 141 or CEM 151 or LBS 171 and ((CE 132 or concurrently) or (LBS 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.

421 Engineering Hydrology
Fall, Spring. 3(2-2) P:M: CE 312 RB: STT 351 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering or Department of Mechanical Engineering in the Biosystems Engineering major.

Hydrologic design of stormwater systems. Equilibrium hydrograph analysis, unit hydrographs, infiltration, hydrograph synthesis, and reservoir routing. Groundwater: Darcy’s law, flow nets, well hydraulics, design of capture wells.

422 Applied Hydraulics
Spring. 3(2-2) P:M: CE 321 or ME 332 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering or Department of Mechanical Engineering in the Biosystems Engineering major.


341 Transportation Engineering
Fall, Spring. 3(3-0) P:M: (CE 234 or concurrently) or (CE 254H or concurrently) or (LBS 220 or concurrently) or (LBS 254H or concurrently) and (CE 271 or concurrently) and completion of Tier I writing requirement. RB: STT 351 R: Open only 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.
Civil Engineering—CE

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/design 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) P:M: (CE 305 and CE 312 and CE 337) or (BCM 305 and BCM 322) R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering and the Building Construction Management program.
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(0-3) P:M: (CEM 161 or CEM 185H or LBS 171L) 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.

481 Environmental Engineering Chemistry
Fall. 3(3-0) P:M: (CEM 151 and CEM 152) or (CEM 181H and CEM 182H) or (LBS 171 and LBS 172) and (CEM 251 or CEM 351) R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering.
Chemistry of environmental processes including alkalinity, precipitation-dissolution reactions, chemical complexation and redox reactions. Engineering applications to processing plants for water and wastewater.

483 Unit Operations and Processes in Environmental Engineering
Fall. 3(3-0) P:M: 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:M: CE 280 and CE 312 R: Open only to juniors or seniors or graduate students in the College of Natural Science.
Geotechnical and environmental design issues for solid waste landfills.

487 Microbiology for Environmental Health Engineering
Spring. 3(3-0) P:M: 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.

800 Bridge Design
Spring of odd years. 3(3-0) RB: CE 400 and CE 405 and CE 406 and CE 312 and CE 806 R: Open to graduate students in the College of Engineering or approval of department.
Design and analysis of bridge structures including bridge types, materials, load conditions, construction, methods, and rehabilitation. Analysis of beams, slab, box girder, curved, and skewed bridges. Conceptual or preliminary design of a bridge project.

801 Nonlinear Structural Mechanics
Spring of odd years. 3(3-0) RB: Basic knowledge on 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 481. 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
Fall. 1(1-0) C: CE 802 concurrently.

804 Advanced Mechanics for Civil Infrastructure
Fall. 3(3-0) RB: (CE 400) or matrix structural analysis R: Open only to graduate students in the College of Engineering.

805 Advanced Design of Steel Structures
Fall. 3(3-0) SA: CE 808
Analysis and design of prestressed and conventionally reinforced concrete structures.

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.

810 Reliability-Based Design in Civil Engineering
Fall. 3(3-0)

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

812 Mechanical Properties of Soils
Fall. 3(2-3)
Permeability, consolidation theory, stress-strain behavior, conditions of failure, shear strength. Laboratory determination of soil properties including interpretation of experimental data.

813 Soil Dynamics
Fall. 1(1-0) SA: CE 803B C: CE 802 concurrently.
815 Selected Topics in Geotechnical Engineering
Spring. 3(3-0) A student may earn a maximum 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)

821 Groundwater Hydraulics
Fall. 3(3-0)

822 Groundwater Modeling

823 Stochastic Groundwater Modeling

829 Mixing and Transport in Surface Waters

831 Advanced Concrete Pavement Analysis and Design
Spring of odd years. 3(3-0) RB: CE 312 and CE 431 Theoretical models for analysis of concrete pavement systems. Impact of concrete material on pavement response and performance. Formulation of improved mechanistic structural 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 relationships. Principles and theories governing mechanical, physical, and durability characteristics of civil engineering materials. Material selection, production, 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 concrete structure and properties for different infrastructure applications.

841 Traffic Flow Theory
Spring. 3(3-0)

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 optimization models as tools for the development of signal timing plans for isolated intersections and coordinated networks. Principles of vehicle actuation and design of actuated timing plans using signal optimization 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 evaluation 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 needs 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:M: CE 444 RB: Graduate student in transportation engineering 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 methods 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 transportation 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 Civil Engineering with emphasis on transportation or environmental engineering R: Open only to graduate students in the College of Engineering. The impact of transportation systems on the environment. Elements of Environmental Impact Statements. 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 students in the College of Engineering. Introduction to soft component techniques including neural networks, genetic algorithms, fuzzy logic, and neuro-fuzzy systems. Application to modeling analysis, and optimization of complex civil engineering problems. Theory, selection of suitable soft computing technique, and proper application.

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. 2 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 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 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.
Civil Engineering—CE

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.

990 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.