

**CIVIL ENGINEERING CE**

**Department of Civil and Environmental Engineering  
College of Engineering**

**221 Statics**

Fall, Spring, Summer. 3(2-2) Interdepartmental with Mechanical Engineering. Administered by Civil Engineering. P: (PHY 183 or PHY 183B or PHY 193H) and ((MTH 234 or concurrently) or (LB 220 or concurrently) or (MTH 254H or concurrently)) SA: MSM 205

Vector description of forces and moments. Two- and three-dimensional equilibrium of particles and rigid bodies. Analysis of trusses, frames, and machines. Coulomb friction.

**271 Introduction to Civil Engineering**

Fall, Spring. 4(3-3) P: (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently)

Measurement, analysis and design with applications in civil engineering. Surveying and error analysis.

**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.

Analysis and design of structural systems. Load estimation and placement. Structural analysis theory. Manual and computer analysis methods and validation of results from computer analysis methods. Proportioning of structural members in steel and reinforced concrete. Applications including bridges and building frames.

**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. Open only to juniors or seniors in the Biosystems Engineering major.

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 ((BE 230 or concurrently) or (CE 271 or concurrently)) R: Open 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 similitude. 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) RB: 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 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: 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 or in the Biosystems Engineering major.

Fundamentals of open-channel flow. Rapidly and gradually varied nonuniform flow analysis. Confined flows past submerged bodies, in pipe networks, and in turbo machinery. Design applications.

**423 Applied Hydrologic Analysis and Design**

Spring. 3(2-2) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CE 321 and CE 421 and (CE 422 or concurrently) R: Open to students in the Department of Civil and Environmental Engineering and open to students in the Department of Geological Sciences and open to students in the Department of Biosystems and Agricultural Engineering.

Project-based work using HEC-RAS and geographic information systems (GIS) to analyze the impacts of land use changes in urban and rural watersheds; design of systems to mitigate specific impacts. Project-based work on water distribution networks, analysis using EPANET to study the use of water storage towers, pressure regulation devices, and cyclic demands.

**431 Pavement Design and Analysis I**

Fall. 3(3-0) P: CE 312 and CE 337 R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering.

Highway and airfield pavement structural design. Performance measures. Failure mechanisms. Popular thickness design procedures. Design considerations for surface friction, pavement joints, and drainage.

**432 Pavement Rehabilitation**

Spring. 3(3-0) P: CE 312 and CE 337 RB: CE 431 R: Open only to seniors or graduate students in the Department of Civil and Environmental Engineering.

Engineering concepts and information needed to rehabilitate pavements. Network and project survey and evaluation: design of rigid and flexible overlays, other methods of rehabilitation, selection of rehabilitation alternatives. Initial and life cycle cost analysis of various rehabilitation alternatives.

**444 Principles of Traffic Engineering**

Fall. 3(3-0) P: STT 351 and CE341 R: Open only to juniors or seniors or graduate students in the Civil Engineering major.

Driver and vehicle characteristics affecting traffic flow and safety. Speed, density, capacity relationships. Signal control in street networks. Freeway management systems. Risk management and liability.

**448 Transportation Planning**

Spring. 3(3-0) P: CE 341 and STT 351  
Transportation planning process and procedures. Estimation of travel demand using traditional models of trip generation, trip distribution, modal split, and traffic assignment. Use of "quick-response" procedures. Traffic impact of new facilities.

## Civil Engineering—CE

- 449 Highway Design**  
Fall, Spring. 3(3-0) P: 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) P: 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) P: (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: (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: ((CEM 151 and CEM 152) or (CEM 181H and CEM 182H) or (LBS 171 and LBS 172)) and (CEM 251 or CEM 351)  
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: 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 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.
- 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 beam-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 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**  
Fall. 1(1-0) C: CE 802 concurrently.  
Dynamic analysis of beam, frame and truss structures. Classical and finite element formulations. Model analysis and numerical integration techniques. Response to earthquakes. Computing response using a finite element program.
- 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.  
Advanced linear mechanics. Potential energy principle. 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) RB: ME 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 infrastructure. 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 Geological 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, interpretation of experimental data.
- 813 Soil Dynamics**  
Fall. 1(1-0) SA: CE 803B C: CE 802 concurrently.  
Wave propagation in visco-elastic media. Seismic site response analysis. Foundation vibrations. Dynamic 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 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)  
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 geotechnical 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 transport equations. Case studies.
- 823 Stochastic Groundwater Modeling**  
Spring of odd years. 3(3-0) P: CE 821 RB: Groundwater Hydrology, groundwater modeling  
Analysis and modeling of flow and solute transport in heterogeneous aquifers. Geostatistics and variogram 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. Numerical 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 circulation 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 pavement systems. Impact of concrete material on pavement response and performance. Formulation of improved mechanistic structural design procedures.
- 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 theoretical models, asphalt material modeling, prediction, and performance. Formulation of improved mechanistic 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 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)  
Microscopic and macroscopic traffic flow models, Queueing theory. Gap acceptance. Simulation models 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 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: 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.

## 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.

**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.