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) or (PHY 231 and PHY 233B)} 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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: (CEM 141 or CEM 151 or LB 171) and ((MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 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
Fall, 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 Civiland 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
Fall. 3(3-0) P: CE 305 R: Open to juniors or seniors or graduate students in the College of 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 theDepartment of Civil and Environmental Engineering.
Design of reinforced concrete beams, slabs, columns and footings.

418 Geotechnical Engineering
Fall. 3(3-0) P: CE 312 R: Open to juniors or seniors or graduate students in the College of 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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CE 321 RB: STT 351 R: Open to juniors or seniors or graduate students in the College of Engineering or in the College of Natural Science or in the 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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CE 321 or ME 332 R: Open to juniors or seniors or graduate students in the College of Engineering.
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 337 R: Open to juniors or seniors or graduate students in the College of 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 337 RB: CE 431 R: Open to seniors or graduate students in the College of 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.

449 Highway Design
Fall. 3(3-0) P: CE 341 R: Open to juniors or seniors or graduate students in the College of 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
Spring. 3(3-2) P: (CSE 131 or EGR 102) 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.

471 Construction Engineering - Equipment, Methods and Planning
Spring. 3(3-0) P: (CE 305 and CE 312 and CE 337) or (CMP 305 and CMP 322) R: Open to juniors or seniors or graduate students in the College of Engineering or in the Department of Management or in the Construction Management major.
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 Environmental Measurements Laboratory
Fall. 1(0-3) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CEM 161 or CEM 185H or LB 171L
Basic chemical and microbiological methods used in the analysis of environmental media. Laboratory safety, quality assurance, quality control, and statistics used in laboratory analysis. Related technical communication, laboratory report writing.

481 Environmental Chemistry: Equilibrium Concepts
Fall. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: (CEM 141 and CEM 142) or (CEM 151 and CEM 152) or (CEM 181H and CEM 182H) or (LB 171 and LB 172)
Chemistry of natural environmental systems and pollutants. Equilibrium concepts and calculations for acid-base, solubility, complexation, redox and phase partitioning reactions and processes. Applications to ecosystem analysis, pollutant fate and transport, and environmental protection.

483 Unit Operations and Processes in Environmental Engineering
Fall. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CE 280 and (CE 321 or concurrently)
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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CE 280 and CE 312
Geotechnical and environmental design of solid waste landfills.

487 Microbiology for Environmental Science and Engineering
Spring. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: CE 280
Fundamentals of microbiology. Application of these concepts to environmental processes such as wastewater treatment, human health and bioremediation.

489 Air Pollution: Science and Engineering
Spring. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: MTH 133 and (CEM 141 or CEM 151) and CE 280
Basic physical and chemical principles governing indoor and atmospheric air pollution. Elements of air pollution meteorology, climate change, atmospheric transformations and transport. Air pollution sources and methods for their control. The role of local, state and federal government in air pollution control.

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.

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
Spring of even years. 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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering.
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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering.
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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. 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) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. 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
Fall. 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
Spring 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.

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.

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.

861 Introduction to Risk and Reliability in Civil and Environmental Engineering
Fall. 1(1-0) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. Not open to students with credit in CE 810.
Characterization of variability using probabilistic and statistical methods.

862 Reliability-Based Design in Civil Engineering
Fall of odd years. 2(2-0) Not open to students with credit in CE 810. C: CE 861 concurrently.
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.

863 Applied Numerical Methods for Civil and Environmental Engineers
Spring. 1 credit. Not open to students with credit in ENE 801.
Computation, visualization and programming tasks in civil and environmental engineering.

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.

880 Civil Engineering Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 2 credits in all enrollments for this course. RB: Graduate student or undergraduate at senior level with a GPA of 3.0 or higher
Current research in civil engineering.

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.