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 and Environmental 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.

272 Civil and Environmental Engineering Analysis
Fall, Spring, 3(3-0) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) Basic operations in AutoCAD. Selected applications of probability and statistics to topics in civil and environmental engineering. Applications of engineering economics including interest, net present worth, benefit-cost analysis, comparison of economic alternatives, and life-cycle costing.

280 Principles of Environmental Engineering and Science
Fall, Spring, 3(3-0) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: (CEM 141 or CEM 151 or LB 171) and (MTH 132 or concurrently) or (MTH 152H or concurrently) (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
Fall, Spring, 3(3-0) P: ME 222 and (CE 271 or concurrently) and (CE 272 or concurrently) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering. Theory of structural analysis for statically determinate structures. Qualitative structural analysis and behavior. Load estimation and placement. Introduction to structural analysis computer software. Introduction to statically indeterminate structures.

312 Soil Mechanics
Fall, Spring, 4(3-3) P: (ME 222 and (CE 271 or concurrently)) and (CE 272 or concurrently) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering and open 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(3-3) P: (MTH 234 or MTH 254H or LB 220) and CE 221 and (IBE 230 or concurrently) or (CE 271 or concurrently) or (CE 272 or concurrently) and completion of Tier I writing requirement) 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 similarity. Internal and external flows. Applications.

337 Civil Engineering Materials I
Fall, Spring, 4(3-3) P: (ME 224 or concurrently) and (CE 271 or concurrently) and (CE 272 or concurrently) R: Open 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) or (CE 272 or concurrently) or (CE 272 or concurrently) and completion of Tier I writing requirement) R: Open to juniors or seniors in the Department of Civil and Environmental Engineering. Not open to students with credit in ME 332 R: Open to juniors or seniors in the College of Engineering. Fundamentals of highway design and operations. Planning and evaluation of transportation system alternatives. Overview of transportation system issues and problems. Fundamentals of highway design and operations. Planning and evaluation of transportation system alternatives.

400 Structural Mechanics
Fall, Spring, 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, 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. 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 and (GLG 201 or GLG 301) 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, Spring, 3(3-2) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: CE 321 and (GLG 201 or GLG 301) R: Open to juniors or seniors or graduate students in the College of Environmental 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(3-2) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: CE 321 and LB 332 R: Open to juniors or seniors or graduate students in the College of Environmental 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(3-2) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: CE 321 and CE 421 and (GLG 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, Spring, 3(3-0) P: CE 337 R: Open to juniors or seniors or graduate students in the College of Engineering. Pavement and airfield pavement structural design. Performance measures. Failure mechanisms. Pavement design and analysis 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.
Transportation planning process and procedures. Use of "quick-response" procedures. Traffic impact of new facilities.

Traffic assignment. Estimation of travel demand using traditional models of trip generation, trip distribution, modal split, and environmental protection.

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.

Driver and vehicle characteristics affecting traffic. Focus on civil engineering dynamics, solving systems of differential equations, and visualizing the results.

Geometric design of highways. Operation, capacity, safety, and geometric features. Alignment, drainage, and pavement design. Use of CAD systems in preparing contract plans.

Geotechnical and environmental design of solid waste landfills.

Environmental 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.

Basic physical and chemical principles governing indoor and atmospheric air pollution. Elements of air pollution meteorology, climate change, atmospheric transport, and sources and methods for their control. The role of local, state and federal government in air pollution control.

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.

Environmental Chemistry: Equilibrium Concepts

Water and Wastewater Engineering

Landfill Design

Microbiology for Environmental Science and Engineering

Air Pollution: Science and Engineering

Independent Study

Selected Topics in Civil Engineering

Senior Design in Civil and Environmental Engineering

Bridge Design

Nonlinear Structural Mechanics

Introduction to Dynamics and Earthquake Engineering

Structural Dynamics

Advanced Mechanics for Civil Infrastructure

Advanced Design of Steel Structures

Advanced Structural Concrete Design
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 build- 
ings, 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 de- 
mands 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, com- 
posite 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 405 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 compo-
sites, 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: earth-
quakes, 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 Geo-
ological 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-
imum 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 input test data. Numerical solution of ge-
technical problems.

821 Groundwater Hydraulics
Fall. 3(3-0) Interdepartmental with Environ-
mental Engineering. Administered by Envi-
ronmental 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) Interdepart-
mental with Environmental Engineering. 
Administered by Environmental Engineer-
ing. 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) Interdepart-
mental with Environmental Engineering. 
Administered by Environmental Engineer-
ing. P: ENE 821 RB: Groundwater Hydrolo-
gy, groundwater modeling Analysis and modeling of 
flow and solute transport in heterogeneous aquifers. Geostatistics and vario-
gram 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. Administration by Environmental Engineering. 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 dispersal 
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 
new 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 the-
etrical 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
Fall. 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
Spring 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.

838 Bituminous Materials
Fall of even years. 3(2-3) RB: CE 431 and 
CE 432 and CE 461 
Superpave asphalt mix design, binder tests, hot mix 
asphalt performance tests, viscoelasticity, continu-
um damage models, image analysis methods.

861 Introduction to Risk and Reliability in 
Civil and Environmental Engineering
Fall. 1(1-0) Interdepartmental with Environ-
mental 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 stu-
dents with credit in CE 810. C: CE 861 con-
currently. 
Probabilistic treatment of live and dead loads: earth-
quakes, 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 under-
graduate 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 to 
grants students in the Department of Civil 
and Environmental Engineering. Approval 
of department. 
Research problems of limited scope not pertaining 
to thesis accomplished under CE 899 or CE 999.
Civil Engineering—CE

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  **Research Strategies and Methods in Civil Engineering**  
Spring. 1(1-0) R: Open to graduate students in the Department of Civil and Environmental Engineering. Not open to students with credit in ENE 900.  
Criteria for quality research, scientific method, scientific arguments, statistical testing, critical thinking skills, reviewing journal articles, literature synthesis, writing proposals and papers, giving presentations, responsible conduct of 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.