CIVIL ENGINEERING  

Department of Civil and Environmental Engineering  
College of Engineering

221 Statics  
Fall, Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Civil Engineering. P: (PHY 183 or PHY 183B or PHY 193H) and (PHY 231 and PHY 233B) and ((MTH 234 or concurrently) or (LB 220 or concurrently) or (MTH 254H or concurrently))  
SA: MGMT 205  

273 Civil and Environmental Engineering Measurements  
Fall, Spring. 2(1-3) P: (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) and (EGR 102 or concurrently)  
SA: CE 271  
Measurements, surveying and error analysis with applications to civil and environmental engineering problems

274 Graphics for Civil and Environmental Engineers  
Fall, Spring. 1(1-3) P: (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) and (EGR 100 or concurrently)  
SA: CE 272  
Basic operations in CAD software with applications in civil and environmental engineering

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) 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  
Fall, Spring. 3(3-0) P: ME 222 and (CE 273 or concurrently) and (CE 274 or concurrently)  
SA: CE 272  
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 273 or concurrently) and (CE 274 or concurrently)  
SA: CE 272  
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.

311 Introduction to Fluid Mechanics  
Fall, Spring. 4(3-0) P: (MTH 235) and CE 221 and Completion of Tier I Writing Requirement  
SA: CE 272  

337 Civil Engineering Materials  
Fall, Spring. 4(3-3) P: (ME 222 or concurrently) and (CE 273 or concurrently) and (CE 274 or concurrently)  
SA: CE 272  
Open to juniors or seniors in the Department of Civil and Environmental Engineering. Common civil engineering construction and paving materials: aggregates, inorganic cements, asphalts, concrete, woods, 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 273 or concurrently) and (CE 274 or concurrently)) and completion of Tier I writing requirement)  
SA: CE 272  
Overview of transportation system issues and problems. Fundamentals of highway design and operations. Planning and evaluation of transportation system alternatives.

342 Hydroelectric Engineering  
Fall, Spring. 3(3-0) P: (MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently) and (EGR 100 or concurrently)  
SA: CE 272  
Principles of sustainable design and engineering economics in Civil and Environmental Engineering.

371 Sustainable Civil and Environmental Engineering Systems  
Fall, Spring. 3(3-0) P: (MTH 234 or concurrently) or (LB 220 or concurrently) or (MTH 254H or concurrently) and ENE 280 R: Open to juniors or seniors in the Civil Engineering Major or in the Environmental Engineering Major. P: CE 321  
SA: CE 272  
Principles and tools of sustainable design and engineering economics in Civil and Environmental Engineering.

372 Risk Analysis in Civil and Environmental Engineering  
Fall, Spring. 2(2-0) P: (MTH 234 or concurrently) or (LB 220 or concurrently) or (MTH 254H or concurrently)  
SA: CE 272  
Open to juniors in the Civil Engineering Major or in the Environmental Engineering Major and open to seniors in the Civil Engineering Major or in the Environmental Engineering Major. Applications of probability, statistics, uncertainty and risk analysis to topics in civil and environmental engineering, characterization of system safety, and comparison tests for engineering quality control and environmental analyses.

390 Structural Mechanics  
Fall, Spring. 3(3-0) P: CE 305 R: Open to juniors or seniors or graduate students in the College of Engineering  
SA: CE 272  

405 Design of Steel Structures  
Spring. 3(3-0) P: CE 305 R: Open to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering or in the College of Engineering. P: CE 321  
SA: CE 272  
Design of steel beams, columns, tension members and connections. Stability and plastic strength.

406 Design of Concrete Structures  
Fall. 3(3-0) P: CE 305 and CE 337 R: Open to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering or in the College of Engineering. P: CE 321  
SA: CE 272  
Design of reinforced concrete beams, slabs, columns and footings.

407 Materials Engineering: Properties, Selection and Processing  
Spring. 3(3-0) P: CE 221 and ME 222 R: MSE 250 R: Open to juniors or seniors in the Chemical Engineering Major or in the Mechanical Engineering Major or in the Civil Engineering Major. P: ME 222 or concurrently) and (EGR 100 or concurrently)  
SA: CE 272  
General families of materials, materials design process for civil and environmental engineering problems, structural materials properties, processing methods and environment, microstructure of materials, structural materials selection by utilizing bubble charts.

418 Geotechnical Engineering  
Fall. 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 or concurrently) or (ME 222 or concurrently) and (EGR 100 or concurrently)  
SA: CE 272  

421 Engineering Hydrology  
Fall. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: CE 321 and (GLG 201 or GLG 301) and (CE 372 or STT 351) 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 Plant, Soil and Microbial Sciences. P: CE 321  
SA: CE 272  
Hydrologic design of storm water 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 Environmental Engineering. P: CE 321 and (GLG 201 or GLG 301) and (CE 372 or STT 351) 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 Plant, Soil and Microbial Sciences. P: CE 321  
SA: CE 272  

431 Pavement Design and Analysis  
Fall. 3(3-0) P: CE 337 R: Open to juniors or seniors or graduate students in the College of Engineering. P: CE 321 and (CE 271) R: Open to juniors or seniors or graduate students in the College of Engineering. P: CE 321  
SA: CE 272  
Focus on civil engineering dynamics, solving systems numerical techniques, and programming methods for civil engineering problems. Physical modeling, theoretical, numerical, and computational methods.

**444 Principles of Traffic Engineering**  
Fall. 3(3-0) P: CE 341 R: Open to juniors or seniors who graduate students in the Civil Engineering Major.  
Driver speed characteristics affecting traffic flow and safety. Speed, density, capacity relationships. Signal control in street networks. Freeway manage-ment systems. Risk management and liability.

**446 Computational Methods in Civil Engineering**  
Spring. 3(3-0) P: CE 341  

**448 Transportation Planning**  
Spring. 3(3-0) P: CE 341  

**449 Highway Design**  
Fall. 3(3-0) P: CE 341 R: Open to juniors or seniors who 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 Nonlinear Structural Mechanics**  
Fall. 3(3-0) P: (EGR 102 and CE 221) and (MTH 235 or MTH 340 or MTH 347H) R: Open to juniors or seniors who graduate students in the Civil Engineering Major.  
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 who 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 Environmental Engineering. P: (CEM 161 or CEM 185H or LB 171L) and ENE 280 and (CEM 142 or CEM 152 or CEM 182H or LB 172) and ((ENE 481 or concurrently) or (ENE 483 or concurrently)) and Completion of Tier I Writing Requirement R: Open to juniors or seniors who graduate students in the College of Engineering.  
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 Environmental Engineering. P: (CEM 141 and CEM 142) or (CEM 151 and CEM 152) or (CEM 161H and CEM 162H) or (LB 171 and LB 172) and (ENE 280 or BE 230 or GLG 201 or GLG 301 or approval of department) 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 Water and Wastewater Engineering**  
Fall. 4(3-2) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. P: (ENE 280 or BE 230) and (CE 321 or CHE 311) R: Open to juniors or seniors who graduate students in the College of Engineering.  
Engineering and scientific basis and design of physical, chemical and biological methods for the treatment of drinking water and wastewater. Operation process selection and design. Field trips required.

**485 Landfill Design**  
Spring. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Civil Engineering. P: ENE 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 Environmental Engineering. P: ENE 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: (CEM 141 or CEM 151 or LB 171) and (MTH 133 or MTH 153H or LB 119) and (ENE 280 or BE 230) and (CE 321 or CHE 311) R: Open to juniors or seniors who graduate students in the College of Engineering.  
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 to seniors in the College of 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, fluid mechanics, geotechnical engineering, hydrol-ogy, pavements, structural engineering, or transpor-tation engineering.

**495 Senior Design in Civil and Environmental Engineering**  
Fall. Spring. 4(2-3) P: (CE 274 and CE 371 and CE 372) and (ENE 421 or ENE 422 or ENE 483 or ENE 489 or CE 418 or CE 431 or CE 405 or CE 406 or CE 444 or CE 449) and (ENE 421 or ENE 422 or ENE 483 or ENE 489 or CE 405 or CE 406 or CE 418 or CE 431 or CE 444 or CE 449) R: Open to seniors in the Civil Engineering Major or in the Environmental Engineering Major.  

**801 Nonlinear Structural Mechanics**  
Spring. 3(3-0) P: 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 sys-tems. 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  

**803 Structural Dynamics**  
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 princi-
ple. Finite element formulations. Applications to prob-
lems in structural, geotechnical and pavement engi-
neering.

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.

Advanced Structural Concrete Design
Spring of even years. 3(3-0) SA: CE 808
Analysis and design of prestressed and convention-
ally reinforced concrete structures.

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 fu-
damental 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.

Structural Fire Engineering
Spring of even years. 3(3-0) RB: CE 400 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.

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 mate-
rials and structures and their use for civil infrastruc-
ture. 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 me-
chanical structures.

Properties of Soils
Fall of odd years. 3(2-3)
Saturated and unsaturated hydraulic properties, con-
solidation and shear strength properties, thermal
properties, and numerical modeling. Laboratory de-
termination of soil properties including, interpretation
of experimental data.

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.

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

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 geotech-
nical problems.

Groundwater Hydraulics
Fall. 3(3-0) Interdepartmental with Environ-
mental Engineering. Administered by Envi-
nmental Engineering.
Physical properties of porous media. Equations of
flow in saturated media. Flow nets, well flow and pa-
rameter measurement. Transport processes and the
advective-dispersion equation for conservative con-
taminants.

Groundwater Modeling
Spring of even years. 3(3-0) Interdepart-
mental with Environmental Engineering. Ad-
ministered by Environmental Engineering.
Analysis and modeling of groundwater flow, surface
water and groundwater interaction, and reactive con-
taminant transport. Applied numerical methods for
solving groundwater flow and contaminant transport
equations. Case studies.

Mixing and Transport in Surface Waters
Fall of odd years. 3(3-0) Interdepartmental
with Environmental Engineering. Adminis-
tered by Environmental Engineering. P: ENE
801 Waves, tides and shallow-water processes. Numeri-
cal solutions and applications of shallow-water equa-
tions to lakes, rivers and estuaries. Principles and
processes of sediment transport, and dispersion of
materials in surface waters. Wind-driven circulation in
Lake Michigan.

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.

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 theoret-
cal models, asphalt material modeling, prediction,
and performance. Formulation of improved mecha-
nistic structural and mix design procedures.

Engineering Management of Pavement
Networks
Spring of even years. 3(3-0)
Theoretical and statistical analysis of pavement net-
works. Engineering monitoring. Determination of dis-
tress mechanisms and engineering solutions. Assign-
ment of priorities to engineering actions.
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.

878  Autonomous Futures: Self-driving Vehicles, Domotics, and Artificial Intelligence in Smart Cities
Fall, 3(3-0) Interdepartmental with Urban Planning. Administered by Urban Planning.
Characteristics of autonomous systems and emerging technology. Perceptions of people on future transport, mobility, housing, and living. International perspectives on ethics and transitions towards autonomous futures. Implications for engineering, policy, business, and planning.

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 to graduate 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.

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.

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.