

**499 Senior Thesis Research**  
 Fall, Spring. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course. R: Approval of department.

An individual research project supervised by a faculty member that demonstrates the student's ability to do independent research and submit or present a major paper.

## CIVIL ENGINEERING CE

### Department of Civil and Environmental Engineering College of Engineering

**271 Engineering Surveying**  
 Fall, Spring. 4(3-3) P: (MTH 114 or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LBS 117 or LBS 118)

Application of surveying and error analysis to civil engineering problems. Earth work. Calculations. Layout and management of construction sites.

**280 Introduction to Environmental Engineering**  
 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)

Elements of hydrology. Groundwater and surface water supply and contamination. Treatment systems for drinking water, wastewater, air, and solid and hazardous waste. Noise and radiation pollution.

**305 Introduction to Structural Analysis and Design**  
 Fall, Spring. 4(3-2) P: (MSM 211) R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering.

Analysis and design of structural systems. Loads 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: (MSM 211) and completion of Tier I writing requirement. R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering or 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 LBS 220) and (ME 221) and completion of Tier I writing requirement. R: Open only 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: (MSM 211 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 LBS 220 or concurrently) and completion of Tier I writing requirement. RB: (STT 351) R: Open only to juniors or seniors in the Department of Civil and Environmental Engineering or in the Urban and Regional Planning major. SA: CE 346

Overview of transportation system issues and problems. Fundamentals of highway design and operations. Planning and evaluation of transportation system alternatives.

**375 Cost Engineering and Engineering Ethics**  
 Fall. 3(3-0) R: Open only to juniors or seniors in the College of Engineering. SA: CE 370

Cost engineering concepts and applications. Time value of money, alternative definitions and decision criteria. Equivalent cash flows. Cost benefit analysis, rate of return, depreciation. Moral foundations, engineering codes of ethics and case studies.

**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.

**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.

**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.

## Civil Engineering—CE

- 462 Technical Communication**  
Spring. 3(3-0) RB: Junior status in a degree program in the College of Engineering.  
Major modes of technical communication such as letters, memoranda, research reports, analysis/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) 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, form work, 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 Water and Wastewater Treatment**  
Fall. 3(3-0) P: (CE 280 and CE 321 or concurrently) R: Open only to juniors or seniors or graduate students in the Department of Civil and Environmental Engineering.  
Distribution of water and collection of sewage. Theory and design of water treatment processes.
- 485 Solid and Hazardous Waste Management**  
Spring. 3(3-0) P: (CE 280) R: Open only to juniors or seniors or graduate students in the College of Engineering.  
Design of solid waste collection and disposal systems. Definition of hazardous waste problems and selection of treatment alternatives.
- 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) P: (CE 321 or CE 341) and (CE 280 or CE 337) and (CE3 05 and CE 312) and (CE 405 or CE 406 or CE 485 or CE 418 or CE 421 or CE 422 or CE 431 or CE 444 or CE 448 or CE 449 or CE 483)  
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 only 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.
- 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) 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.
- 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 Department of Geological Sciences. RB: (CE 821)  
Processes influencing groundwater flow and solute transport. Mathematical equations and numerical methods to describe these processes.
- 812 Mechanical Properties of Soils**  
Fall. 3(2-3)  
Permeability, consolidation theory, stress-strain behavior, conditions of failure, shear strength. Laboratory determination of soil properties including interpretation of experimental data.
- 813 Soil Dynamics**  
Fall. 1(1-0) SA: CE 803B C: CE 802 concurrently.  
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.

- 831 Pavement Design and Analysis II**  
Spring. 3(3-0)  
Theoretical models for analysis of pavement systems. Evaluation and application of current design practices related to elastic and plastic theory. Formulation of improved 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.
- 837 Civil Infrastructure Materials**  
Fall. 3(3-0)  
Elastic and inelastic behavior and modeling of materials for civil infrastructure; design for desired properties and response of infrastructure components and systems. Constituents, manufacturing, stiffness, strength, failure, and durability of pavements, structural concretes, and fiber reinforced polymer composites.
- 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 841)  
Statistical analysis of highway geometric designs and operational-control strategies with respect to the optimal flow of traffic: intersection, arterial, network design and control models. Traffic simulation. System management and optimization.
- 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 Statewide Transportation Network Evaluation**  
Spring of odd years. 3(3-0)  
Transportation system measures, needs studies, sufficiency ratings. Cost allocation models, programming and budget constraints. Corridor analysis, transportation economics, demand elasticity.
- 847 Simulation Models for Transportation Applications**  
Fall of even years. 3(3-0)  
Simulation models for analysis and optimization of transportation systems. Experimentation with planning and traffic simulation models for signal timing and capacity analysis.
- 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.
- 872 Finite Element Method**  
Fall, Spring. 3(3-0) Interdepartmental with Mechanical Engineering. Administered by Department of 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 Civil Engineering master's students. Approval of department.  
Research problems of limited scope not pertaining to thesis accomplished under CE 899 or CE 999.
- 891 Selected Topics in Civil Engineering**  
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.  
Selected topics in new or developing areas of civil engineering.
- 892 Master's Research Project**  
Fall, Spring, Summer. 1 to 5 credits. A student may earn a maximum of 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 Civil Engineering doctoral students  
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.

## CLASSICAL STUDIES

CLA

### Department of French, Classics, and Italian College of Arts and Letters

- 120 Latin and Greek Roots of English Words**  
Spring of even years. 3(3-0)  
Prefixes, suffixes, and roots of English vocabulary from Greek and Latin word elements.
- 140 Greek and Roman Mythology**  
Fall. 3(3-0)  
Introduction to Greek and Roman myths, with emphasis on myth as social discourse and as an influence on ancient poets and thinkers.
- 160 Myth, Legend, and J.R.R. Tolkien**  
Spring. 3(3-0)  
Myth and myth-making in Tolkien's *The Lord of the Rings* and his other works. Ways of reading myth and legends that served as Tolkien's sources and inspiration.
- 210 Greek Civilization**  
Fall. 3(3-0)  
General survey of salient aspects of ancient Greek civilization and modern approaches to its study.
- 211 Roman Civilization**  
Spring. 3(3-0) SA: CLA 310  
Ancient Roman civilizations and modern approaches to their study.
- 292 Introduction to Ancient Studies**  
Fall. 2(1-2) Interdepartmental with Arts and Letters; History of Art; History. Administered by College of Arts and Letters.  
Methods and current trends in the study of the Greek and Roman world. Visits to library and museum collections.
- 350 Greek and Roman Literature in English Translation**  
Fall of even years. 3(3-0) R: Not open to freshmen.  
Representative works of major Greek and Roman authors.
- 360 Ancient Novel in English Translation**  
Spring of odd years. 3(3-0) R: Not open to freshmen.  
Translation of the ancient Greek and Roman novel. Interpretation of assigned novels. The role of popular literature in Greco-Roman society.
- 400 Women in Classical Greek Society**  
Spring of odd years. 3(3-0) Interdepartmental with Women's Studies. R: Not open to freshmen or sophomores.  
Image, role, and status of women in Greek society as seen through literary sources.