

## CIVIL ENGINEERING CE

### 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) 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.
- 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) 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 273 or concurrently) and (CE 274 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(3-2) P: (MTH 235) and CE 221 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 similitude. Internal and external flows. Applications.
- 337 Civil Engineering Materials**  
Fall, Spring. 4(3-3) P: (ME 222 or concurrently) and (CE 273 or concurrently) and (CE 274 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 273 or concurrently) and (CE 274 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 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.
- 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. 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) R: 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. SA: CE 272  
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.
- 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**  
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.  
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.  
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 RB: 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.  
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.  
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(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 Engineering or in the College of Natural Science or in the Department of Plant, Soil and Microbial Sciences.  
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 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.
- 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.  
Highway and airfield pavement structural design. Performance measures. Failure mechanisms. Popular thickness design procedures. Design considerations for surface friction, pavement joints, and drainage.

## CE—Civil Engineering

- 432 Pavement Rehabilitation**  
Spring of odd years. 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: CE 341 R: Open 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  
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: (EGR 102 and CE 221) and (MTH 235 or MTH 340 or MTH 347H) 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 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 or 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 181H and CEM 182H) 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 or 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 or 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, hydrology, pavements, structural engineering, or transportation 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) 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.  
Preliminary design. Application of design concepts in civil engineering. Integrated design solutions using geotechnical, hydrological, pavement, structural, environmental, and transportation considerations. Planning the design process. Design Specifications. Cost. Written and oral presentations. Issues of professional practice.
- 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.
- 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 Environmental 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 Environmental 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.
- 829 Mixing and Transport in Surface Waters**  
Fall of odd years. 3(3-0) Interdepartmental with Environmental Engineering. Administered by Environmental 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.
- 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, continuum damage models, image analysis methods.
- 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.
- 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.
- 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.

## CE—Civil 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.
- 878 Autonomous Futures: Self-driving Vehicles, Domatics, 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.
- 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 36 credits in all enrollments for this course.  
Doctoral dissertation research.