Civil Engineering (C E)

C E 301 Civil Engineering Systems 3 Hours
Introduction to civil engineering as a career; engineering problem solving; use of computers for text, graphics, and data analysis; introduction to civil engineering measurements; breadth of disciplines within civil engineering; engineering ethics, sustainability.

C E 107K, 207K, 307K Topics in Civil Engineering 1-3 Hours

C E 311K Introduction to Computer Methods 3 Hours
Organization and programming of civil engineering problems for computer solutions.

C E 311S Probability and Statistics for Civil Engineers 3 Hours
Basic theory of probability and statistics with practical applications to civil engineering problems, including statistical inference and sampling. Additional subjects may include reliability and risk analyses, estimation and regression analyses, and experimental design.

C E 319F Elementary Mechanics of Fluids 3 Hours
Fluid properties, hydrostatics, elements of fluid dynamics, energy and momentum, boundary layers, similitude, pipe flow, metering instruments, drag forces.

C E 119S, 219S, 319S, 419S, 519S, 619S, 719S, 819S, 919S Topics in Civil Engineering 1-9 Hours
Used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Fariborz Maseeh Department of Civil, Architectural, and Environmental Engineering. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program.

C E 321 Transportation Systems 3 Hours
Planning, economics, location, construction, operation, maintenance, and design of transportation systems; concepts of various modes of transportation.

C E 324P Properties and Behavior of Engineering Materials 3 Hours
Structure, properties, and behavior of engineering materials, including concrete and metals. Laboratory exercises illustrate mechanical behavior of typical materials and demonstrate selected principles of mechanics.

C E 329 Structural Analysis 3 Hours
Classical methods of analysis for determinate and indeterminate structures under stationary and moving loads.

C E 129S, 229S, 329S, 429S, 529S, 629S, 729S, 829S, 929S Topics in Civil Engineering 1-9 Hours
Used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Fariborz Maseeh Department of Civil, Architectural, and Environmental Engineering. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program.

C E 331 Reinforced Concrete Design 3 Hours
Design of reinforced concrete beams and columns.

C E 333T Engineering Communication 3 Hours
Technical communication skills for engineers, especially researching and writing technical documents for many kinds of readers, managing and documenting sources of information, using and explaining graphics, delivering oral presentations, working collaboratively, and eliciting information from experts and stakeholders.

C E 335 Elements of Steel Design 3 Hours
Analysis and design of tension members, beams, columns, and bolted and welded connections.

C E 341 Introduction to Environmental Engineering 3 Hours
Quantitative evaluation of the environmental, economic, and technical problems involved in control of pollutants of the air, water, and land.

C E 342 Water and Wastewater Treatment Engineering 3 Hours
Application of chemical, biological, and physical principles to the analysis and design of treatment processes for drinking water, industrial process water, municipal wastewater, and water reuse applications.

C E 346 Solid Waste Engineering and Management 3 Hours
Characteristics of municipal and industrial solid wastes, generation rates, collection systems, recycling, processing, and disposal.

C E 351 Concrete Materials 3 Hours
Portland cement, aggregates, supplementary cementing materials, properties of fresh and hardened concrete, concrete durability, mixture proportioning, concrete construction, and special concretes.

C E 356 Elements of Hydraulic Engineering 3 Hours
Flow in closed conduits, hydraulic machinery; open-channel flow; flow measurement; design of storm sewers.

C E 357 Geotechnical Engineering 3 Hours
Engineering properties of soils; hydraulic conductivity and shear strength of soils; soil compaction and consolidation; stresses with the soil mass; settlement of foundations of structures; laboratory measurements.

C E 358 Introductory Ocean Engineering 3 Hours
Wave theory and its applications to coastal engineering, wave energy conversion, and offshore structure technology. Includes fundamentals of inviscid and viscous flow of incompressible fluids, and applications of computational fluid dynamics (CFD) in design.

C E 360K Foundation Engineering 3 Hours
Effect of geotechnical conditions on the behavior, proportioning, and choice of foundation type; design of shallow and deep foundations; study of foundation case histories.

C E 362M Advanced Reinforced Concrete Design 3 Hours
Design of reinforced concrete buildings, including floor systems and structural walls.

C E 362N Advanced Steel Design 3 Hours
Design of steel buildings, beam columns, composite beams, plate girders, and connections.

C E 363 Advanced Structural Analysis 3 Hours
Structural analysis for forces and deflections using stiffness and flexibility approaches; application of energy methods in structural analysis; stiffness methods for computer-based structural analysis.

C E 364 Design of Wastewater and Water Treatment Facilities 3 Hours
Explore analysis, synthesis, and integrated design of municipal water and wastewater treatment plants.

C E 366K Design of Bituminous Mixtures 3 Hours
Fundamental properties of asphalt and aggregates, design and construction of asphalt mixtures, special mixtures, and superpave design method.

C E 367G Design and Evaluation of Ground-Based Transportation Systems 3 Hours
Methods for design and evaluation of transportation systems, emphasizing roadway and non-motorized travel, in light of traveler safety, system operations, construction and maintenance costs, environmental impacts, and other considerations.

C E 367P Pavement Design and Performance 3 Hours
Basic principles of design of pavements for highways, airfields, and railroads; pavement construction, maintenance, and rehabilitation.

C E 367R Optimization Techniques for Transportation Engineers 3 Hours
Overview of optimization techniques, including linear programming, nonlinear optimization, and network flow algorithms including shortest path, maximum flow, and minimum spanning tree. Examples and applications primarily drawn from transportation engineering, with connections to other areas.

C E 367T Traffic Engineering 3 Hours
Driver and vehicle characteristics, traffic studies, traffic laws and ordinances, intersection capacity, signs, markings, signals, bus transit, parking, design of street systems, and operational controls.

C E 369L Air Pollution Engineering 3 Hours
Characterization of sources, emissions, transport, transformation, effects, and control of outdoor and indoor air pollutants. Applications of chemistry, thermodynamics, and fluid mechanics in the selection and design of air pollution control equipment.

C E 369R Indoor Air Quality 3 Hours
Sources, properties, transport and fate, human exposure, and adverse responses to indoor air pollutants. Control strategies and engineered technologies to mitigate impacts of gaseous and particle phase air pollutants in indoor environments.

C E 370K Environmental Sampling and Analysis 3 Hours
Principles of environmental chemistry; measurement of contaminants in air, water, and land environments; applications to municipal, industrial, and ambient samples.

C E 370L Climate Change Mitigation 3 Hours
Explore the large-scale solutions to climate change systematically. Examine the fundamentals of climate science, mitigation of climate change through transformation of energy supply and end-use, geoengineering, and industrial carbon management. Discuss the social and economic context for engineered solutions.

C E 370P Engineering Professionalism 3 Hours
Examines professional engineering licensure, ethics, leadership, public service, and public policy, with an emphasis on multidisciplinary perspectives, legal and business considerations, and the importance of lifelong learning. Includes participation in a culminating major design project in public service, reflecting knowledge from technical electives and base level coursework.

C E 171P Engineering Professionalism 1 Hour
Examines professional engineering licensure, ethics, leadership, public service, and public policy, with an emphasis on multidisciplinary perspectives, legal and business considerations, and the importance of lifelong learning. Includes participation in a culminating major design project in public service, reflecting knowledge from technical electives and base level coursework.

C E 374K Hydrology 3 Hours
Phases of the hydrologic cycle and associated transport processes; land surface-atmosphere interaction; soil infiltration; rainfall runoff; unit hydrograph; flow routing; hydrologic statistics; and extreme events, including design storms and flows.

C E 374N Topics in Natural Water Systems Engineering 3 Hours

C E 374N.1 River Mechanics 3 Hours
Explore the application of engineering hydraulics to analysis of river behavior and sediment transport through complex natural topography. Examine basin-scale and reach-scale river dynamics as well as river restoration design and analyses.

C E 374N.2 Ecohydraulics 3 Hours
Explore the application of engineering hydraulics to analysis of river and stream behavior at small scales that interact with ecology. Examine sustainable design with vegetation to mitigate sediment impacts as well as hydraulic effects on invasive species.

C E 374U Topics in Urban Water Systems Engineering 3 Hours

C E 374U.1 Urban Stormwater 3 Hours
Explore the application of engineering hydraulics to design and analyses of urban stormwater infrastructure. Examine engineering hydrology for design storms; an introduction to hydraulic and hydrologic modeling tools; and design requirements for controlling urban water quality and enhancing sustainability.

C E 374U.2 Smart Water Infrastructure 3 Hours
Explore the application of engineering hydraulics to design and analyses of urban water distribution systems. Examine computational modeling and control of pipe networks as well as considerations of variable user demand, fireflow, and contaminant transport.

C E 375 Earth Slopes and Retaining Structures 3 Hours
Earth fills, excavations, and dams; soil compaction and ground improvement, seepage and dewatering; stability of natural slopes and embankments; earth-pressure theories; design of earth retaining structures.

C E 177K, 277K, 377K Topics in Civil Engineering 1-3 Hours
Various specified topics or conference course.

C E 177K.7, 277K.7, 377K.7 Independent Study 1-3 Hours
Conduct independent research with a tenure track faculty member in the Fariborz Maseeh Department of Civil, Architectural, and Environmental Engineering. Prepare a project proposal and a final report, each of which is evaluated by the faculty supervisor.

C E 177R Internship 1 Hour

C E 679H Undergraduate Honors Thesis 6 Hours
Research performed during two consecutive semesters under the supervision of an engineering faculty member; topics are selected jointly by the student and the faculty member with approval by the director of the Engineering Honors Program. The student makes an oral presentation and writes a thesis.

C E 380D Experimental Methods in Fluid Dynamics 3 Hours
Explore experimental techniques and instrumentation for studying common turbulent flows. Examine fundamentals of signal processing, data pre- and post-processing techniques for optical and acoustic instrumentation, turbulent flow analysis, and experimental design. Utilize particle image velocimetry, laser induced fluorescence, and acoustic Doppler velocimetry.

C E 380P Topics in Ocean Engineering Principles: Theory and Applications 3 Hours

C E 380P.4 Boundary Element Methods 3 Hours
Formulation and numerical implementation of boundary element methods; applications to problems in fluid mechanics, structural analysis, and solid mechanics.

C E 380P.5 Hydrodynamics of Marine Propulsors and Turbines 3 Hours
Hydrofoil and lifting surface theory, actuator disk and lifting line theory, modeling via vortex lattice, panel methods, and Reynolds-Averaged Navier-Stokes solvers, optimum loading and blade design techniques for propellers and turbines, unsteady blade and shaft forces, and modeling of sheet cavitation.

C E 380S Environmental Fluid Mechanics 3 Hours
Fundamentals of fluid mechanics applied in natural systems; analysis of energy; momentum, diffusion, turbulence, and stratification in lakes, rivers, and estuaries.

C E 380T Computational Environmental Fluid Mechanics 3 Hours
Basics of numerical methods as applied to the solution of the steady and unsteady fluid flow equations, such as the Euler and the Navier-Stokes equations and the advection-diffusion equation. Emphasis on finite volume methods as applied to fluid mechanics problems in civil and environmental engineering.

C E 380W Water Resources Engineering Research Seminar 3 Hours
Presentations and discussions on various topics in water resources engineering.

C E 381D Linear Regression and Discrete Choice Methods 3 Hours
Examine econometric model estimation methods and use of behavioral models in service design, marketing, and prediction. Discuss practical problems in the context of transportation planning to gain familiarity with models used and experience in data handling and estimation.

C E 381E Design of Energy Efficient and Healthy Buildings 3 Hours
Design of buildings for low energy use and optimal indoor air quality. Includes ventilation, energy efficiency, moisture problems, and prevention by design.

C E 381P Computer Methods in Structural Analysis 3 Hours
Linear and nonlinear analysis of trusses and frames; introduction to structural stability; and computational aspects of linear and nonlinear structural analysis.

C E 381R The Finite Element Method 3 Hours
Introductory concepts; weighted residual methods; strong and weak forms; boundary conditions; global v. local basis functions; error estimates; smooth and nonsmooth problems; one-dimensional second- and fourth-order problems; two-dimensional potential and plate problems; two-dimensional and three-dimensional elasticity; dynamic and eigenvalue problems; numerical, computational, and meshing issues; applications using commercial software.

C E 381T Numerical Modeling of Physical Systems 3 Hours
Survey of numerical methods; weighted residuals, finite differences, finite elements, boundary elements; applications to equilibrium, eigenvalue, and propagation problems.

C E 381W Introduction to Wave Physics 3 Hours
An introductory course in the theory and modeling of propagating waves. Subjects may include scalar waves in 1-D and 2-D, traveling and standing waves, flexural waves in beams, dispersion, phase and group velocity, vector waves in 2-D and 3-D, waves in infinite media and semi-infinite media, P waves, SH waves, SV waves, Rayleigh and Love surface waves, Stoneley waves, reflection and transmission at interfaces, numerical modeling, radiation conditions, scattering and radiation from obstacles, and fluid-solid interaction.

C E 382H Structural Health Monitoring and Nondestructive Evaluation 3 Hours
Explore the principal methods used for non-destructive evaluation (NDE) and structural health monitoring (SHM) of structural components. Examine relevant physical principles of continuum mechanics, electrical engineering, acoustics, and elastic wave propagation underlying the experimental methods. Examine sensor data acquisition and interrogation and ultrasonic digital signal processing. Utilize laboratory demonstrations on selected subjects.

C E 382L Plastic Design in Metals 3 Hours
Principles and methods of plastic analyses and design, and their applications to continuous beams, frames, plates, connections, and multistory buildings.

C E 382N Structural Systems 3 Hours
Application of systems engineering principles to planning, design, and construction of building and bridge structures with emphasis on performance requirements and economic factors.

C E 383C Experimental Methods in Structural Engineering 3 Hours
Survey of experimental methods used in structural engineering, including loading and measurement techniques and systems used in structural research.

C E 383D Steel Bridge Design 3 Hours
Design of steel highway bridges, including the analysis and design of composite girder, box girder, and cable-stayed bridges.

C E 383F Structural Fire Engineering 3 Hours
Behavior and design of structures subjected to fire; heat transfer fundamentals and modeling of fires; material properties at elevated temperature; structural fire resistance and protection; calculating structure-fire response.

C E 383L Advanced Reinforced Concrete Members 3 Hours
Behavior of reinforced concrete members; critical review of specifications; limit states; anchorage and development of reinforcement; shear; torsion.

C E 383N Advanced Reinforced Concrete Structures 3 Hours
Behavior of reinforced concrete structures, with emphasis on ductility and detailing of frames, slabs, and braced (shearwall) structures. Detailing for seismic loads.

C E 383P Prestressed Concrete 3 Hours
Theory, advantages, and limitations; various systems of prestressing; composite construction; continuous span theory.

C E 383R Repair and Strengthening of Reinforced Concrete Structures 3 Hours
Evaluation of condition, strength, serviceability, and ductility of existing structures; criteria for rehabilitation; retrofit techniques for change in function, loading, and seismic forces.

C E 383S Structural Concrete Bridges 3 Hours
Planning, design, and construction of reinforced concrete and prestressed concrete bridges, including arch, frame, girder, and cable stay systems; aesthetics, economy, and durability.

C E 383T Plasticity in Structural Concrete 3 Hours
Application of plasticity theory to structural concrete columns, girders, frames, and joints. Development and application of transparent detailing methods such as truss models, strut-and-tie models, and both strip and yield line methods for slabs.

C E 384P Dynamic Response of Structures 3 Hours
Single and multidegree-of-freedom systems; dynamic load factors, response to harmonic excitation; damping; modal analysis; direct integration of equations of motion; analysis in time and frequency domains; application to earthquake, wind, wave, and traffic loadings.

C E 384R Earthquake Engineering 3 Hours
Earthquake characteristics; seismic loads; elastic and inelastic response; analysis and design of buildings for earthquakes.

C E 384S Structural Reliability 3 Hours
Load and resistance factors in reliability-based design; first- and second-order reliability methods; Monte Carlo simulation techniques with variance reduction and importance sampling refinements; reliability of systems; fault-tree and event-tree models; inverse reliability procedures; and random fields and stochastic finite element analysis for reliability analysis.

C E 384T Blast-Resistant Structural Design 3 Hours
Physics of explosions and basic blast phenomenology; structural loading due to blast effects; nonlinear dynamic response of blast-loaded structures; protective design; progressive collapse.

C E 385D Water Resources Planning and Management 3 Hours
Application of engineering economics and operations research to the planning and management of water systems. Major subjects include water supply, water resources management, multi-objective planning, and optimization techniques. Focus on programming skills and implementation of the models using a programming language.

C E 385G Transboundary Water Resources 3 Hours
Introduction to planning, policy, and development of water resources in the international setting, with emphasis on transboundary situations. Basic concepts of water rights and international law pertaining to transboundary water use and protection; economic analysis and applications to transboundary water resources problems; international development goals and how these relate to water supply and use.

C E 385J Hazardous Waste Management 3 Hours
Legal and technological approaches to effective and sustainable control of hazardous wastes and contaminated sites, studied through problem evaluation and solution.

C E 385K Topics in Water Quality 3 Hours
Analysis of water quality in natural systems and of effects of wastewater discharges.

C E 385K.1 Stream, Impoundment, and Estuarine Analysis I 3 Hours
Basic physical, chemical, and biological properties of streams, impoundments, estuaries, and coastal waters; methods for analysis of water quality problems.

C E 385K.2 Stream, Impoundment, and Estuarine Analysis II 3 Hours
Application of methods of analysis to development of a water quality management plan for a water body in Texas.

C E 385K.3 Water Quality Modeling 3 Hours
Mathematical modeling of water quality, including dissolved oxygen, nutrients, and toxic substances in lakes, reservoirs, rivers, and estuaries.

C E 385K.4 Water Pollution Ecology 3 Hours
Advanced topics in the application of engineering solutions to ecological problems in freshwater and marine environments.

C E 385L Topics in Water and Wastewater Treatment 3 Hours
Principles of sustainable treatment of domestic and industrial water, wastewater, and sludges.

C E 385L.1 Physical and Chemical Treatment 3 Hours

C E 385L.2 Biological Wastewater Treatment and Sludge Processing 3 Hours

C E 385L.3 Advanced Treatment Processes 3 Hours
Project-based course addressing advanced topics in treatment process design: alternative designs, computer models, laboratory testing, economics, and least-cost designs.

C E 385M Unit Operations in Water and Wastewater Treatment 3 Hours
Physical, chemical, and biological unit operations for sustainable water and wastewater treatment.

C E 385N Industrial Wastewater Treatment 3 Hours
Industrial wastewater characteristics; methods of in-plant control; application of various biological, chemical, and physical processes in practical water pollution control systems.

C E 385R Land Treatment of Wastes 3 Hours
Principles of the use of land in management of municipal and industrial wastewaters, sludges, and solids; includes problem evaluations.

C E 385S Stochastic Hydrology 3 Hours
Probability and statistics applied to the solution of hydrological problems; extreme event frequency analysis, time series analysis of hydrologic data, autocorrelation and spectral analysis, theory of regionalized variables and applications.

C E 385W Drinking Water: Treatment and Public Health Issues 3 Hours
Fundamentals and applications of drinking water treatment processes, interactions among treatment processes, source water quality, and public health issues.

C E 386M Water Treatment and Wastewater Treatment Plant Design 3 Hours
Design of water and wastewater treatment facilities; pumps and hydraulic considerations; design of wastewater collection systems; design of systems for handling and disposal of residuals. Specific facilities may be selected to meet individual interests.

C E 386P Engineering Fracture Mechanics 3 Hours
Application of fracture mechanics to fracture-safe design of metal structures; material behavior and analysis of components containing cracks.

C E 386R Inelastic Behavior of Materials 3 Hours
Introduction to theories of inelastic behavior; theory of plasticity; applications to materials such as steel, concrete, and soils; implementation of constitutive equations in structural analysis.

C E 387C Geoenvironmental Engineering 3 Hours
Hydraulic conductivity of soils; clay behavior; compacted clay barriers; unsaturated soil behavior and barriers; geosynthetics and geosynthetic barriers; contaminants and solid waste; liquid drainage layers; stability of landfills; contaminant transport through barriers.

C E 387G Engineering Geology 3 Hours
Fundamental concepts of geology, including geologic time and plate tectonics. Interactions among earth materials, landforms, and geologic processes across a range of spatial and temporal scales. Emphasizes common interests shared by engineers and geologists, as well as gaps between the disciplines, such as those posed by the geologic vocabulary.

C E 387L Topics in Soil Mechanics I 3 Hours

C E 387L.1 Consolidation and Shearing Properties of Soils 3 Hours
Theoretical and experimental studies of the consolidation and shearing properties of both saturated and unsaturated soils.

C E 387L.2 Foundation Engineering 3 Hours
Bearing capacity, design of piers and pile foundations.

C E 387M Topics in Soil Mechanics II 3 Hours

C E 387M.1 Stability of Earth Slopes 3 Hours
Development and application of limit equilibrium procedures, including effects of seepage, rapid drawdown, and seismic loading and reinforcement for stability analysis of natural and constructed slopes.

C E 387M.3 Underground Openings 3 Hours
Explore the engineering of underground openings in both soil and rock. Examine rock mechanics and rock mass characterization, tunnel design and construction methodologies, and pre- and post-excavation ground improvement with regards to design and construction of safe and economical tunnels.

C E 387R Topics in Soil Mechanics III 3 Hours

C E 387R.2 Soil and Rock Dynamics 3 Hours
Wave propagation in soil and rock, foundation vibration and isolation, dynamic behavior of soil.

C E 387R.4 Earth Retaining Structures 3 Hours
Types of earth retaining systems, earth pressure theory; gravity, semi-gravity, and modular walls; reinforcing elements; mechanically stabilized earth walls and reinforced soil slopes; soil nail walls; sheet pile walls, drilled shaft walls and anchored walls; advances in soil reinforcement.

C E 387R.5 Geotechnical Earthquake Engineering 3 Hours
Application of soil dynamics to earthquake engineering; influence of soil conditions on ground motion characteristics; evaluation of site response using wave propagation techniques; liquefaction of soils; liquefaction mitigation; seismic response of earth structures; seismic slope stability.

C E 387T Decision, Risk, and Reliability 3 Hours
Principles and theory for modeling uncertainty in civil engineering, analyzing how uncertainties affect performance, and developing rational bases for design and decision making under uncertain conditions.

C E 388H Climate Change Mitigation 3 Hours
Explore the large-scale solutions to climate change systematically. Examine the fundamentals of climate science, mitigation of climate change through transformation of energy supply and end-use, geoengineering, and industrial carbon management. Discuss the social and economic context for engineered solutions.

C E 388N Engineering and Management of Municipal and Industrial Residuals 3 Hours
Characterization and collection of solid wastes; biological, chemical, and physical principles and integrated systems applicable to the treatment and disposal of municipal and industrial residuals.

C E 388Q Air Quality, Aerosols and Health 3 Hours
Explore physicochemical processes governing indoor and outdoor air quality, human exposure to gas-phase and particle-phase pollutants, and factors affecting human health. Examine the connection between air quality, regulatory perspectives, engineering solutions and acute and chronic environmental issues impacting human exposure. Discuss research questions through efficient data retrieval and run simple dispersion models.

C E 388R Novel Air Quality Measurement Techniques 3 Hours
Explore technological advancements in measurements of indoor and outdoor air quality. Discuss operation principles of novel real-time trace-gas sensors and mass spectrometers. Examine air quality measurements at different spatiotemporal scales, utilizing analytical instrumentation, data acquisition, and data processing. Explore research questions in air quality through hands-on laboratory and field measurements.

C E 389C Advanced Technical Communication for Engineers 3 Hours
Advanced work in theory and practice of communicating research and design results to a variety of audiences, in print, orally, and through multimedia. Students use their own work and writing projects as the material to communicate.

C E 389D Sustainable Building Design 3 Hours
Explore the physical basics of sustainable building design for reducing energy demand and providing on-site renewable energy.

C E 389H HVAC Design 3 Hours
Design of heating, ventilation, and air-conditioning systems.

C E 389S Smart Buildings and Cities 3 Hours
Explore applied machine learning for analyzing data in the domain of buildings (nexus of cities, water and energy).

C E 389T Indoor Air Quality: Transport and Control 3 Hours
Transport and control of indoor pollutants. Includes particulate removal and pollutant transport into and within indoor environments.

C E 389V Modeling of Air and Pollutant Flows in Buildings 3 Hours
Fundamentals of indoor airflow modeling, use of computational fluid dynamics (CFD) for air quality and thermal comfort analyses, application of CFD for analysis of air velocity, temperature, humidity, and contaminant distributions with different ventilation systems.

C E 390J Engineering Microbiology 3 Hours
Fundamentals of microbiology and biochemistry as applied to environmental pollution and sustainable treatment processes, energetics and kinetics of microbial growth, and biological fate of pollutants; introduction to laboratory techniques.

C E 390L Environmental Analysis 3 Hours
Advanced analytical procedures for the sampling, monitoring, and analyses of air, liquid, and other wastes.

C E 390N Water Pollution Chemistry 3 Hours
Advanced topics in the application of engineering solutions to chemical problems in freshwater and marine environments.

C E 390P Environmental Organic Chemistry 3 Hours
Advanced subjects in the environmental chemistry of organic contaminants in groundwater, soil, and air systems; includes sustainable chemistry.

C E 390Q Chemical Dynamics in the Environment 3 Hours
Environmental chemodynamics: interphase equilibrium, reactions, transport processes, and related models for anthropogenic substances across natural interfaces (air-water-sediment-soil) and associated boundary regions.

C E 390R Engineering Microbiology Applications 3 Hours
Application of microbiology and molecular biology tools for monitoring environmental systems and biological treatment processes.

C E 391C Analysis and Design of Transportation Systems I 3 Hours
Introduction to conceptual, methodological, and mathematical foundations of analysis and design of transportation services; review of probabilistic modeling; application of discrete choice models to demand analysis.

C E 391D Analysis and Design of Transportation Systems II 3 Hours
Operations research techniques for modeling system performance and design of transportation services; routing and scheduling problems, network equilibration, and spatially distributed queueing systems.

C E 391E Advances in Transportation Demand Analysis 3 Hours
Developments in the econometric and behavioral aspects of demand analysis and forecasting; supply-demand integration; dynamic models. Applications to passenger and freight transportation and other infrastructure services.

C E 391F Advanced Theory of Traffic Flow 3 Hours
Relations among traffic variables; distribution functions; single lane and multilane traffic flow; characterization of traffic in cities; kinematic waves; yellow signal dilemma; merging; fuel consumption; emissions; and special topics. Emphasis on the interplay among theory, experimentation, and observation.

C E 391J Transportation Planning: Methodology and Techniques 3 Hours
Analysis of a wide range of planning studies to establish the logic and foundation for the transportation planning process. Emphasis on techniques of estimation and forecasting population, economic activity, land use, and mobility patterns; determination of goals and objectives; decision making; economic analysis; and alternative evaluation.

C E 391L Advanced Traffic Engineering 3 Hours
Characterization and analysis of arterial street and freeway traffic operations using theoretical and experimental techniques, especially computer simulation. Introduction to the most current analysis and optimization tools for control device design and implementation.

C E 391M Advanced Geometric Design 3 Hours
Geometric design of highways and guideways, including topics on levels of service, alignment, vehicle operations, intersection and interchange design, roadside design, lighting, and economics.

C E 391N Engineering System Evaluation and Decision Making 3 Hours
Advanced methods for selection of transportation and other infrastructure systems in the presence of multiple criteria, multiple decision makers, and uncertainty.

C E 391P Topics in Highway and Airport Pavement Systems 3 Hours

C E 391P.1 Theory and Behavior of Pavements 3 Hours
Theories of pavement behavior and concepts of pavement design.

C E 391P.2 Design and Performance of Pavements 3 Hours
Pavement performance evaluation and the application of theory to the design of pavements.

C E 391P.3 Pavement Management Systems 3 Hours
Defines the interrelationships among all aspects of pavement technology. Application of computer-based management methodology.

C E 391Q Bituminous Materials 3 Hours
Design and use of asphalt mixtures; chemical, physical, and rheological properties of asphalt; and practical applications in highways, airports, and other construction.

C E 391R Airport Design and Operation 3 Hours
Aircraft characteristics, site selection, airport configuration, capacity, terminal design, traffic control, and interfacing with other transportation modes.

C E 391T Topics in Contemporary Transportation Issues 3 Hours
Consideration, analysis, and evaluation of recent transportation-related innovations and developments.

C E 391W Transportation Systems Operations and Control 3 Hours
Concepts and advanced methods for the design of control strategies for transportation systems operations, including highway traffic systems (signalized street networks and freeways), transit systems, and private carrier operations, including airlines.

C E 392C Transportation Network Analysis 3 Hours
Transportation network analysis focusing on planning and optimization using static traffic assignment models. Subjects include deterministic and stochastic equilibrium, traditional and modern solution methods, shortest path algorithms, combined models, and basic nonlinear programming skills.

C E 392D Dynamic Traffic Assignment 3 Hours
Theory and practice of dynamic traffic assignment as an evolving field. Subjects include basic flow models (point queues, cell transmission model, and link transmission model), time-dependent shortest path algorithms, equilibrium algorithms (convex combinations, simplicial decomposition, and gradient methods), and case studies from practice.

C E 392E Acquisition and Analysis of Transportation Data 3 Hours
Methods and technologies for the acquisition and analysis of data on various aspects of transportation systems, including properties of different data sources and types; stated versus revealed preferences; traffic sensing; survey design; sampling strategies; probabilistic methods of data analysis; overview of statistical methods and various regression models, including random-utility, ordered-choice, simultaneous-equations, time-series, and spatial econometric models.

C E 392F Sensors and Signal Interpretation 3 Hours
Explore the physics concepts related with sensors, basic circuits, and wireless communications. Examine properties and specifications of sensors, and their importance in practical use cases. Discuss sensor noise properties and explore the use of signal processing in time and frequency domains to reduce noise. Explore data and model fusion using classical estimation methods (linear observers and Kalman filters).

C E 392H Regional Transportation Planning: Applications and Tools 3 Hours
Explore various aspects of regional transportation system performance forecasting, including methods for anticipating Americans' evolving travel choices. Examine key data sources and model specifications for planning activities; forecasting and validation of predictions, for personal vs. commercial travel; and system-wide applications for traffic and travel pattern forecasts.

C E 392L Experimental Measurements of Soil Properties 3 Hours
Theoretical and practical knowledge of transducers, sensors, and data acquisition systems for soil and general laboratory testing. Experimental techniques used to characterize properties of geomaterials.

C E 392M Public Transportation Engineering 3 Hours
Introduction to public transportation systems, including demand forecasting, operations, and design. Includes statistical methods, driver and vehicle scheduling, algorithms, and survey sampling techniques.

C E 392N Topics in Infrastructure Systems 3 Hours
Management principles, modeling techniques, computer applications, and emerging technologies for the analysis, engineering, and management of infrastructure systems.

C E 392N.1 Infrastructure Systems Management 3 Hours
Concepts, principles, theories, and models for infrastructure management, with emphasis on civil infrastructure systems.

C E 392N.2 Reliability and Maintainability of Infrastructure Systems 3 Hours
Theory of reliability, maintainability, and availability and its application for the analysis of infrastructure systems.

C E 392N.3 Intelligent Infrastructure Systems 3 Hours
Concepts, frameworks, and models of intelligent infrastructure systems, with emphasis on the application of emerging technologies and advanced modeling techniques.

C E 392P Sustainable Pavement Engineering 3 Hours
Pavement design; back calculation; use of locally available materials for pavement construction; recycled asphalt pavements and shingles; warm mix and cold mix asphalt; industrial by-products and waste incorporated in pavement materials; emerging technologies for sustainable pavement design and pavement management.

C E 392R Discrete Choice Theory and Modeling 3 Hours
Methods and statistics of model estimation, with emphasis on maximum-likelihood; individual choice theory; binary choice models; unordered multinomial and multidimensional choice models; sampling theory and sample design; ordered models and aggregate prediction with choice models; introduction to advanced concepts, such as unobserved population heterogeneity, joint slated preference and revealed preference modeling, and longitudinal choice analysis.

C E 392S Intermodal Transportation Systems 3 Hours
Strategic planning of intermodal freight transportation systems (infrastructure and rolling stock). Freight logistics, intermodal technology, and intermodal terminal operations. Intermodal freight transportation policy, planning, and operational systems and programs.

C E 392T Transport Economics 3 Hours
Application of economic theory and principles to transportation systems analysis and evaluation. Subjects include individual demand decisions, optimal private and public transport supply (including pricing strategies and input demands), market imperfections and externalities, and welfare-based transport policy.

C E 392U Transportation Systems Management 3 Hours
Evolving concepts of transportation agency organization, management, and delivery of transportation programs, products, and services. Separation versus integration of transport policymaking and service delivery functions; emerging models for delivering programs and services, such as outsourcing, privatization, and state-owned enterprises; review of national and international experiences with innovative approaches and the benefits and costs associated with change.

C E 392V Methods to Characterize Bituminous Materials 3 Hours
Introduction to the design and performance prediction of asphalt mixtures. Experimental and computational methods used to characterize the chemical and mechanical properties and performance of bituminous materials at several different length scales. Includes computational models.

C E 392W Characterization of Viscoelastic Materials 3 Hours
Test methods and physical models used to characterize the mechanical response of linear and nonlinear viscoelastic materials. Use of correspondence principles to solve simple boundary value problems for linear viscoelastic materials. Introductory topics on modeling damage and nonlinear response of viscoelastic materials.

C E 393 Advanced Concrete Materials 3 Hours
Comprehensive coverage of Portland cement concrete materials. Topics include cement and aggregate properties, chemical and mineral admixtures, concrete microstructure and the effects of chemical and mechanical properties, durability issues, concrete construction, and special concretes.

C E 393C Experimental Methods in Cement Chemistry 3 Hours
Cement chemistry, hydration, and microstructural formation; analytical techniques used in the investigation of cement and concrete.

C E 393D Concrete Durability 3 Hours
Examine comprehensive coverage of durability issues affecting portland cement concrete. Includes transport properties (e.g., diffusion, osmosis, sorption, etc.), alkali-silica reaction, external sulfate attack, delayed ettringite formation, corrosion of reinforcing steel, freezing and thawing, and salt scaling. Explore, for each durability issue, the underlying mechanism are presented, along with methods for preventing such distress in new concrete construction.

C E 393M Topics in Environmental Engineering Research Seminar 3 Hours
Presentation and discussion of environmental topics in surface water, groundwater, air resources, and land resources.

C E 393N Novel Structural Materials 3 Hours
Material selection criteria, including mechanical and environmental factors; selected case studies of emerging materials, including derivation of properties and potential applications.

C E 393S Structural Engineering Research Seminar 3 Hours

C E 394 Topics in Interaction of Soils and Structures 3 Hours
Beams on foundation, laterally loaded piles, applications of the finite-element method, beam-columns with nonlinear soil support, and behavior of pile groups.

C E 394.1 Dynamic Soil-Structure Interaction 3 Hours
Fundamentals of wave propagation; determination of foundation stiffnesses; mat foundations on the surface of a layered soil; embedded foundations; pile foundations; effect of foundation conditions on dynamic response of structures to applied loads (machine foundations) and to seismic excitation.

C E 394K Topics in Engineering Hydrology 3 Hours

C E 394K.1 Groundwater Pollution and Transport 3 Hours
Groundwater flow and hydrogeologic modeling, sources of contamination, multiphase partitioning, advection-dispersion transport and modeling.

C E 394K.2 Surface Water 3 Hours
Rainfall runoff processes, hydrograph theory, linear and nonlinear hydrologic system models, hydrologic and hydraulic streamflow routing, rainfall and flood flow frequency analysis, watershed models.

C E 394K.3 Geographic Information Systems in Water Resources 3 Hours
Principles of geographic information systems, hydrology, and database management systems applied to water resources problems.

C E 394M Advanced Analyses in Geotechnical Engineering 3 Hours
Development and application of linear and nonlinear finite element procedures for solution of geotechnical engineering problems related to embankments, excavations, static soil-structure interaction, and seepage.

C E 395N Industrialized Production of the Built Environment 3 Hours
Explore the integration of mass manufacturing, digital technologies, and automated processes for the production of the built environment. Learn how such approaches can improve productivity, safety, quality, and sustainability. Discuss key concepts behind industrialization and examine key technologies spanning design, offsite manufacturing, and onsite assembly.

C E 395P Topics in Project Automation 3 Hours

C E 395P.1 Advanced CAD Procedures 3 Hours
Introduction to advanced CAD procedures and CAD systems, and their influence on building design and construction.

C E 395P.2 Introduction to Construction Automation and Integration 3 Hours
Construction automation and integration activities, methods for opportunity identification and financial analysis of systems, and tools from several disciplines that are used in construction automation and integration; students prepare a project that synthesizes this information.

C E 395P.3 Design of Automated Construction Systems 3 Hours
The elements of construction systems, including mechanisms, sensors, and control; systems design methods and concerns. Students develop an individual design project.

C E 395P.4 Sensing in Civil Engineering 3 Hours
Sensor types and properties, data acquisition, sensor data analysis, sensor fusion, and classes of civil engineering applications. Students are encouraged to work on projects related to their research areas.

C E 395Q Topics in Project Controls 3 Hours

C E 395Q.1 Project Controls 3 Hours
Fundamentals of planning, scheduling, and cost management on projects. Topics include network scheduling, activity and resource management, cost loading and cost control, and computer tools used for project controls, such as schedule simulation and three-dimensional and four-dimensional CAD.

C E 395Q.2 Project Production Systems 3 Hours
Advanced topics in project controls, including supply chain management, procurement, interorganizational controls and incentives, process modeling, and simulation.

C E 395Q.5 Financial Management for Engineering and Construction Firms 3 Hours
Introduction to financial, managerial, and tax accounting concepts, as well as corporate finance and strategy as they relate to engineering and construction firms. Emphasis is on content, interpretation, and uses of various accounting reports and financial statements in general, as well as those specific to engineering and construction industries. Topics include determination and reporting of net income methods and financial position unique to engineering and construction firms, and theories underlying business financial statements, as well as the consideration of managerial accounting and financial management topics that cover the planning and controlling of business operations and how financial management impacts a company's overall business success.

C E 395R Topics in Project Information Systems 3 Hours

C E 395R.2 Project Information Management Systems 3 Hours
Information systems design and management concepts and their implementation in construction projects. Data acquisition, transmission, and storage; database management systems and information systems design.

C E 395R.3 Decision and Risk Analysis 3 Hours
Fundamentals of decision analysis and risk assessment; construction engineering/project management applications in decision analysis; methods of risk management; overview of project insurance.

C E 395R.4 Metrics 3 Hours
Measurement systems and benchmarking approaches for many aspects of construction projects. Included are measurement systems for design effectiveness, construction productivity, safety, cost and schedule controls, and overall industry statistics.

C E 395R.5 Data Mining 3 Hours
Fundamentals of data mining. Techniques for data classification, prediction, clustering, and association rules mining. Data mining as an advanced data analysis method in engineering and construction. Implementation issues.

C E 395R.6 Quantitative Methods for Project Analysis 3 Hours
Practical methods of data analysis for evaluating project performance metrics. Includes quantitative methods for solving everyday problems such as bid selection, capital budgeting, assignment of resources, equipment replacement analysis, and the optimization of capital structure. Techniques for developing models under conditions of risk using Microsoft Excel and add-ins such as At Risk.

C E 395R.7 Building Information Modeling for Capital Projects 3 Hours
Building information models in plan execution for a building construction project. Focus on implementation of building information modeling concepts throughout the lifecycle of a building, from planning and design to construction and operations.

C E 395R.8 Urban Systems Engineering 3 Hours
Explore system thinking concepts and sociotechnical system modeling of civil infrastructure systems. Examine defining system boundaries, abstracting interdependencies and system structure, and implementing mathematical models for the analyses of systems.

C E 395S Topics in Project Organization 3 Hours

C E 395S.1 Human Resources Project Management 3 Hours
Evaluation of individual, group, and organizational behavior in construction work. In-depth study of communication, decision making, and the relationship between controls and behavior.

C E 395S.2 Construction Productivity 3 Hours
Construction productivity improvement by group field studies. In-depth study of the way overtime, changes, weather, and staffing levels influence productivity. Industrial engineering techniques are applied to the construction environment to improve the use of equipment and human and material resources.

C E 395S.4 Project Management 3 Hours
Overall aspects of project and portfolio management from inception to successful operation: project selection and feasibility, contracting methods, project scheduling, cost control systems, project communications, project scope and quality management, human resource management, partner selection and management, project leadership, project closeout, and global project management.

C E 395T Topics in Project Technology 3 Hours

C E 395T.3 Heavy Civil Construction 3 Hours
Methods and materials in heavy civil construction; earthwork, concrete, structural steel, and deep foundations; equipment selection, configuration, productivity, and safety issues; site and craft planning, environmental issues, and optimization modeling; and field studies.

C E 395T.6 Value Management Processes I 3 Hours
Industry value management processes, including value engineering and life cycle costing, process simplification, function analysis concept development, design to capacity, constructability, modularization and preassembly, and design effectiveness.

C E 395T.7 Value Management Processes II 3 Hours
Industry value management processes, including mechanical reliability modeling, predictive maintenance, design for maintainability, waste minimization and pollution prevention, sustainable design and construction, planning for startup, lean construction, postoccupancy evaluation, and knowledge management and lessons learned systems.

C E 395T.8 Industrial Construction 3 Hours
Methods and materials in industrial construction; heavy lifts, mechanical equipment, process piping, electrical, and instrumentation work; equipment selection, configuration, productivity, and safety issues; preassembly, modularization, and work planning in the industrial environment; and field studies.

C E 395U General Topics in Construction Engineering and Project Management 3 Hours

C E 395U.1 Front-End and Contractor Planning 3 Hours
Principles and applications of advanced project planning techniques for capital facility owners and contractors. Effective owner front-end planning of capital facilities, including team alignment, and preproject planning processes and tools. Contractor preconstruction planning, including team selection, scope and budget review, procurement, strategic sequencing, and planning assessment tools.

C E 395U.3 Advanced Legal Concepts 3 Hours
Contracts, documentation requirements, claims avoidance, and settlement of claims by alternative dispute resolution. Students conduct and present in-depth studies of the most frequent causes of claims (delay, disruption, acceleration, soil conditions, and changes) and consider the way the court establishes causation and determines damages.

C E 395U.4 Construction Safety 3 Hours
Causes and effects of construction safety incidents, proactive preventative strategies, and tactics.

C E 395V Topics in Construction Engineering and Projects: Seminar/Conference 3 Hours

C E 395V.1 Doctoral Research Methods Seminar 3 Hours
Construction research methods seminar, including concepts and practice of research in construction engineering and management. Research methodologies and steps in the research process, including review and framing research questions. Students develop and critique a research proposal.

C E 395V.2 Conference Course 3 Hours

C E 395V.3 Construction Industry Seminar 3 Hours
Construction industry issues and best practices, such as front-end planning and zero accident techniques, developed by the Construction Industry Institute (CII). Guest lecturers include CII management staff and visiting industry leaders. Emphasis on implementation of proven practices on projects.

C E 396L Topics in Air Resources Engineering 3 Hours
Sources, transport, fate, impacts, characteristics, and control of air contaminants; source control and prevention; urban air quality; occupational and residential indoor air quality.

C E 396L.1 Air Pollution Chemistry 3 Hours
Classification, transport, transformation, deposition, sampling, and analysis of particulate and gaseous air pollutants in urban, regional, and global-scale systems. Emphasis on sustainable engineering.

C E 396L.3 Air Pollution Control 3 Hours
Design of air pollution control systems for stationary sources. Technical, regulatory, and economic fundamentals related to the control of gaseous and particulate emissions.

C E 396L.4 Indoor Air Quality: Physics and Chemistry 3 Hours
Sources, transport, and fate of indoor air pollutants. Interactions between indoor pollutants and indoor materials. Indoor air chemistry. Human exposure to pollutants in indoor environments.

C E 396L.5 Atmospheric Transport and Dispersion Modeling 3 Hours
Mathematical models of contaminant transport in the atmosphere; atmospheric turbulence and air pollution meteorology; Gaussian plume, gradient transport, and higher-order closure models; theoretical development and practical applications to engineering problems.

C E 396L.6 Human Exposure to Indoor Air Pollution 3 Hours
Human exposure to air pollution in the built environment, including the effects of sustainable building design on human exposure to toxic air pollutants. Subjects may include inhalation intake fractions for risk calculations and comparisons of sources of air pollution, transmission of airborne infectious disease, pharmacokinetic modeling, and case studies involving several important air pollutants.

C E 396M Advanced Topics in Atmospheric Science 3 Hours

C E 396M.1 General Topics 3 Hours

C E 396M.2 Air Pollution Meteorology 3 Hours
Basic meteorology applied to air pollution; diffusion of conservative and nonconservative pollutants; plume rise; air pollution models.

C E 197, 297, 397 Special Topics in Civil Engineering 1-3 Hours

C E 197.14, 297.14, 397.14 Design of Wood Members and Systems 1-3 Hours
Design and behavior of solid wood and glued-laminated wood structural members; light-frame and heavy timber systems, including trusses and arches.

C E 197.16, 297.16, 397.16 Evaluation, Materials, and Techniques for Concrete Repair 1-3 Hours
Causes of distress, evaluation methods, repair materials, repair techniques, and quality control methods for repair of concrete.

C E 197.17, 297.17, 397.17 Air Sampling and Analysis 1-3 Hours
Collection and analysis of air samples for gaseous and particulate contaminants. Gas flow rate and calibration techniques, stationary source sampling and analysis, indoor air sampling, ozone and NOx ambient air monitoring.

C E 197.20, 297.20, 397.20 Computer Methods for Civil Engineers 1-3 Hours
Essential methods for computer-aided problem solving in transportation and other civil engineering areas. Topics may include computer operating systems concepts; the Internet and World Wide Web site design; advanced programming with C programming language; data structures; file manipulation and management; Monte Carlo simulation techniques; interfacing with spreadsheets, SQL databases, and computer-aided design packages; introduction to Geographic Information Systems. Team programming is emphasized.

C E 197.22, 297.22, 397.22 Intelligent Transportation Systems Seminar 1-3 Hours
Introduction to Intelligent Transportation Systems (ITS) concepts, evolution, and current initiatives. Program evolution from Mobility 2000, through IVHS and strategic planning activities by the Department of Transportation and ITS America, to current operational tests and deployment projects.

C E 197.32, 297.32, 397.32 Hydrodynamics of Propulsors and Dynamic Positioning Systems 1-3 Hours
Hydrofoil and lifting surface theory, actuator disk and lifting line theory, vortex-lattice and panel methods, blade design techniques, propulsor-inflow and propulsor-hull interaction, unsteady blade and shaft forces, and modeling of sheet cavitation.

C E 197.35, 297.35, 397.35 Introduction to Structural Mechanics 1-3 Hours
Discussion of force and stress, vectors and tensors; equilibrium; displacement and deformation; compatibility; constitutive equations, with examples from linear elasticity, linear viscoelasticity, and plasticity; principle of virtual work; elastic structures, principle of minimum potential energy, reciprocity theorem; critical equilibrium, stability; linear theories of beams, plates, and shells.

C E 197.4, 297.4, 397.4 Freight Transportation 1-3 Hours
Topics include review of transport systems analysis; shipper objectives; demand and supply modeling; freight flow data; network analysis; truck size and weight policies; finance.

C E 197.50, 297.50, 397.50 Water Resources Development and Policies 1-3 Hours
Analysis of water resources projects, particularly international water projects, with emphasis on engineering and planning considerations and their relation to governmental policies.

C E 197.54, 297.54, 397.54 Water Pollution Control 1-3 Hours
The application and evaluation of new concepts in water pollution abatement and advanced water and wastewater treatment.

C E 197.56, 297.56, 397.56 Air Pollution Control 1-3 Hours
Evaluation of new theoretical approaches to air pollution control.

C E 197.6, 297.6, 397.6 Traffic Science Seminar 1-3 Hours
Topics range from fundamentals of vehicular traffic science to relevant methodologies in physics, applied mathematics, and operational science.

C E 197.78, 297.78, 397.78 Design of Offshore Structures 1-3 Hours
Selection of design storm; wave forces on structures; preliminary analysis of steel jacket platforms; joint design; fatigue considerations; foundation design; dynamic effects and responses.

C E 197C, 297C, 397C, 697C Master's Research 1,2,3,6 Hours

C E 197D, 297D, 397D, 697D Dissertation Research 1,2,3,6 Hours

C E 397F Forensic Engineering: Materials and Structures 3 Hours
Methods of forensic analysis; role of the expert witness; methods of dispute resolution; case studies; term project.

C E 397K Stability of Structures 3 Hours
Stability as it relates to actual behavior and design; elastic and inelastic theories; evaluation of specifications; columns, beams, and frames.

C E 397L Advanced Structural Metals 3 Hours
Elastic and inelastic design methods for steel members, connections, and structures; torsion of open and closed sections, welding, plate buckling, and column stability; bracing design.

C E 397N Nondestructive Testing Techniques 3 Hours
Basic signal processing knowledge; introduction to wave propagation theory; nondestructive testing (NDT) principles and applications to steel structures; evaluation of concrete structures and foundations; NDT methods selection; emerging technologies.

C E 197Q, 297Q, 397Q, 697Q Special Independent Studies in Civil Engineering 1,2,3,6 Hours

C E 698 Thesis 6 Hours

C E 398D Departmental Report 3 Hours
Preparation of a report to fulfill the requirement for the master's degree under the departmental report option.

C E 398R Master's Report 3 Hours
Preparation of a report to fulfill the requirement for the Master of Science in Engineering degree under the Graduate School report option.

C E 398T Supervised Teaching in Civil Engineering 3 Hours
Special training in teaching methods and procedures for civil engineering courses, including laboratory courses; the development of new material and methods to update present courses.

C E 399W, 699W, 999W Dissertation 3,6,9 Hours