Civil Engineering (CE)

CE 214  Engineering Mechanics-Statics  (3 credit hours)
Basic force concepts and equilibrium analysis; distributed forces; centroids; moments of inertia; application to structural elements. Credit will not be given for both CE 214 and MA 206.
Grade of C or better in PY 205 and MA 241; Co-requisite: MA 242.
Typically offered in Fall, Spring, and Summer

CE 215  Engineering Mechanics-Dynamics  (3 credit hours)
 Kinematics and kinetics of particles; mass flow; vibrations; plane kinematics and kinetics of rigid bodies; selected topics from three-dimensional rigid body dynamics, and orbital motion.
Prerequisite: Minimum GPA => 2.5, Grade of C- or better in CE 214, and MA 242.
Typically offered in Fall, Spring, and Summer

CE 225  Mechanics of Solids  (3 credit hours)
Elementary analysis of deformable solids subjected to force systems. Concepts of stress and strain; one, two and three-dimensional stress-strain relationships for the linear elastic solid. Statically determinate and indeterminate axial force, torsion and bending members. Stress transformations, pressure vessels, combined loadings. Introduction to column buckling.
Grade of C- or better in CE 214; MA 242.
Typically offered in Fall, Spring, and Summer

CE 250  Introduction to Sustainable Infrastructure  (3 credit hours)
History and future of civil infrastructure; engineering problem solving; environmental sustainability and life-cycle assessment; social sustainability; engineering economics; problem-driven, sustainability-focused case studies related to different aspects of civil infrastructure.
CE, ENE, or CON majors only; co-requisite: CSC 111 and CE 214.
Typically offered in Fall and Spring

CE 263  Introduction to Construction Engineering  (3 credit hours)
Introduction to fundamental concepts in Construction Engineering and Management including principles of project management; profit, risk, and profitability; estimating, including WBS, productivities, costs, durations, and fundamentals of equipment selection and utilization; scheduling using both CPM and Linear scheduling techniques; contract methods and control principles; professional and legal aspects of construction; fundamentals of leadership; and basic construction safety.
Corequisites: CE 214 and CE 250; R: CON Majors Only.
Typically offered in Spring only

CE 282  Hydraulics  (3 credit hours)
Fluid properties; mass, energy and momentum conservation laws; dimensional analysis and modeling; laminar and turbulent flows; surface and form resistance; flow in pipes and open channels; elementary hydrodynamics; fluid measurements; characteristics of hydraulic machines. Credit will not be given for both CE 282 and MAE 308.
Prerequisite: C- or better in CE 214; Corequisites: MA 341 or MA 305 or ST 370.
Typically offered in Fall, Spring, and Summer

CE 297  Current Topics in Civil Engineering  (1-4 credit hours)
Presentation of material not normally available in regular course offerings, or offering of new courses on a trial basis. Credits and content determined by faculty member in consultation with Department Head.
Typically offered in Fall, Spring, and Summer

CE 301  Civil Engineering Surveying and Geomatics  (3 credit hours)
Plane surveying, topographical surveying, horizontal and vertical curves, topographic surveys, construction surveys, earthwork, route surveying. Data collection using sight-based, laser-based, and global positioning system equipment. Methods for analysis and presentation of surveying and positioning data, including dealing with errors. Use and applications of GPS information. Limited to CON and CE majors. Credit will not be given for both BAE 325 and CE 301.
Junior standing; CON and CE Majors.
Typically offered in Fall and Spring

CE 305  Traffic Engineering  (3 credit hours)
Integrated approach to planning, design, and operation of transportation systems with an emphasis on highway and street systems. Roadway design, traffic operations and performance, and control systems.
C- or better in CE 250; Corequisite: ST 370.
Typically offered in Fall and Spring

CE 324  Structural Behavior Measurement  (1 credit hours)
Prerequisite: Grade of C- or better in CE 313.
Typically offered in Fall and Spring

CE 325  Structural Analysis I  (3 credit hours)
Analysis of determinate and indeterminate bars, trusses, beams and frames using the matrix displacement method. Qualitative deflected shapes and shear and bending moment diagrams. Implementation of analysis procedures through computer programming and commercial structural analysis software.
CSC 111 and C- or better in CE 225.
Typically offered in Fall and Spring

CE 327  Reinforced Concrete Design  (3 credit hours)
Behavior, strength, and design of reinforced concrete members subjected to moment, shear, and axial forces. Introduction to the design of reinforced concrete structures.
Prerequisite: C- or better in CE 225
Typically offered in Fall and Spring

CE 332  Materials of Construction  (3 credit hours)
MSE 200 and C- or better in CE 225.
Typically offered in Fall and Spring
CE 339  Civil Engineering Systems  (3 credit hours)
A broad perspective, systematic approach to civil planning, analysis, evaluation and design for large scale projects in construction, structures, transportation, water resources and other civil engineering areas.

CSC 111 and (MA 341 or MA 305); Junior standing.
Typically offered in Spring only

CE 342  Engineering Behavior of Soils and Foundations  (4 credit hours)
Description, identification, and engineering classification of soils. The basic principles and mechanics of flow of water through soils, deformation and strength of soils, and the processes of consolidation and compaction. Effective stress concepts, stress and settlement analyses, and evaluation of shear strength. Methods of analysis and geotechnical engineering design concepts.

C- or better in CE 225 and CE 282.
Typically offered in Fall and Spring

CE 365  Construction Equipment and Methods  (3 credit hours)
Study of construction operations as dynamic production processes. Utilization of equipment and other resources to achieve highest levels of productivity, safety, and quality. Covers a wide range of traditional and state-of-the-art construction methods.

Corequisite: CE 263 and ST 370
Typically offered in Spring only

CE 367  Mechanical and Electrical Systems in Buildings  (3 credit hours)
Introduction to mechanical and electrical systems in building construction. Includes HVAC, lighting and electrical systems, focusing on design concepts, equipment application, design of the construction process, and coordination using BIM, for modern building systems.

C- or better in CE 282.
Typically offered in Spring only

CE 373  Fundamentals of Environmental Engineering  (3 credit hours)
Concepts of sustainability and green engineering; energy and climate; overview of contaminants in water, air and terrestrial environments; introduction to water and wastewater treatment, air pollution control, and solid waste management.

Corequisites: CE 250 and (CHE 205 or CE 282).
Typically offered in Fall and Spring

CE 378  Environmental Chemistry and Microbiology  (4 credit hours)
Principles of Environmental Chemistry and Microbiology, experimental techniques for assessing water and air quality; sampling; statistical interpretation of data.

Prerequisite: Junior standing in Environmental Engineering, MEA 323 or SSC 442, and C- or better in CE 250 and CE 373; Corequisite: ST 370.
Typically offered in Fall only

CE 381  Hydraulics Systems Measurements Lab  (1 credit hours)
Introduction to experimental techniques for the analysis of hydraulic systems; measurement of viscosity, fluid pressures, velocity distributions, flow rates; investigations into the friction, momentum transfer, and turbulence on fluid flow.

Corequisite: CE 282
Typically offered in Fall and Spring

CE 383  Hydrology and Urban Water Systems  (3 credit hours)
Study of engineering hydrology and design of elements of urban stormwater systems. Commonly encountered applications in urban stormwater management, flood control and groundwater engineering. Familiarization with effects of watershed development on quantity and quality of streamflow.

C- or better in CE 282; Corequisite: ST 370; CE, ENE, and CON Majors.
Typically offered in Fall and Spring

CE 390  Engineering Economics  (1 credit hours)
Fundamental principles of engineering economics and their application to civil engineering planning and evaluation. Time value of money, interest and equivalence, and methods for assessing the feasibility and relative economic value of alternatives.

CSC 111 and (MA 341 or MA 305); Junior standing.
Typically offered in Fall and Spring

CE 400  Transportation Engineering Project  (3 credit hours)
Integrated team approach to design of major transportation engineering projects. Professional topics in transportation engineering practice.

Prerequisite: CE 390, C- or better in CE 305, and one of the following courses: CE 401, 402, 403, or 413
Typically offered in Spring only

CE 401/CE 501  Transportation Systems Engineering  (3 credit hours)
Multi-modal transportation systems; railroads, airports, highways, and other modes. Planning, analysis, and design. Fundamental concepts; supply, demand, flows, impacts, and network optimization.

Prerequisite: C- or better in CE 305
Typically offered in Fall only

CE 402/CE 502  Traffic Operations  (3 credit hours)
Highway capacity; traffic control systems; intelligent vehicle/highway systems; and other advanced topics. Credit for both CE 402 and CE 502 is not allowed.

Prerequisite: C- or better in CE 305
Typically offered in Fall only

CE 403/CE 503  Highway Design  (3 credit hours)
Corridor selection; highway alignment; design of roadsides, intersections, and interchanges. Completion of research paper for students taking course for graduate credit. Credit will not be given for both CE 403 and CE 503.

Prerequisite: C- or better in CE 305
Typically offered in Fall only

CE 405/CE 505  Railroad System Planning, Design, and Operation  (3 credit hours)
Students will learn about railroad technology and how to plan, design, and operate rail systems especially the design of alignments, track, and terminals; and the operation of freight and passenger services (ranging from transit through commuter rail to intercity and high speed rail). Field trips are involved during non-scheduled class time. Students must be able, if necessary, to provide their own transportation.

Prerequisite: CE 305
Typically offered in Spring only
CE 413 Principles of Pavement Design (3 credit hours)
Basic principles of analysis, design and performance of highway and airport pavements with critical evaluation of current design and maintenance strategies.

CE 332 and CE 342
Typically offered in Fall only

CE 420 Structural Engineering Project (3 credit hours)
Planning, analysis and design of complete structural systems composed of steel and reinforced concrete. Professional topics in structural engineering practice.
C- or better in CE 325 and CE 327 and CE 342 and CE 426.
Typically offered in Fall and Spring

CE 421 Structural Engineering Senior Project - Bridge Design (3 credit hours)
This structural engineering senior project course covers the fundamentals of bridge analysis and design including conceptual design, superstructure analysis, AASHTO-LRFD bridge specifications, flat slab bridge design, pre-stressed concrete bridge design, strut and tie modeling, column design, and foundations. A series of three bridges will be designed including a cable stay or suspension pedestrian bridge, flat slab bridge, and girder bridge. At the conclusion of the course, students will be able to analyze and design simple, but complete concrete bridge structures.

Prerequisites: C or better in each of the following: CE 325, CE 327, and CE 426; Corequisite: CE 390
Typically offered in Fall only

CE 425/CE 525 Structural Analysis II (3 credit hours)
Analysis of beam, 2D and 3D truss, 2D and 3D frame and plane strain structures using the matrix displacement method. Introduction to the finite element method of analysis by deriving the element stiffness matrices using Virtual Work. Beam and frame elements include shearing deformation and geometric stiffness effects. Computer implementation of analysis procedures using MATLAB and commercial structural analysis software. Modeling issues including convergence, symmetry and antisymmetry. Introduction to structural dynamics. Credit not given for both CE 425 and CE 525.

Prerequisite: C- or better in CE 325
Typically offered in Fall only

CE 426 Structural Steel Design (3 credit hours)
Design and behavior of structural steel members and their connections subjected to moment, shear, and axial forces. Introduction to the design of steel structures.
C- or better in CE 225.
Typically offered in Fall, Spring, and Summer

CE 435 Engineering Geology (3 credit hours)
Application of both geology and geotechnical engineering to engineering projects. Illustrations of relevant materials properties and techniques utilized in describing subsurface conditions.
Prerequisite: MEA 101 and Junior standing in colleges of Agriculture and Life Sciences, Engineering, Natural Resources, College of Sciences or Textiles
Typically offered in Spring only

CE 437 Civil Engineering Computing (3 credit hours)
Computational approaches to modeling with applications in construction, structures, transportation, water resources and other civil engineering areas; matrix computations, digital terrain modeling, network applications and algorithms, heuristic optimization.
Senior standing; CSC 111 and (MA 341 or MA 305).
Typically offered in Fall only

CE 440 Geotechnical Engineering Project (3 credit hours)
Integrated team approach to design of building foundations involving site selection, analysis and design of shallow and deep foundations, establishment of performance criteria, economic analysis, identification of potential construction problems and matters regarding professional practice and ethics.
Prerequisite: C- or better in CE 342; Corequisite: CE 390
Typically offered in Fall only

CE 443 Seepage, Earth Embankments and Retaining Structures (3 credit hours)
Review of shear strength concepts; ground water hydraulics; slope stability; lateral earth pressure problems; placement of fills.
C- or better in CE 342.
Typically offered in Fall only

CE 444 An Introduction to Foundation Engineering (3 credit hours)
This course will cover the basics of subsurface analysis and foundation design. Subsurface analysis includes the planning and interpretation of site investigation programs, including insitu testing and sampling, and laboratory testing and data interpretation. Foundation design will include the study of shallow and deep foundations subject to a combination of vertical and lateral loads.
C- or better in CE 342.
Typically offered in Spring only

CE 450 Civil Engineering Project (3 credit hours)
Integrated multi-disciplinary team approach to large-scale civil engineering design including topics from geotechnical engineering, land development, transportation engineering, and water resources engineering. Professional topics in civil engineering practice and ethics.
Prerequisite: CE 305 & CE 342 & CE 383; Corequisite: one of (CE 403, CE 413, CE 443, CE 444, or CE 488).
Typically offered in Fall only

CE 463 Construction Estimating, Planning, and Control (3 credit hours)
Overview of the construction industry; life cycle of construction projects, work breakdown structure, activity cost and time estimation, computerized planning and scheduling methods, resource leveling, time-cost tradeoff; computerized cost estimating, bidding and negotiation strategies; and cost/schedule control systems.
Prerequisite: CE 263 and CE 365 and TDE 220
Typically offered in Fall only
CE 464/CE 564 Legal Aspects of Contracting (3 credit hours)
Legal aspects of contract documents, drawings and specifications; owner-engineer-contractor relationships and responsibilities; bids and contract performance, Labor laws; governmental administrative and regulatory agencies; torts; business organizations; ethics and professionalism.

Prerequisite: CE 463; Corequisite: CE 365
Typically offered in Spring only

CE 466 Building Construction Engineering (3 credit hours)
Construction processes for buildings and other structures including codes and standards, structural and architectural components and systems, form work and bracing design, erection and assembly methods.

Corequisite: CE 327
Typically offered in Fall only

CE 468/CE 568 Construction Engineering Laboratory (1 credit hour)
Measurements with and calibration of measurement instruments used in construction engineering field tests for quality and safety of the construction process. Interpretation of ANSI, ASTM, ACI and AISC specifications and standards. Credit for both CE 468 and CE 568 is not allowed.

Prerequisite: CE 332. Corequisite: CE 327 or CE 426
Typically offered in Spring only

CE 469 Construction Engineering Project (3 credit hours)
Capstone course involving integrated team approach in the design of the construction process, utilizing computerized tools for cost estimation, planning, scheduling, process design, and management of two construction projects. Each student also selects an individual project. Lecture topics include: ethics, professionalism, marketing, bid presentations, business planning, finance, and other appropriate topics by guest speakers from industry.

"Co-requisite: CE 464"
Typically offered in Spring only

CE 476 Air Pollution Control (3 credit hours)
Introduction to air pollution control fundamentals and design. Fundamentals include the physics, chemistry and thermodynamics of pollutant formation, prevention and control. Design will include gas treatment, process modification, and feedstock modification. Pollutants to be addressed include sulfur dioxide, nitrogen oxides, particulate matter, volatile organic compounds, hydrocarbons, and air toxics. Credit for both CE 476 and CE 576 will not be given.

CE 373 and MAE 201; Corequisite: ST 370 or CHE 450 (CHE majors)
Typically offered in Fall only

CE 477 Principles of Solid Waste Engineering (3 credit hours)
Solid waste management including generation, storage, transportation, processing, land disposal and regulation. Processing alternatives including incineration and composting. Integration of policy alternatives with evaluation of engineering decisions.

CE 250, CE 282 and CE 373.
Typically offered in Spring only

CE 478/CE 578 Energy and Climate (3 credit hours)
Interdisciplinary analysis of energy technology, natural resources, and the impact on anthropogenic climate change. Topics include basic climate science, energetics of natural and human systems, energy in fossil-fueled civilization, the impact of greenhouse gas emissions on climate, and technology and public policy options for addressing the climate challenge. The course is quantitative with a strong emphasis on engineering and science.

Prerequisite: Senior standing
Typically offered in Fall only

CE 479/MEA 479 Air Quality (3 credit hours)
Introduction to: risk assessment, health effects, and regulation of air pollutants; air pollution statistics; estimation of emissions; air quality meteorology; dispersion modeling for non-reactive pollutants; chemistry and models for tropospheric ozone formation; aqueous-phase chemistry, including the "acid rain" problem; integrated assessment of air quality problems; and the fundamentals and practical aspects of commonly used air quality models. Credit is allowed only for one of CE/MEA 479 or CE/ MEA 579.

CE 282 and CE 373; or CHE 311 (CHE Majors); or MEA 421 (MEA Majors); Corequisite: ST 370; or ST 380 (MEA Majors)
Typically offered in Spring only

CE 480 Water Resources Engineering Project (3 credit hours)
Engineering design of selected projects in water resources engineering involving interactions with other scientific and engineering disciplines. Discussion of ethical conduct and professional engineering practice. Projects will include site work, storm drainage, water supply, water transmission and water-quality issues.

Corequisite: CE 390; Prerequisite: Grade of C- or better in CE 382 and CE 383
Typically offered in Spring only

CE 481 Environmental Engineering Project (3 credit hours)
Engineering design of selected projects in environmental engineering involving interactions with other scientific and engineering disciplines. Discussion of ethical conduct and professional engineering practice.

Prerequisite: CE 378, 383, 390, Corequisite: CE 484 and two of: CE 476, 477, 479, 488
Typically offered in Spring only

CE 484 Water Supply and Waste Water Systems (3 credit hours)
Elements of the design of water supply and wastewater disposal systems.

CE 282 and CE 373.
Typically offered in Fall only

CE 487 Introduction to Coastal and Ocean Engineering (3 credit hours)
Introduction to the analysis of civil engineering projects in the ocean and along the coastline. Basic wave mechanics, tides, and ocean dynamics as applied to the understanding of coastal erosion control and other marine problems. An optional two-day field trip to the North Carolina Outer Banks at a nominal student expense is a regular feature of the course.

Senior standing and CE 282.
Typically offered in Spring only
CE 488/CE 588 Water Resources Engineering (3 credit hours)
Extension of the concepts of fluid mechanics and hydraulics to applications in water supply, water transmission, water distribution networks and open channels to include water-supply reservoirs, pump and pipe selection, determinate and indeterminate pipe networks, and analysis of open channels with appurtenances.
Prerequisite: CE 339 and CE 383
Typically offered in Fall only

CE 493 Independent Study in Civil Engineering (1-4 credit hours)
Independent study of a topic in Civil Engineering. Topic and mode of study determined by faculty member(s) and student(s). Individualized/Independent Study and Research courses require a "Course Agreement for Students Enrolled in Non-Standard Courses"
Typically offered in Fall only

CE 497 Current Topics in Civil Engineering (1-4 credit hours)
Presentation of material not normally available in regular course offerings or offering of new courses on a trial basis. Credits and content determined by faculty member in consultation with the Department Head.
Typically offered in Fall, Spring, and Summer

CE 498 Special Problems in Civil Engineering (1-4 credit hours)
Directed reading in the literature of civil engineering, introduction to research methodology, seminar discussion dealing with special civil engineering topics of current interest.
Prerequisite: Senior standing
Typically offered in Fall and Spring

CE 499 Undergraduate Research Thesis in Civil, Construction and Environmental Engineering (1-3 credit hours)
Faculty mentored research related to civil, construction or environmental engineering. A plan of work is required describing the independent research culminating in a thesis. Presentation at the NC State Undergraduate Research Symposium, or other similar venue, may be included. The student must identify a research advisor from within the CCEE faculty. Departmental approval is required.
Senior standing. Departmental Approval Required.
Typically offered in Fall, Spring, and Summer

CE 501/CE 401 Transportation Systems Engineering (3 credit hours)
Multi-modal transportation systems; railroads, airports, highways, and other modes. Planning, analysis, and design. Fundamental concepts; supply, demand, flows, impacts, and network optimization.
Prerequisite: C- or better in CE 305
Typically offered in Fall only

CE 502/CE 402 Traffic Operations (3 credit hours)
Highway capacity; traffic control systems; intelligent vehicle/highway systems; and other advanced topics. Credit for both CE 402 and CE 502 is not allowed.
Prerequisite: C- or better in CE 305
Typically offered in Fall only

CE 503/CE 403 Highway Design (3 credit hours)
Corridor selection; highway alignment; design of roadsides, intersections, and interchanges. Completion of research paper for students taking course for graduate credit. Credit will not be given for both CE 403 and CE 503.
Prerequisite: C- or better in CE 305
Typically offered in Spring only

CE 504 Airport Planning and Design (3 credit hours)
Analysis, planning and design of air transportation facilities.
Prerequisite: C- or better in CE 305
Typically offered in Fall only

CE 505/CE 405 Railroad System Planning, Design, and Operation (3 credit hours)
Students will learn about railroad technology and how to plan, design, and operate rail systems especially the design of alignments, track, and terminals; and the operation of freight and passenger services (ranging from transit through commuter rail to intercity and high speed rail). Field trips are involved during non-scheduled class time. Students must be able, if necessary, to provide their own transportation.
Prerequisite: CE 305
Typically offered in Spring only

CE 506 Transportation Engineering Data Collection and Analysis (3 credit hours)
Broad range of transportation engineering data collection and analysis applications encompassing the modes of highway, transit and pedestrian travel and the contexts of system planning, design and operation. Proposal preparation with primary focus on methodology and work plan development for addressing important research and practice questions.
Prerequisite: CE 305, ST 370
Typically offered in Fall only

CE 507 Sensors, Instrumentation, and Data Analytics for Transportation Networks (3 credit hours)
Students will learn about the use of sensors, instrumentation, and big data analysis in transportation systems to observe, monitor, and evaluate performance. This includes the technology employed, the deployment strategies, the challenges associated with obtaining high-quality data, the fusion of data from independent sources, the imputation of missing data, and evaluation of performance based on the data assembled. The highway mode is the principal focus, including analyses of travel times, delays, queue dynamics, and spatial and temporal demand patterns.
Typically offered in Fall only

CE 509 Highway Safety (3 credit hours)
Methods to reduce collisions and injuries on highways. Identifying promising locations, choosing appropriate countermeasures, and evaluating past projects. Understanding the institutional context and establishing appropriate highway design standards.
Prerequisite: CE 305, Corequisite: ST 370 or equivalent
Typically offered in Spring only
CE 515 Advanced Strength of Materials (3 credit hours)
Stresses and strains at a point; rosette analysis; torsion and unsymmetrical bending of open and closed sections; nonlinear and curved beams; stress concentration; beams on elastic foundations; shear deformation of beams; classical plasticity; fracture
Prerequisite: CE 225 or MAE 314
Typically offered in Fall only

CE 522 Theory and Design Of Prestressed Concrete (3 credit hours)
Principles and concepts of design in prestressed concrete including elastic and ultimate strength analyses for flexure, shear, torsion, bond and deflection. Principles of concordancy and linear transformation for indeterminate prestressed structures. Application of pre-stressing to tanks and shells.
Prerequisite: CE 327
Typically offered in Fall only

CE 523 Theory and Behavior Of Steel Structures (3 credit hours)
Theory and behavior of steel structures leading to the development of design requirements contained in current specifications; flexural, torsional and flexural-torsional buckling of columns; plastic analysis of beams and frames; lateral-torsional buckling of beams; stability and strength of flat plates; beam-columns.
Prerequisite: CE 426
Typically offered in Fall only

CE 524 Analysis and Design Of Masonry Structures (3 credit hours)
Theory and design of masonry arches, culverts, dams, foundations and masonry walls subjected to lateral loads.
Prerequisite: CE 327
Typically offered in Fall only

CE 525/CE 425 Structural Analysis II (3 credit hours)
Analysis of beam, 2D and 3D truss, 2D and 3D frame and plane strain structures using the matrix displacement method. Introduction to the finite element method of analysis by deriving the element stiffness matrices using Virtual Work. Beam and frame elements include shearing deformation and geometric stiffness effects. Computer implementation of analysis procedures using MATLAB and commercial structural analysis software. Modeling issues including convergence, symmetry and antisymmetry. Introduction to structural dynamics. Credit not given for both CE 425 and CE 525.
Prerequisite: C- or better in CE 325
Typically offered in Fall only

CE 526 Finite Element Method in Structural Engineering (3 credit hours)
Development of the finite element method with an emphasis on understanding the fundamental principles governing the analysis technique. Applications to two-dimensional solids with particular attention to applications in structural engineering. Typical m
Prerequisite: CE 515
Typically offered in Spring only

CE 527 Structural Dynamics (3 credit hours)
Analysis of single and multi-degree-of-freedom structures subjected to various types of excitations and initial conditions. Computational aspects of dynamic analysis. Introduction to approximate methods of analysis.
Prerequisite: CE 425 or CE 525
Typically offered in Spring only

CE 528/FB 528 Structural Design in Wood (3 credit hours)
Behavior, strength and design of wood structural members subjected to moment, shear and axial forces. Design of connections and introduction to design of wood structural systems.
Prerequisite: C- or better in CE 325
Typically offered in Fall only

CE 529 FRP Strengthening and Repair of Concrete Structures (3 credit hours)
Fundamental behavior of Fiber-Reinforced Polymer (FRP) strengthened/ repaired reinforced concrete structures. Creation of sustainable and resilient civil infrastructure by extending the useful life of existing structures using advances materials. Applica
Prerequisite: CE 327 and CE 325
Typically offered in Fall only

CE 530 Properties of Concrete and Advanced Cement-Based Composites (3 credit hours)
This course consists of three parts. First part covers basic properties of cements, mineral/chemical admixtures, and concrete production. Second part covers mechanical properties including compressive and tensile strength, multi-axial loading, composite models, and fracture mechanics. Models of porosity and microstructures are also discussed. Third part covers durability and deterioration mechanisms including corrosion of steel in concrete, mass transport, service life prediction. Advanced laboratory techniques are discussed. This course also covers emerging topics such as geopolymers and aluminate cements.
Prerequisite: CE 332 and CE 225
Typically offered in Spring only

CE 532 Introduction to Numerical Methods for Civil Engineers (3 credit hours)
Introduction to widely-used numerical methods through application to civil and environmental engineering problems. Emphasis will be on implementation and application rather than the mathematical theory behind the numerical methods.
Prerequisite: MA 302, MA 341, or MA 401
Typically offered in Spring and Summer

CE 537/OR 537 Computer Methods and Applications (3 credit hours)
Computational approaches to support civil planning, analysis, evaluation and design. Applications to various areas of civil engineering, including construction, structures, transportation and water resources.
Prerequisite: CSC 112 and (MA 341 or MA 305)
Typically offered in Fall only
CE 538 Information Technology and Modeling (3 credit hours)
Computing research and advanced technologies of interest to civil engineers. Issues in the design and development of engineering software systems and engineering modeling of structures, assemblies, processes and phenomena. Additional topics from the most predominant and recent developments and advances in civil engineering computing.
Prerequisite: CE 390
Typically offered in Fall and Spring

CE 548 Engineering Properties Of Soils I (3 credit hours)
Significant soil properties in earthwork engineering, including soil elasticity and soil mineralogy, hydraulic conductivity, stress-strain relations and shear strength, compressibility and compaction. Evaluating laboratory work including plasticity, triaxial compression, permeability, consolidation and compaction tests.
Prerequisite: CE 342
Typically offered in Fall only

CE 549 Soil and Site Improvement (3 credit hours)
Principles and design methodologies for techniques related to densification, including dynamic compaction, vibro-compaction and compaction grouting; drainage, including wick drains, horizontal drains and dewatering; physical and chemical modification, including admixtures, chemical and cement grouting, soil mixing, jet grouting and soil freezing; and use of inclusions, including stone columns, soil nailing, and meta and geosynthetic reinforcement.
Prerequisite: CE 342
Typically offered in Spring only

CE 557 Engineering Measurement and Data Analysis (3 credit hours)
The course will introduce students to fundamentals of experimental design, measurement systems and applied data analysis techniques and includes ‘hands-on’ laboratory exercises with sensors and computer-based data acquisition. Emphasis is on general concepts and their practical application towards engineering problems. The goal of the class is to build needed background, skills and vocabulary to develop students’ experimental practice rather than focusing on the underlying fundamentals of distinct areas. Students will develop more topic/media-specific knowledge through a team experimental project. Prerequisites include a course in statistics (e.g. ST 370, ST 515 or equivalent) and some coursework or experience involving scientific programming (e.g. CE 536 or 537; Matlab, Python, R, Igor Pro, IDL). Appropriate background can be determined via discussion with instructor.
Typically offered in Fall only

CE 561 Construction Project Management (3 credit hours)
Construction project management and control using network based tools, time-money analysis and other quantitative and qualitative techniques. Planning and scheduling, critical path, lead-lag, resource allocation, uncertainty, cash flow and payment scheduling, change orders, project acceleration, coordination and communication, record keeping. Emphasis on computer-based techniques.
Prerequisite: CE 463

CE 562 Lean Construction Concepts and Methods (3 credit hours)
Student teams apply concepts and methods in field studies of real project management processes and construction operations by using principles and methods in Lean Production, Construction, Design, Assembly, Supply, Production Control, and Work Process Design.
Prerequisite: CE 463
Typically offered in Fall only

CE 564/CE 464 Legal Aspects of Contracting (3 credit hours)
Legal aspects of contract documents, drawings and specifications; owner-engineer-constructor relationships and responsibilities; bids and contract performance, Labor laws; governmental administrative and regulatory agencies; torts; business organizations; ethics and professionalism.
Prerequisite: CE 463; Corequisite: CE 365
Typically offered in Spring only

CE 565 Construction Safety Management (3 credit hours)
Fundamentals of safety management principles. Detailed review of OSHA regulations and standards critical to construction engineers and managers who expect to design and administer safety related systems in a construction project. Analysis and design of example minimum safety requirements for application in construction field operations. Review of OSHA Standards for the Construction Industry, a review of selected sections of OSHA Standards for General Industry, a review of general principles of construction safety management.
Prerequisite: CE 465 or CE 466
Typically offered in Spring only

CE 567 Risk and Financial Management in Construction (3 credit hours)
Fundamental concepts in financial and risk analysis in construction; accounting and financial metrics in construction; risk assessment and risk management in construction including the cost of risk, decision making strategies, the role of sureties, effects of risk in project delivery methods and contract types; risk effects in project financing including a review of financing sources, considerations for financing local and international projects; and the impact of financial and risk management in strategic planning in construction.
Prerequisite: ACC 220, CE 463
Typically offered in Spring only

CE 568/CE 468 Construction Engineering Laboratory (1 credit hour)
Measurements with and calibration of measurement instruments used in construction engineering field tests for quality and safety of the construction process. Interpretation of ANSI, ASTM, ACI and AISC specifications and standards. Credit for both CE 468 and CE 568 is not allowed.
Prerequisite: CE 332, Corequisite: CE 327 or CE 426
Typically offered in Spring only
CE 571 Physical Principles of Environmental Engineering (3 credit hours)
Mass balances, equation of motion for small particles, small particle interactions, particle collision/coagulation, partitioning, adsorption isotherms, fluid mechanics, diffusion, interphase mass transport and resistance models, elementary/non-elementary reactions, residence time distributions.
Prerequisite: CE 282, Graduate standing
Typically offered in Spring only

CE 573 Biological Principles of Environmental Engineering (3 credit hours)
Concepts in environmental microbiology including cell structure and function, phylogeny, survey of environmentally relevant microbial groups, metabolism under different redox conditions, catabolism of macromolecules, methods in microbial ecology. Relationships to engineering processes and systems will be emphasized.
Prerequisite: Graduate standing in CE, BAE, CHE, or SSC
Typically offered in Fall only

CE 574 Chemical Principles of Environmental Engineering (3 credit hours)
Inorganic and organic environmental chemistry including acid-base equilibria, precipitation, complexation, redox reactions, and natural organic matter. The role of these factors in controlling the fate of contaminants in engineered treatment systems and natural environments.
Prerequisite: Graduate standing in CE, CHE, BAE, NE, MEA, SSC
Typically offered in Fall only

CE 576 Engineering Principles Of Air Pollution Control (3 credit hours)
Introduction to air pollution control fundamentals and design. Fundamentals including physics, chemistry and thermodynamics of pollutant formation, prevention and control. Design including gas treatment and process and feedstock modification. Addressed pollutants including sulfur dioxide, nitrogen oxides, particulate matter, volatile organic compounds, hydrocarbons and air toxins. Investigation of current research. Credit for both CE 476 and CE 576 is not allowed.
Prerequisite: CE 375, CE 470, CHE 315 or MAE 301(CHE Majors), or MEA 421(MEA Majors), Corequisite: ST 370, ST 380(MEA Majors)
Typically offered in Spring only

CE 577 Engineering Principles Of Solid Waste Management (3 credit hours)
Solid waste management including generation, storage, transportation, processing, land disposal and regulation. Processing alternatives including incineration and composting. Integration of policy alternatives with evaluation of engineering decisions. Investigation of current research. Credit is only allowed for one of CE 477 and CE 577.
Prerequisite: CE 373
Typically offered in Spring only

CE 578/CE 478 Energy and Climate (3 credit hours)
Interdisciplinary analysis of energy technology, natural resources, and the impact on anthropogenic climate change. Topics include basic climate science, energetics of natural and human systems, energy in fossil-fueled civilization, the impact of greenhouse gas emissions on climate, and technology and public policy options for addressing the climate challenge. The course is quantitative with a strong emphasis on engineering and science.
Prerequisite: Senior standing
Typically offered in Fall only

CE 579 Principles of Air Quality Engineering (3 credit hours)
Introduction to: risk assessment, health effects, and regulation of air pollutants; air pollution statistics; estimation of emissions; air quality meteorology; dispersion modeling for non-reactive pollutants; chemistry and models for tropospheric ozone formation; aqueous-phase chemistry, including the "acid rain" problem; integrated assessment of air quality problems; and the fundamentals and practical aspects of commonly used air quality models. Credit is allowed only for one of CE/MEA 479 or CE/MEA 579.
Prerequisite: CE 373, CE 382 or CHE 311(CHE Majors), or MEA 421(MEA Majors), Corequisite: ST 370, ST 380(MEA Majors)
Typically offered in Spring only

CE 581/MEA 581 Fluid Mechanics in Natural Environments (3 credit hours)
Free surface flows of water and air occurring in natural fluid systems and influencing environmental transport and mixing. Review of fundamental principles of fluids, covering the scales relevant to both engineering and geophysical applications. Topics and examples include waves, instability, stratification, turbulent boundary layers, jets and plumes, and open channel flows. Cannot receive credit for both CE 581 and MEA 581.
Prerequisite: CE 282 or MEA 463 or permission of instructor
Typically offered in Fall only

CE 582 Coastal Hydrodynamics (3 credit hours)
This course gives an introduction to water wave mechanics for engineers and scientists. Topics include wave generation, propagation, kinematics, transformation, breaking, forces, and dissipation.
Prerequisite: CE 282 or permission of instructor.
Typically offered in Spring only

CE 583 Engineering Aspects Of Coastal Processes (3 credit hours)
Coastal environment, engineering aspects of mechanics of sediment movement, littoral drift, beach profiles, beach stability, meteorological effects, tidal inlets, inlet stability, shoaling, deltas, beach nourishment, mixing processes, pollution of coastal waters, interaction between shore processes and man-made structures, case studies.
C- or better in CE 282.
Typically offered in Spring only

CE 584 Hydraulics Of Ground Water (3 credit hours)
Introduction to ground water hydraulics and hydrology. Hydrologic cycle, basic ground water hydraulics, numerical solution of governing equations, ground water hydrology of North Carolina, well design and construction, flow net development, and ground water contamination sources.
Prerequisite: CE 382
Typically offered in Fall only
CE 585  Principles of Surface Water Quality Modeling  (3 credit hours)
This course addresses how human inputs affect natural and engineered aquatic systems, through mathematical modeling of system dynamics. Course topics integrate physical, chemical, and biologic processes related to pollutants and lower food-web dynamics. Lectures and assignments cover both theory and application. Applications are relevant to informing management, protection, and restoration of inland and coastal waters.

Prerequisite courses include environmental processes (e.g., CE 373) and quantitative calculus-based hydrology (e.g., CE 383), or permission of instructor.

Typically offered in Spring only

CE 586  Engineering Hydrology  (3 credit hours)
Hydrologic principles underlying procedures for surface water modeling; applications of common hydrologic models to actual watersheds.

Prerequisite: CE 383

Typically offered in Fall only

CE 588/CE 488  Water Resources Engineering  (3 credit hours)
Extension of the concepts of fluid mechanics and hydraulics to applications in water supply, water transmission, water distribution networks and open channels to include water-supply reservoirs, pump and pipe selection, determinate and indeterminate pipe networks, and analysis of open channels with appurtenances.

Prerequisite: CE 339 and CE 383

Typically offered in Fall only

CE 590  Special Topics in Civil Engineering  (1-6 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 591  Special Topics in Civil Engineering Computing  (1-6 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 592  Special Topics in Construction Engineering  (1-6 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 593  Special Topics in Geotechnical Engineering  (1-3 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 594  Special Topics in Structures and Mechanics  (1-6 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 595  Special Topics in Transportation Engineering  (1-6 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 596  Special Topics in Water Resource and Environmental Engineering  (1-6 credit hours)
New or special course on recent developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 603  Construction Engineering Seminar  (1 credit hours)
Discussions and reports of subjects in civil engineering and allied fields.

Typically offered in Fall and Spring

CE 605  Structures and Mechanics Seminar  (1 credit hours)
Discussions and reports of subjects in civil engineering and allied fields.

Typically offered in Fall and Spring

CE 607  Water Resource and Environmental Engineering Seminar  (1 credit hours)
Discussions and reports of subjects in civil engineering and allied fields.

Typically offered in Fall and Spring

CE 610  Special Topics CE  (1-6 credit hours)

CE 635  Advanced Reading in Civil Engineering  (1-3 credit hours)
Directed reading of advanced topics in some phase of civil engineering.

Prerequisite: Graduate standing

Typically offered in Summer only

CE 675  Civil Engineering Projects  (1-6 credit hours)
Research- or design-oriented independent study and investigation of a specific civil engineering topic, culminating in final written report.

Typically offered in Fall, Spring, and Summer

CE 685  Master's Supervised Teaching  (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Master's student

Typically offered in Fall, Spring, and Summer
**CE 688** Non-Thesis Masters Continuous Registration - Half Time Registration (1 credit hours)
For students in non-thesis master's programs who have completed all credit hour requirements for their degree but need to maintain half-time continuous registration to complete incomplete grades, projects, final master's exam, etc.

Prerequisite: Master's student
Typically offered in Summer only

**CE 689** Non-Thesis Master Continuous Registration - Full Time Registration (3 credit hours)
For students in non-thesis master's programs who have completed all credit hour requirements for their degree but need to maintain full-time continuous registration to complete incomplete grades, projects, final master's exam, etc. Students may register for this course a maximum of one semester.

Prerequisite: Master's student
Typically offered in Summer only

**CE 693** Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
Typically offered in Summer only

**CE 695** Master's Thesis Research (1-9 credit hours)
Thesis research.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

**CE 696** Summer Thesis Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Master's student
Typically offered in Summer only

**CE 699** Master's Thesis Preparation (1-9 credit hours)
For students who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their thesis.

Prerequisite: Master's student
Typically offered in Summer only

**CE 701** Urban Transportation Planning (3 credit hours)
Planning and design of urban transportation systems as related to comprehensive urban planning; principles of land use planning, urban thoroughfare planning and regional planning.

Prerequisite: CE 501
Typically offered in Fall only

**CE 702** Traffic Flow Theory (3 credit hours)
Stream flow, shock wave, queuing, and other macroscopic theories; car following, gap acceptance, and other microscopic theories; distributions of traffic stream parameters; building traffic simulation models.

Prerequisite: CE 502, Corequisite: ST 370
Typically offered in Fall only

**CE 703** Economic Analysis of Transportation Systems (3 credit hours)
Transportation economics in terms of its supply and demand, costs, pricing, and regulation, especially the way in which the theory of economics in the marketplace and for public and private firms applies to the transportation market given its unique characteristics.

Typically offered in Fall only

**CE 705** Intelligent Transportation Systems (3 credit hours)
Intelligent Transportation Systems (ITS) planning and human factor elements; application of monitoring, communications and information dissemination technologies to transportation systems; advanced traffic management for freeway and arterial systems; traveler information and public transportation systems; automated vehicle and highway systems. ITS evaluation methods and models.

Prerequisite: CE 501 and CE 502
Typically offered in Fall only

**CE 706** Advanced Traffic Control (3 credit hours)
Advanced signalized traffic control methods at intersections, arterials and networks. Applications of mathematical optimization techniques to signal timing and coordination. Use of traffic simulation and optimization models for signal evaluation and design. Roundabout analysis and design.

Prerequisite: CE 502
Typically offered in Spring only

**CE 707** Transportation Policy and Funding (3 credit hours)
Understanding and debating important current transportation policy issues in the U.S. Raising and allocating funds for building and maintaining the transportation system. Highway, public transit, rail, air, and other modes.

Prerequisite: CE 501 or graduating in Economics or Public Administration
Typically offered in Spring only

**CE 708** Transportation Logistics Planning and Optimization (3 credit hours)
The mathematical treatment of transportation logistics from the perspective of infrastructure providers and system operators, including models used by freight service providers to determine how they will meet the demands for freight service. Private and common carrier operations are covered. Rail, truck, and air are the primary modes examined.

Typically offered in Fall only

**CE 714** Stress Waves (3 credit hours)
Theory of stress waves in solids. Origins and nature of longitudinal transverse and surface waves originating at an impact site or from other transient disturbances. Determination of stresses, particle velocities, wave velocities. Wave interaction with other waves and with boundaries and dissimilar materials. Modern instrumentation and seismic refraction exploration.

Prerequisite: MA 341; CE 225 or PY 411 or MA 401
Typically offered in Fall only

**CE 718** Constitutive Modeling of Engineering Materials (3 credit hours)
Stresses and strains (vectors, tensors and indicial notations), general theorems for elastic-plastic solids, constitutive modeling of metals and concrete, numerical implementations of plasticity models.

Prerequisite: CE 515 (old CE 715)
Typically offered in Spring only
CE 721  Matrix and Finite Element Structural Analysis  (3 credit hours)
Prerequisite: CE 526
Typically offered in Spring only

CE 723  Advanced Structural Dynamics  (3 credit hours)
Finite element formulation of equations of motion; advanced analysis techniques for discrete parameter systems; investigation of damping; analysis of continuous systems; applications to civil engineering structures.
Prerequisite: CE 527
Typically offered in Fall only

CE 724  Probabilistic Methods Of Structural Engineering  (3 credit hours)
Prerequisite: MA 421
Typically offered in Fall only

CE 725  Earthquake Structural Engineering  (3 credit hours)
Effects of earthquakes on structures and of design of structures to resist earthquake motions; earthquake mechanisms and ground motions; response of structures to earthquake motions; behavior of materials, structural elements and assemblages subjected to earthquakes; principles of earthquake-resistant design practice; soil-structure interaction; and special topics.
Prerequisite: CE 527
Typically offered in Fall only

CE 726  Advanced Theory Of Concrete Structures  (3 credit hours)
Prerequisite: CE 522
Typically offered in Spring only

CE 728  Performance Based Seismic Design of Bridges  (3 credit hours)
This course covers the seismic analysis and design of bridge structures. The progression through the course follows six thematic areas, namely: Conceptual design; Analysis approaches; Capacity Design; Response Verification; Assessment and Retrofit of Bridges; and New (or underutilized) frontiers in bridge engineering. The emphasis during the course will be on the relationships between engineer's choices, analysis, and design.
Prerequisite: CE 725
Typically offered in Spring only

CE 730  Mechanics and Failure of Quasi-Brittle Materials  (3 credit hours)
This course is in three parts. Part one covers fundamentals of composites including estimating the mechanical and theromechanical properties, failure of composites, laminate, and shear-lag model. Advanced topics including homogenization theories, Eigenstrain and Eigenstress, dilute, self-consistent and Mori-Tanaka methods are also covered. Part two covers fundamental of fracture mechanics including Griffith theory, stress field at crack tip, energy release rate, crack tip plasticity, and mixed mode fracture. Part three covers interface cracks, cracks approaching an interface, and fracture of composites.
Prerequisite: CE 515 and Corequisite: CE 526
Typically offered in Fall only

CE 737  Computer-Aided Engineering Systems  (3 credit hours)
Design and implementation issues for building real-world computer-aided engineering systems. Engineering data modeling; data definition, query and manipulation methodologies; application program interfaces; problem-oriented languages and software supervisors; and knowledge-based systems to support engineering design and decision making.
Prerequisite: CE 537 or 538
Typically offered in Spring only

CE 741  Geomechanics of Stress Deformation  (3 credit hours)
Concepts of volume change and effective stress, stress-strain behavior of clays and sands, stress path and failure conditions; mechanistic interaction between solids and water, problems in elasticity and plasticity pertaining to stress distribution, elastic, consolidation and secondary settlements, and tolerance limits to deformation levels.
Prerequisite: CE 440, or CE 443 or CE 548

CE 742  Deformation and Instability of Soils  (3 credit hours)
Prerequisite: CE 440, or CE 443 or CE 548

CE 744  Foundation Engineering  (3 credit hours)
Subsoil investigations; excavations; design of sheeting and bracing systems; control of water; footing, grillage and pile foundations; caisson and cofferdam methods of construction.
Prerequisite: CE 342
Typically offered in Spring only
CE 746 Soil Dynamics and Earthquake Engineering (3 credit hours)
Dynamics of discrete and continuous systems with application to soil dynamics: dynamic soil properties, analysis of foundation vibration, construction-induced vibration, dynamic soil-structure interaction. Geotechnical earthquake engineering: ground motion characteristics, dynamic response of soil sites, effect of local site conditions on design ground motion, liquefaction of soils.
Prerequisite: CE 440, or CE 443 or CE 548
Typically offered in Spring only

CE 747 Geosynthetics in Geotechnical Engineering (3 credit hours)
Introduction to use, manufacturing techniques, design and construction of geosynthetics in geotechnical engineering applications; design and analysis of geotextiles, geonets, geogrids and geomembranes in pavements base and subbase reinforcement, reinforced walls, slopes, moisture barriers, dams and hazardous impoundment, landfill liners and covers.
Prerequisite: CE 548
Typically offered in Fall only

CE 751 Theory Of Concrete Mixtures (3 credit hours)
In-depth study of theory of portland cement concrete mixtures including types and properties of portland special cements; chemical reactions; brief examination of history of mixture design; detailed study of current design methods; properties of fresh a
Prerequisite: CE 332
Typically offered in Fall only

CE 755 Highway Pavement Design (3 credit hours)
Theoretical analysis and design of highway pavements with critical evaluation of current design practices. Pavement materials characterization; stresses and strains in pavements; traffic consideration; pavement performance models; and actual thickness
Prerequisite: CE 342
Typically offered in Fall only

CE 757 Pavement Management Systems (3 credit hours)
Fundamental concepts in process of pavement management at both network level and project level. Distress identification and evaluation; concepts and methods for rehabilitation and maintenance techniques; nondestructive testing of pavements; performance
Prerequisite: CE 755
Typically offered in Spring only

CE 758 Multiscale Characterization of Asphalt Materials (3 credit hours)
Multiscale characterization of asphalt concrete. Chemical, rheological, and damage characterization of asphalt binder; asphalt binder oxidative aging; asphalt modification; asphalt emulsions; asphalt mastics; fine aggregate matrix; coarse aggregate structure. Graduate course on Asphalt and Bituminous Materials or consent by the instructor.
Typically offered in Spring only

CE 759 Inelastic Behavior Of Construction Materials (3 credit hours)
Application of principles of linear and nonlinear viscoelasticity, fracture mechanics and damage mechanics to modeling inelastic behavior of construction materials. Mechanical analog of time-dependent response; linear and nonlinear elastic-viscoelastic correspondence principles; time-temperature superposition; stress intensity factor; energy release rate; J-integral; and continuum damage mechanics.
Prerequisite: CE 515
Typically offered in Spring only

CE 761 Design Of Temporary Structures in Construction (3 credit hours)
Computer-based analysis of temporary structures in construction and their design, safety and control. Emphasis on concrete formwork, falsework, earth support, cofferdams, underpinning, lifting and rigging.
Prerequisite: CE 522 or CE 744 or CE 766
Typically offered in Fall only

CE 762 Construction Productivity (3 credit hours)
Methods of collecting, assembling and analyzing construction productivity data in order to increase construction productivity. Applications of methods improvement techniques such as time-lapse photography, flow charts, process charts and time standards to improvement of construction productivity. Safety and human factors in construction and their relation to construction productivity.
Prerequisite: CE 463
Typically offered in Spring only

CE 763 Materials Management In Construction (3 credit hours)
Fundamental concepts and methods; construction specific models for integrated materials management; computer usage; vendor analysis and "best-buy;" materials requirement planning and control; management of material waste; automated materials tracking;
Prerequisite: CE 463, CE 465

CE 765 Construction Equipment Systems (3 credit hours)
Analysis of heavy construction processes as systems in order to optimize the selection and deployment of construction equipment. Considerations in system design, cost and productivity estimation, operational procedures, safety and maintenance. Computer applications utilizing analytical and simulation techniques.
Prerequisite: CE 761 or 762
Typically offered in Spring only

CE 766 Building Construction Systems (3 credit hours)
Prerequisite: CE 466 or CE 327 or Graduate standing in ARC
Typically offered in Fall and Spring
CE 771  Physical-Chemical Water Treatment Processes  (3 credit hours)
Physical-chemical treatment processes for the treatment of water, including sedimentation, flotation, filtration, coagulation, oxidation, disinfection, precipitation, adsorption, and membrane treatment processes. Current issues in drinking water quality and treatment are discussed.

Prerequisite: CE 574, Corequisite: CE 571
Typically offered in Spring only

CE 772/NE 772  Environmental Exposure and Risk Analysis  (3 credit hours)
Course covers the identification, transport, and fate of hazardous substances in the environment; quantification of human exposures to such substances; dose-response analysis; and uncertainty and variability analysis. The general risk assessment framework, study design aspects for exposure assessment, and quantitative methods for estimating the consequences and probability of adverse health outcomes are emphasized.

Prerequisite: ST 511 or 515
Typically offered in Spring only

CE 774  Environmental Bioprocess Technology  (3 credit hours)
Principles of microbiological, biochemical, and biophysical processes used in environmental waste treatment and remediation processes, with particular emphasis on water quality control processes.

Prerequisite: CE 573, CE 574
Typically offered in Spring only

CE 775  Modeling and Analysis Of Environmental Systems  (3 credit hours)

Prerequisite: CE 339 and CE 282
Typically offered in Fall only

CE 776  Advanced Water Management Systems  (3 credit hours)
Application of systems analysis methods to design, analysis and management of water resources and environmental engineering.

Prerequisite: CE 339, CE 775
Typically offered in Spring only

CE 777  Stochastic Methods in Water Resources and Environmental Engineering  (3 credit hours)
Stochastic modeling, water resources and environmental data analysis, Dimension reduction, estimation and detection of periodicities in water resources and environmental data, parametric and non-parametric methods in water and environmental modeling.

Prerequisite: CE 586 or ST 515
Typically offered in Spring only

CE 779  Advanced Air Quality  (3 credit hours)
Local, regional and global scale chemical interactions, transport and behavior of trace gases (sulfur carbon, nitrogen, hydrocarbon, and photochemical oxidants) in the atmosphere. covers three primary elements of air quality: anthropogenic and natural emissions of trace gases; interactions of the pollutants in the atmosphere; and monitoring and sampling of gaseous and particulate pollutants.

Prerequisite: (CH 201 or CH 203) and MEA(CE) 479
Typically offered in Spring only

CE 784  Ground Water Contaminant Transport  (3 credit hours)
Introduction to movement and attenuation of contaminants in the subsurface. Common contaminant sources; advection and dispersion; numerical modeling of contaminant transport; chemical and biological processes in the subsurface; and ground water restorat

Prerequisite: CE 584 and 574
Typically offered in Spring only

CE 786  Hydroclimatology  (3 credit hours)
Hydroclimatology, El-Nino southern oscillation, climate and streamflow forecasting, forecast verification measures, downscaling, Budyko's Framework, long-term water balance, data assimilation, ensemble Kalman Fiter.

Prerequisite: CE 586
Typically offered in Spring only

CE 790  Advanced Topics In Civil Engineering  (1-3 credit hours)
New or special course on advanced developments in some phase of civil engineering. Specific topics and prerequisites identified for each section and varied from term to term.

Typically offered in Fall and Spring

CE 791  Advanced Topics in Civil Engineering Computing  (1-3 credit hours)
Typically offered in Fall and Spring

CE 792  Advanced Topics in Construction Engineering  (1-3 credit hours)
Typically offered in Fall and Spring

CE 793  Advanced Topics in Geotechnical Engineering  (1-3 credit hours)
Typically offered in Fall and Spring

CE 794  Advanced Topics in Structures and Mechanics  (1-3 credit hours)
Typically offered in Fall and Spring

CE 795  Advanced Topics in Transportation Engineering  (1-3 credit hours)
Typically offered in Fall and Spring

CE 796  Advanced Topics in Water Resource and Environmental Engineering  (1-3 credit hours)
Typically offered in Fall and Spring

CE 803  Advanced Construction Engineering Seminar  (1 credit hours)
Typically offered in Fall and Spring

CE 805  Advanced Structures and Mechanics Seminar  (1 credit hours)
Typically offered in Fall and Spring
CE 807  Advanced Water Resource and Environmental Engineering Seminar  (1 credit hours)
Typically offered in Fall and Spring

CE 839  Advanced Reading In Civil Engineering  (1-3 credit hours)
Directed reading of advanced topics in some phase of civil engineering.
Prerequisite: Graduate standing
Typically offered in Fall, Spring, and Summer

CE 885  Doctoral Supervised Teaching  (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.
Prerequisite: Doctoral student
Typically offered in Summer only

CE 890  Doctoral Preliminary Examination  (1-9 credit hours)
For students who are preparing for and taking written and/or oral preliminary exams.
Prerequisite: Doctoral student
Typically offered in Summer only

CE 893  Doctoral Supervised Research  (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.
Prerequisite: Doctoral student
Typically offered in Summer only

CE 895  Doctoral Dissertation Research  (1-9 credit hours)
Dissertation research.
Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

CE 896  Summer Dissertation Research  (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.
Prerequisite: Doctoral student
Typically offered in Summer only

CE 899  Doctoral Thesis Preparation  (1-9 credit hours)
For students who have completed all credit hour, full-time enrollment, preliminary examination, and residency requirements for the doctoral degree, and are writing and defending their dissertations.
Prerequisite: Doctoral student
Typically offered in Fall and Summer