

# CIVIL ENGINEERING (CE)

## Civil Engineering (CE) Courses

### **CE 5001. Process and Ethics in Thesis/Dissertation Research Development. (1-0) 1 Credit Hour.**

Course discusses the process and the ethical issues involved in conducting research and developing a thesis or dissertation. It covers research organizational skills, literature searches, technical writing, honesty in writing and plagiarism issues. Differential Tuition: \$55.

### **CE 5013. Civil Engineering Systems Analysis. (3-0) 3 Credit Hours.**

Systems approach to optimization and problem solving; operations research applications in civil engineering; mathematical modeling and analysis techniques including linear programming, dynamic programming, decision analysis and use of software to solve linear and nonlinear programming problems. Differential Tuition: \$165.

### **CE 5033. Experiential Learning in Civil Engineering. (3-0) 3 Credit Hours.**

Students may obtain credit for professional work experiences outside of UTSA that align with areas of graduate study in Civil Engineering. Students must develop a portfolio of work demonstrating that they have achieved learning objectives established by a faculty advisor. The portfolio will be evaluated by the faculty advisor, and if approved, the student must pass a proficiency exam evaluating his/her proficiency in the course learning outcomes. Differential Tuition: \$165.

### **CE 5043. Advanced Civil Engineering Statistics. (3-0) 3 Credit Hours.**

Statistical analysis methods include descriptive statistics, interval estimation and hypothesis testing, analysis of variance, design of experiments, regression analysis, and time series analysis. Additional topics covered include probabilistic methods, decision analysis and reliability analysis applied to civil engineering systems. Differential Tuition: \$165.

### **CE 5093. Geographic Information Systems (GIS). (3-0) 3 Credit Hours.**

Introduces vector, raster and tabular concepts, emphasizing the vector approach. Topics include spatial relationships, map features, attributes, relational database, layers of data, data ingesting, digitizing from maps, projections, output, applications, and availability of public data sets. Focus will be placed on spatial/temporal data analyses using digitized maps and database information in an area of CE specialization. (Formerly CE 5293. Credit cannot be earned for both CE 5093 and CE 5293.) Differential Tuition: \$165.

### **CE 5103. Advanced Steel Design. (3-0) 3 Credit Hours.**

Connection design, welded and bolted, moment-resistant connections, plate girders, column stability, bracing design, and seismic design of frames. (Formerly CE 5343 Topic 4: Advanced Steel Design. Credit cannot be earned for both CE 5103 and CE 5343 Advanced Steel Design.) Differential Tuition: \$165.

### **CE 5123. Bridge Engineering. (3-0) 3 Credit Hours.**

Design loads, load distribution, design of superstructures and substructures, and evaluation and load rating capacity of bridges. (Formerly CE 5343 Topic 8: Bridge Engineering. Credit cannot be earned for both CE 5123 and CE 5343 Bridge Engineering.) Differential Tuition: \$165.

### **CE 5133. Advanced Reinforced Concrete. (3-0) 3 Credit Hours.**

Curved beams, torsion design, retaining walls and shear walls, stairs, two-way slabs, yield-line theory, biaxial load on columns, slenderness effects, joint design, strut-and-tie methods, and concrete elasticity and failure criteria. (Formerly CE 5343 Topic 2: Advanced Reinforced Concrete Structures. Credit cannot be earned for both CE 5133 and CE 5343 Advanced Reinforced Concrete Structures.) Differential Tuition: \$165.

### **CE 5143. Numerical Methods in Civil Engineering. (3-0) 3 Credit Hours.**

Mathematical equation root finding and optimization methods, matrix equations, solution methods, eigenvector and eigenvalue solution methods, finite difference methods, curve-fitting methods, numerical integration and differentiation techniques, and introduction to finite element formulations. Differential Tuition: \$165.

### **CE 5153. Prestressed Concrete. (3-0) 3 Credit Hours.**

Overview of prestressed concrete development; design properties of materials; analysis and design of pre-tensioned and post-tensioned concrete members; full and partial prestressing; serviceability and strength requirements, code criteria for prestressed continuous beams, statically indeterminate frames and other structures. (Formerly CE 5343 Topic 3: Prestressed Concrete. Credit cannot be earned for both CE 5153 and CE 5343 Prestressed Concrete.) Differential Tuition: \$165.

### **CE 5163. Advanced Structural Analysis. (3-0) 3 Credit Hours.**

The class covers the matrix analysis method applied to structural analysis. The course will cover all the facets of the structural analysis method including the assembly of element and structure stiffness matrices, fixed end force and moment vectors, and nodal displacements. Differential Tuition: \$165.

### **CE 5173. Dynamics and Vibrations. (3-0) 3 Credit Hours.**

The class covers the fundamentals of structural dynamics, including single-degree-of-freedom and multi-degree-of-freedom systems. The course presents common analysis techniques used to calculate the dynamic response of structures to different types of time-varying loads. Differential Tuition: \$165.

### **CE 5183. Experimental Stress Analysis. (3-0) 3 Credit Hours.**

The course covers basic principles of experimental measurements, including basic modeling theory, similitude laws, and dimensional analysis. The course will also cover basic principles of commonly-used sensors for measuring strain, displacement, and load. Students will learn to build and operate sensors through experiments. Differential Tuition: \$165.

### **CE 5193. Finite Element Methods. (3-0) 3 Credit Hours.**

Derivation and computer implementation of the finite element method for the solution of civil engineering boundary value problems. (Formerly CE 5023. Same as ME 5483. Credit cannot be earned for more than one of the following: CE 5023, CE 5193, or ME 5483.) Differential Tuition: \$165.

### **CE 5253. Introduction to Masonry Design. (3-0) 3 Credit Hours.**

Design philosophy and methodology for masonry structures. Flexure design, axial load design, and shear design of basic masonry components. Differential Tuition: \$165.

### **CE 5263. Design of Buildings for Lateral Loads. (3-0) 3 Credit Hours.**

The class will cover methods to calculate lateral loads for the design of buildings and their application to the design of steel, concrete, wood and masonry structures. Differential Tuition: \$165.

### **CE 5283. Design of Nuclear Facilities I. (3-0) 3 Credit Hours.**

The course covers U.S. Nuclear Regulatory Commission regulations, ACI and AISC design codes for nuclear safety-related structures, computation of facility-specific design loads for seismic and other natural hazards and facility operations, ACI and AISC load combinations, design of components of reinforced concrete and steel structures, and safeguards evaluation for explosive and impact loads. Differential Tuition: \$165.

**CE 5303. Hydrometeorology. (3-0) 3 Credit Hours.**

The main objective of this course is to familiarize the student with the local and global distribution of freshwater. Conceptualizations of the water balance/budget are developed using principles of physical hydrology and meteorology. Emphasis will be on recent research and modern methods for data analysis and modeling. Real life events and phenomena will be discussed. In addition to the text, material will be presented from other sources. Guest instructors will give presentations on some case studies. Differential Tuition: \$165.

**CE 5323. River Science. (3-0) 3 Credit Hours.**

An in-depth examination of river sediment transport principles. Topics include water and sediment supply, sediment dynamics, river morphology, and channel instability. Field trip required. (Formerly CE 5653. Same as GEO 5413. Credit can be earned for only one of the following: CE 5653, CE 5323, or GEO 5413.) Differential Tuition: \$165.

**CE 5363. Coastal Engineering. (3-0) 3 Credit Hours.**

This course introduces coastal engineering principles. This course will cover various fundamental and applied aspects of coastal engineering, including: wave mechanics, wave-structure interaction, coastal water level fluctuations, coastal zone processes, and design considerations for coastal structures and beach nourishment projects. Differential Tuition: \$165.

**CE 5373. Risk Analysis of Water/Environmental Systems. (3-0) 3 Credit Hours.**

This course is focused on risk and uncertainty analysis applied to hydrology, hydraulics, groundwater, water resources, and environmental engineering systems. Tools for estimating the risk of failure and the reliability of water resources and environmental engineering systems based on probability and statistical methods as well as stochastic simulation techniques will be discussed. Differential Tuition: \$165.

**CE 5383. Water Resources Planning and Management. (3-0) 3 Credit Hours.**

Management and planning of natural and constructed water systems; the planning process, systems analysis methods; institutional framework for water resources engineering; comprehensive integration of engineering, economic, environmental, legal and political considerations in water resources development and management. Integrated management and case studies of water use and environmental resources. Differential Tuition: \$165.

**CE 5393. River Mechanics and Engineering Applications. (3-0) 3 Credit Hours.**

Prerequisite: CE 5323 or equivalent. This course focuses on the application of sediment transport principles to practical river mechanics and environmental problems. Applications include laboratory experiments, and numerical simulations related to the solution of practical river engineering problems. (Formerly CE 5663. Credit cannot be earned for both CE 5393 and CE 5663.) Differential Tuition: \$165.

**CE 5403. Advanced Characterization of Highway Materials. (3-0) 3 Credit Hours.**

Basic and advanced level of the fundamentals of material response to static and repeated loading; emphasis on the deformation and fatigue behavior of asphalt mixtures, constitutive modeling for mixtures, microstructure characterization for mixtures, nondestructive testing of pavements, asphalt binder characterization, unbound materials (base and sub-base materials) evaluation and characterization. Differential Tuition: \$165.

**CE 5423. Advanced Pavement Analysis and Design. (3-0) 3 Credit Hours.**

Asphalt concrete and portland concrete pavement analysis and design. Layered elastic, nonlinear, and viscoelastic analysis. Slabs under environmental and traffic stresses. Software for layer analysis and slab analysis. AASHTO 1993 design method. Asphalt Institute and Portland Cement Association method. NCHRP 1-37A developed mechanistic-empirical design method. (Formerly CE 5513 Topic 5: Pavement Design. Credit cannot be earned for both CE 5423 and CE 5513 Pavement Design.) Differential Tuition: \$165.

**CE 5433. Advanced Geometric Design. (3-0) 3 Credit Hours.**

Course deals with the geometric design of highways and streets. Topics include highway functions, design controls and criteria, elements of design, local roads and streets, freeways, and intersections. (Formerly CE 5513 Topic 6: Advanced Geometric Design. Credit cannot be earned for both CE 5433 and CE 5513 Advanced Geometric Design.) Differential Tuition: \$165.

**CE 5443. Pavement Management. (3-0) 3 Credit Hours.**

Pavement evaluation and performance, evaluation of pavement distress condition surveys, evaluation of pavement roughness ride quality, skid resistance of pavements, evaluation of pavement structural capacity, maintenance and rehabilitation, prioritization and optimization of pavement maintenance, and rehabilitation needs. (Formerly CE 5513 Topic 4: Pavement Management Systems. Credit cannot be earned for both CE 5443 and CE 5513 Pavement Management Systems.) Differential Tuition: \$165.

**CE 5453. Transportation Engineering. (3-0) 3 Credit Hours.**

Study of the Highway Capacity Manual, traffic stream parameters and relationships, analytical techniques in traffic engineering such as capacity analysis, queuing theory, and traffic simulation. Design and operation of advanced traffic management systems including signalization, real-time motorist information, urban incident management, and ITS concepts. (Formerly CE 5513 Topic 8: Principles of Traffic Engineering. Credit cannot be earned for both CE 5453 and CE 5513 Principles of Traffic Engineering.) Differential Tuition: \$165.

**CE 5473. Transportation Planning. (3-0) 3 Credit Hours.**

An introductory course in urban transportation planning. It includes, an overview of highway capacity concepts, trip generation, trip distribution, modal split and trip assignments. Course gives hands-on exposure to software implementing these steps and discusses case studies of San Antonio's 2020 master plan. Finally, it extends this approach to air passenger and road freight transportation. Differential Tuition: \$165.

**CE 5483. Urban Transportation. (3-0) 3 Credit Hours.**

This course is an introduction to urban passenger transportation planning in the USA with a sustainability focus. It is structured around three components: (1) History, theory, and problem definition; (2) The planning process; and (3) Solutions and analytical techniques. The course will help to understand the planning process comprehensively along with its multiple dimensions, how our current transportation systems has evolved over time, what is a sustainable system, policies and planning approaches that help to achieve it, and challenges related to planning. The course provides opportunities to hear from local and regional planners about their work, and learn from their experience about the methods they use in practice. Differential Tuition: \$165.

**CE 5493. Traffic Engineering. (3-0) 3 Credit Hours.**

This course will introduce to students the theories that seek to describe the interactions between the vehicles, drivers, and the infrastructure. The models and theories that characterize the flow of highway traffic, signalized and unsignalized intersections will also be presented. The course will also provide opportunity to learn emerging techniques and to apply them for traffic and incident management. Differential Tuition: \$165.

**CE 5523. Retaining Structures. (3-0) 3 Credit Hours.**

This course covers lateral earth pressure theories and their applications in various retaining wall designs. The included types of retaining walls are mechanically stabilized earth (MSE) wall, soil nail wall, tie-back wall, soldier pile wall, and drilled shaft wall. Students will be required to design and analyze different types of retaining structures using the learned theories. In addition, popular computer software packages will also be introduced in this course as design tools. Differential Tuition: \$165.

**CE 5533. Slope Stability. (3-0) 3 Credit Hours.**

The course includes advanced theories of soil strength and failure, theories of lateral earth pressure with applications, infinite slope analysis, limit equilibrium slope analysis, finite element slope analysis, and mechanics and analysis of reinforced slopes using finite element software and spreadsheet applications. Differential Tuition: \$165.

**CE 5543. Ground Improvement. (3-0) 3 Credit Hours.**

This course covers the fundamental principles and concepts of ground improvement methods. How to use these concepts for design and analysis of various ground improvements. The content of this course focus on the applicability of various ground improvement, design and analysis methods and construction details. Differential Tuition: \$165.

**CE 5553. Advanced Soil Mechanics. (3-0) 3 Credit Hours.**

Permeability and seepage analysis involving dams and sheet piles, stress distribution in earth masses, advanced study of drained and undrained shear strength of soil, behavior of unsaturated soil, and laboratory and field methods for evaluation of soil properties in design practice. Differential Tuition: \$165.

**CE 5563. Foundation Engineering. (3-0) 3 Credit Hours.**

Shallow and deep foundations, including footings, slabs on-grade, cofferdams, sheet-pile walls, drilled shafts, piles and retaining walls. (Formerly CE 5463. Credit cannot be earned for both CE 5463 and CE 5563.) Differential Tuition: \$165.

**CE 5613. Environmental Chemistry. (3-0) 3 Credit Hours.**

This course explores the chemistry of the environment, the chemistry underlying environmental problems and solutions to environmental problems. Emphasis is placed on thermodynamics and kinetics of reaction cycles; sources, sinks and transport of chemical species; and quantitation of chemical species. Examples are selected from the chemistry of natural and contaminated air, water, and soil. Differential Tuition: \$165.

**CE 5623. Advanced Treatment Processes for Water Quality Control. (3-0) 3 Credit Hours.**

Principles, modeling and design aspects of physical chemical treatment processes in drinking water, wastewater and groundwater remediation applications. (Formerly CE 5233 Topic 1: Physical and Chemical Treatment Operations. Credit cannot be earned for both CE 5623 and CE 5233 Physical and Chemical Treatment Operations.) Differential Tuition: \$165.

**CE 5643. Sustainable Energy Systems. (3-0) 3 Credit Hours.**

Course explores various facets of sustainable energy systems and their role in securing America's energy future. It covers national and global energy trends, social, political, regulatory, technical/economic constraints and policy considerations. The course uses a systems approach in examining the technology and economics behind each alternative energy source and the major qualitative and quantitative factors affecting their large-scale deployment. (Same as ME 5273. Credit cannot be earned for both CE 5643 and ME 5273.) Differential Tuition: \$165.

**CE 5673. Environmental Microbiology. (3-0) 3 Credit Hours.**

To provide a basic understanding of environmental microbiology primarily from two aspects: microbial interactions with chemical pollutants in the environment and the fate of microbial pathogens in the environment. Topics covered include microbial environments, detection of bacteria and their activities in the environment, microbial biogeochemistry, bioremediation and water quality. (Formerly CE 5203. Same as ES 5063. Credit can be earned for only one of the following: CE 5673, CE 5203, or ES 5063.) Differential Tuition: \$165.

**CE 5683. Biological Phenomena in Environmental Engineering. (3-0) 3 Credit Hours.**

The major biological phenomena and processes used in environmental engineering control. Fundamentals of microbiology and biochemistry as applied to wastewater treatment, drinking water treatment, and hazardous waste remediation. (Formerly CE 5213. Credit cannot be earned for both CE 5683 and CE 5213.) Differential Tuition: \$165.

**CE 5703. Special Topics in Hydraulics and Hydrology. (3-0) 3 Credit Hours.**

Course deals with special aspects of hydraulics and hydrology. May be repeated for credit as topics vary. Differential Tuition: \$165.

**CE 5713. Special Topics in Structures. (3-0) 3 Credit Hours.**

Course deals with special aspects of structural engineering. May be repeated for credit as topics vary. Differential Tuition: \$165.

**CE 5723. Special Topics in Transportation. (3-0) 3 Credit Hours.**

Course deals with special aspects of transportation engineering. May be repeated for credit as topics vary. Differential Tuition: \$165.

**CE 5733. Special Topics in Environmental Engineering. (3-0) 3 Credit Hours.**

Course deals with special aspects of environmental engineering. May be repeated for credit as topics vary. Differential Tuition: \$165.

**CE 5743. Special Topics in Geotechnical Engineering. (3-0) 3 Credit Hours.**

Course deals with special aspects of geotechnical engineering. May be repeated for credit as topics vary. Differential Tuition: \$165.

**CE 5973. Special Project. (0-0) 3 Credit Hours.**

Work carried out by nonthesis Master's students under the direction of their Advisory Committee to fulfill the project requirement of their degree. It may involve applied or theoretical work and a report documenting the findings. Differential Tuition: \$165.

**CE 5981. Master's Thesis. (0-0) 1 Credit Hour.**

Prerequisite: Approval of the student's Advisory Committee. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. (Formerly CE 6983.) Differential Tuition: \$55.

**CE 5982. Master's Thesis. (0-0) 2 Credit Hours.**

Prerequisite: Approval of the student's Advisory Committee. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. (Formerly CE 6983.) Differential Tuition: \$110.

**CE 5983. Master's Thesis. (0-0) 3 Credit Hours.**

Prerequisite: Approval of the student's Advisory Committee. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. (Formerly CE 6983.) Differential Tuition: \$165.

**CE 5991. Graduate Seminar. (1-0) 1 Credit Hour.**

Graduate seminar may be repeated for credit up to 3 semester credit hours. Differential Tuition: \$55.

**CE 6123. Theory of Plates and Shells. (3-0) 3 Credit Hours.**

The class covers the fundamentals of plate and shell theories, formulation of finite element analysis using plate and shell elements, and basic solutions for various types of loading and boundary conditions in plate and shell structures. Differential Tuition: \$165.

**CE 6133. Advanced Behavior of Reinforced Concrete Members. (3-0) 3 Credit Hours.**

The class covers the behavior of reinforced concrete members under the effects of flexure, axial load, and shear. Technical references are presented that provide the foundation for modern reinforced concrete analysis theories and reinforced concrete design codes. The references discussed in the class provide a basic understanding of the intent and limitations of design code provisions as well as introduce students to techniques for modeling the behavior of reinforced concrete structures in the nonlinear range of response. Differential Tuition: \$165.

**CE 6163. Non-linear Finite Element Analysis. (3-0) 3 Credit Hours.**

The class covers the modeling, formulation, and application of the finite element method for nonlinear problems in structural mechanics. Differential Tuition: \$165.

**CE 6173. Earthquake Engineering. (3-0) 3 Credit Hours.**

The class presents an introduction to engineering seismology including the most important characteristics of earthquake ground motions. The class will also cover methods to simulate the response of structures to strong earthquakes, methodologies employed by seismic design codes, and performance-based design. Differential Tuition: \$165.

**CE 6263. Repair and Rehabilitation of RC Structures. (3-0) 3 Credit Hours.**

Prerequisites: CE 5163 and CE 6173 or equivalents. Condition assessment of existing structures. Evaluation of in-situ capacity of structures using advanced modeling and numerical simulation techniques. Methods for repair and rehabilitation of deficient structures. Differential Tuition: \$165.

**CE 6283. Design of Nuclear Facilities II. (3-0) 3 Credit Hours.**

The course covers the structural design of nuclear facilities including steel components in accordance with AISC N690 and concrete components in accordance with ACI 349 and ACI 359. Differential Tuition: \$165.

**CE 6313. Hydrologic Modeling and Analysis. (3-0) 3 Credit Hours.**

This course will address hydrological modeling (both theory and practical applications with focus on the latter) and related issues. Multimedia and advanced visualization will be used in lectures and class work. Most of the course is dedicated to hands-on, problem-oriented applications using a variety of practical techniques. It will provide students with the knowledge and tools necessary to use data derived from geographical information systems (GIS) to develop hydrologic estimates needed for different applications. (Formerly CE 6013. Credit cannot be earned for both CE 6313 and CE 6013.) Differential Tuition: \$165.

**CE 6323. Control of Floods and Droughts. (3-0) 3 Credit Hours.**

This course will discuss flood and drought characteristics, impacts; structural, nonstructural flood control measures; drought prediction, drought control, and drought management. Focus will be on preparedness, mitigation, and risk management to respond to these phenomena. Differential Tuition: \$165.

**CE 6343. Water Resources Systems Analysis. (3-0) 3 Credit Hours.**

Systems Analysis methods use algorithmic and mathematical approaches for problem-solving. These are powerful methods that can be applied to solve complex design and management problems for water resources systems and other engineering areas. This class will focus on optimization methods, such as linear programming, integer programming, nonlinear programming, genetic algorithms, and dynamic programming, and their application to water resources systems. Differential Tuition: \$165.

**CE 6363. Advanced Fluid Mechanics. (3-0) 3 Credit Hours.**

This course will be theory oriented with advanced mathematical and physical concepts. Starting with basic conservation laws and constitutive equations of fluid mechanics and flow kinematics, the course will first cover ideal (inviscid) flows and then viscous flows of incompressible fluids. Two-dimensional potential flows will be covered as part of ideal fluid flows. Exact solutions and low-Reynolds number approximate solutions of Navier-Stokes equations will be covered as part of viscous fluid flows. Differential Tuition: \$165.

**CE 6383. Global Change. (3-0) 3 Credit Hours.**

Changes in the global distribution of plants and animals and the causes of the changes will be examined. Factors that are apparently coupled to changes in the atmosphere and environmental temperature will be examined. (Formerly CE 6113. Same as ES 5043 and GEO 5043. Credit can be earned for only one of the following: CE 6383, CE 6113, ES 5043, or GEO 5043.) Differential Tuition: \$165.

**CE 6403. Airport Engineering. (3-0) 3 Credit Hours.**

This course covers airport master planning and layout, aircraft characteristics and their effects on airport design, and orientation of runways and taxiways including length and cross sections. The course also covers airport capacity and delay, types of airport configurations and methods to design of airport pavements. Differential Tuition: \$165.

**CE 6423. Railway Engineering. (3-0) 3 Credit Hours.**

This course provides an overview of industry-specific topics including key statistics that shape design, construction, maintenance, operations, and evaluation of rail infrastructure and networks. Specific topics also include track-train dynamics, safety, intercity and urban passenger and freight rail operations and capacity, motive power and equipment. Differential Tuition: \$165.

**CE 6453. Pavement Sustainability. (3-0) 3 Credit Hours.**

This course provides design tools that will encourage the use of sustainable pavement materials and structures, such as permeable pavements, rubber asphalt, recycled asphalt pavement (RAP), recycled asphalt shingles (RAS) and alternative cement binders. The course covers potential multiple use of asphalt pavement roadways to have a considerable impact on energy production, fuel consumption, reduced greenhouse gas (GHG) emissions, and life-cycle costs. Differential Tuition: \$165.

**CE 6503. Landfill Design. (3-0) 3 Credit Hours.**

The course will include principles of waste disposal, sanitary landfill site assessment, in-depth design, construction, operation and maintenance of sanitary landfill including landfill gas and leachate management and groundwater monitoring issues close to landfills. Differential Tuition: \$165.

**CE 6513. Advanced Foundation Engineering. (3-0) 3 Credit Hours.**

This course is an extension of CE 5563 Foundation Engineering and covers advanced foundation theories and analytical methods. In addition, this course will cover latest advancements in foundation testing such as static test and Osterberg tests. The concept of sustainability in foundation design will also be introduced in this course. Differential Tuition: \$165.

**CE 6533. Remediation Geotechnics. (3-0) 3 Credit Hours.**

Application of geotechnical engineering to the disposal of wastes, remediation of polluted sites containing contaminated soil and groundwater. Topics include subsurface exploration techniques and geotechnically-oriented remedial action technologies including pump and treat method, soil vapor extractions, air sparging, PRBs, etc. Differential Tuition: \$165.

**CE 6603. Fate and Transport of Contaminants in the Environment. (3-0) 3 Credit Hours.**

The course deals with the hydrodynamics of mixing and transport, as well as the interaction of mixing and various reaction rate processes. Applications in the course will include water and wastewater treatment, groundwater pollution, and transport and mixing in rivers, lakes and reservoirs. (Formerly CE 6103 and CE 6053 Topic 1: Fate and Transport of Contaminants in Environmental System. Credit can be earned for only one of the following CE 6603, CE 6103, or CE 6053 Fate and Transport of Contaminants in Environmental System.) Differential Tuition: \$165.

**CE 6621. Graduate Seminar in Environmental Science and Engineering. (1-0) 1 Credit Hour.**

Will include presentations of current research by faculty and invited guests who are experts in various aspects of research in the environmental sciences and engineering, and advanced graduate students who are about to complete their dissertation research. The grade report for the course is either "CR" (satisfactory) or "NC" (unsatisfactory). May be repeated for credit. (Formerly CE 6221. Same as ES 5981.) Differential Tuition: \$55.

**CE 6951. Independent Study. (0-0) 1 Credit Hour.**

Prerequisites: Written permission of the instructor and the student's Advisory Committee. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the student's program of study. Differential Tuition: \$55.

**CE 6952. Independent Study. (0-0) 2 Credit Hours.**

Prerequisites: Written permission of the instructor and the student's Advisory Committee. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the student's program of study. Differential Tuition: \$110.

**CE 6953. Independent Study. (0-0) 3 Credit Hours.**

Prerequisites: Written permission of the instructor and the student's Advisory Committee. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the student's program of study. Differential Tuition: \$165.

**CE 6961. Comprehensive Examination. (0-0) 1 Credit Hour.**

Prerequisite: Written permission of the student's Advisory Committee. The comprehensive examination course is intended as a 1 semester credit hour substitute for the Master of Science degree in Civil Engineering thesis or the Master of Civil Engineering graduate seminar. Students may register for this course in a semester in which the examination is to be taken, if they are not enrolled in other courses. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). Differential Tuition: \$55.

**CE 6991. Graduate Seminar in Civil Engineering. (1-0) 1 Credit Hour.**

Will include presentations of current research by faculty and invited guests who are experts in various aspects of research in civil engineering, and advanced graduate students who are about to complete their dissertation research. May be repeated for credit. Differential Tuition: \$55.

**CE 7211. Doctoral Research. (0-0) 1 Credit Hour.**

Prerequisites: For CE Ph.D. students, consent of advisor; for ESE Ph.D. students, admission to Doctoral candidacy; consent of the student's Dissertation Committee and consent of the DSC. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than 15 hours may be applied to the Doctoral degree. Differential Tuition: \$55.

**CE 7212. Doctoral Research. (0-0) 2 Credit Hours.**

Prerequisites: For CE Ph.D. students, consent of advisor; for ESE Ph.D. students, admission to Doctoral candidacy; consent of the student's Dissertation Committee and consent of the DSC. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than 15 hours may be applied to the Doctoral degree. Differential Tuition: \$110.

**CE 7213. Doctoral Research. (0-0) 3 Credit Hours.**

Prerequisites: For CE Ph.D. students, consent of advisor; for ESE Ph.D. students, admission to Doctoral candidacy; consent of the student's Dissertation Committee and consent of the DSC. Research work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but no more than 15 hours may be applied to the Doctoral degree. Differential Tuition: \$165.

**CE 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.**

Prerequisites: For CE Ph.D. students, successful defense of comprehensive exam; for ESE Ph.D. students, successful defense of the oral defense; consent of the student's Dissertation Committee and consent of the DSC. Dissertation work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but not more than 15 hours may be applied to the Doctoral degree. Differential Tuition: \$55.

**CE 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.**

Prerequisites: For CE Ph.D. students, successful defense of comprehensive exam; for ESE Ph.D. students, successful defense of the oral defense; consent of the student's Dissertation Committee and consent of the DSC. Dissertation work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but not more than 15 hours may be applied to the Doctoral degree. Differential Tuition: \$110.

**CE 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.**

Prerequisites: For CE Ph.D. students, successful defense of comprehensive exam; for ESE Ph.D. students, successful defense of the oral defense; consent of the student's Dissertation Committee and consent of the DSC. Dissertation work carried out by the student under the supervision of their Dissertation Committee. May be repeated as necessary, but not more than 15 hours may be applied to the Doctoral degree. Differential Tuition: \$165.