Civil Engineering (CEE)

CEE 0845. The Environment. 3 Credit Hours.
In today's world characterized by rapid and global environmental changes, it is crucial that citizens have an understanding of the key concepts in environmental science. This course provides students with an introduction to the science behind critical environmental debates and breaks down the requirements for creating and maintaining sustainable ecosystems. A major focus of the course is to develop critical thinking skills and apply them to assess relevant questions such as: How do we predict trends in the growth of populations or climate change? How do human activities impact the nitrogen and phosphorus cycles and how does this in turn affect the environment? How can we quantify and value biodiversity? Should we eat lower on the food chain or are genetically modified crops a sustainable solution? What were the key outcomes of the 2015 U.N. Climate Change Conference in Paris and how will various countries carry out their commitments to protect the environment? This course will enhance awareness of the impacts that our everyday decisions have on the environment and will provide students with strategies to become better environmental stewards. NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core. Students cannot receive credit for this course if they have successfully completed CEE 0945, CEE 1051, ENVT 0845, ENVT 0945, or ENVT 1051.

Course Attributes: GS, SE, SF

Repeatability: This course may not be repeated for additional credits.

CEE 0945. Honors: The Environment. 3 Credit Hours.
In today's world characterized by rapid and global environmental changes, it is crucial that citizens have an understanding of the key concepts in environmental science. This course provides students with an introduction to the science behind critical environmental debates and breaks down the requirements for creating and maintaining sustainable ecosystems. A major focus of the course is to develop critical thinking skills and apply them to assess relevant questions such as: How do we predict trends in the growth of populations or climate change? How do human activities impact the nitrogen and phosphorus cycles and how does this in turn affect the environment? How can we quantify and value biodiversity? Should we eat lower on the food chain or are genetically modified crops a sustainable solution? What were the key outcomes of the 2015 U.N. Climate Change Conference in Paris and how will various countries carry out their commitments to protect the environment? This course will enhance awareness of the impacts that our everyday decisions have on the environment and will provide students with strategies to become better environmental stewards. (This is an Honors course.) NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core. Students cannot receive credit for this course if they have successfully completed CEE 0845, CEE 1051, ENVT 0845 or ENVT 0945.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: GS, HO, SE, SF

Repeatability: This course may not be repeated for additional credits.

CEE 1001. Introduction to Civil Engineering. 3 Credit Hours.
This course provides an understanding of the study and practice associated with Civil Engineering. It stresses the importance of good communications and teamwork skills in a successful engineering career. Students will understand the basics of problem solving and design. Laboratory included.

Repeatability: This course may not be repeated for additional credits.

CEE 1051. Introduction to the Environment. 3 Credit Hours.
Basic environmental issues, systems and change; biogeochemical cycles; human population; ecosystems and their management and restoration; biological diversity, productivity and energy flow; biogeography; environmental health, pollution and toxicology; energy; and global warming. Hands on laboratory exercises are an integral part of the course. The lab exercises are conducted within the class schedule at each campus. NOTE: Students cannot receive credit for this course if they have successfully completed CEE 0845, CEE 0945, ENVT 0845, ENVT 0945 or ENVT 1051.

Course Attributes: SE, SF, SS

Repeatability: This course may not be repeated for additional credits.

CEE 1105. Surveying. 2 Credit Hours.
Calculating closure and area of a traverse; computing offset angles and chord distances to layout circular and spiral curves; determine elevations to layout vertical curves; computing volumes from terrain cross sections. Field problems using surveying instruments to layout a traverse and a circular curve. Students will work on teams, which will be responsible for performing field work, analytic calculations, and report presentation associated with loop leveling and closed-loop traverse surveys.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 1021 to 4999, 'Y' in MC5, 'Y' in MC6, 'Y' in MC6A, 'Y' in MATW, or 'Y' in MC6T)

CEE 1115. Surveying Laboratory. 1 Credit Hour.
Students will work on teams, which will be responsible for performing field work, analytic calculations, and report presentation associated with loop leveling and closed-loop traverse surveys.

Repeatability: This course may not be repeated for additional credits.

CEE 2011. Civil Engineering Materials. 2 Credit Hours.
Basic laboratory and field tests conducted with aggregate, soil, concrete, steel, masonry, wood and other construction materials.

Repeatability: This course may not be repeated for additional credits.

CEE 2341. Construction Materials Laboratory. 2 Credit Hours.
Basic laboratory and field tests conducted with aggregate, soil, concrete, steel, masonry, wood and other construction materials. Students are required to submit lab reports on the test results of various materials.

Repeatability: This course may not be repeated for additional credits.

CEE 2711. Environmental Chemistry & Microbiology. 3 Credit Hours.
This course covers the structure of atoms; chemical bonds and reactions; water, solutions, and colloids; acids, bases, and pH; carbohydrates, lipids, proteins; nucleotides and nucleic acids; commonly occurring organic contaminants; and microorganisms and contamination remediation.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1031 or CHEM 1035) and CHEM 1033.

CEE 2712. Introduction to Environmental Engineering. 3 Credit Hours.
This course will provide an introduction to the sources, effects, and control of pollution in different environmental compartments. Topics include air and water quality (indicator parameters), mass transport, solid and hazardous waste classification, risk assessment, environmental regulations (air, water, solids). Water and wastewater treatment are introduced as well as water resources engineering (rainfall/runoff analysis).

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (CHEM 1031 or CHEM 1951) and (MATH 1042 (C or higher), MATH 1942 (C or higher), 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

CEE 2715. Principles of Sustainable Engineering. 3 Credit Hours.
Sustainable engineering principles include calculations of environmental emissions and resource consumption. Mass and energy balance calculations in context of pollution generation and prevention, resource recovery and life-cycle assessment. Economic aspects of sustainable engineering decision-making. Social impacts of technology system design decisions including ethical frameworks, government legislation and health risks. Students will gain an awareness of challenges to sustainable water and energy and inter-linkages between these. Energy-water design trade-offs will be investigated for various energy and water processing facilities, e.g. electric power or desalination plants.

Course Attributes: SE, SF, SS

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 2712.

CEE 2811. Sustainable Projects in the Developing World I. 2 Credit Hours.
This course focuses on multiple aspects of developing and implementing projects in underserved areas of the world following guidelines established by Engineers Without Borders. This course will prepare students for international travel to work on projects currently being undertaken or considered by the EWB Temple University student chapter. The course topics include development of community partnerships, identification of community needs, budgeting, fundraising, communication, and sustainable project design. Topics covered each semester will be dependent on the current project status. The course is open to students across all disciplines with an interest in applying their education to projects in the developing world. This is the first of a two course sequence with CEE 2812.

Course Attributes: SF

Repeatability: This course may be repeated for additional credit.

CEE 2812. Sustainable Projects in the Developing World II. 1 Credit Hour.
This course focuses on multiple aspects of developing and implementing projects in underserved areas of the world following guidelines established by Engineers Without Borders. In this course students will develop a topic related to the service learning trip undertaken as part of CEE 2811 and write an in-depth technical report. Topics may include, but are not limited to, development of community partnerships, identification of community needs, and sustainable engineering design. This course is open to students across all disciplines who have successfully completed CEE 2811 and traveled on an EWB-Temple, or similar, service trip. This is the second of a two course sequence (with CEE 2811).

Course Attributes: SF

Repeatability: This course may be repeated for additional credit.

Pre-requisites: Minimum grade of C- in CEE 2811.

CEE 3048. Probability, Statistics & Stochastic Methods. 3 Credit Hours.
A practical course on uncertainty and risk analysis for engineers and scientists, including modern computer algebra software applications. Random variables and probability distributions. Simulations of random systems, analytical models and Monte Carlo simulations. Systems with jointly distributed random variables. Estimation theory in engineering. Fitting probability models to data. Regression analysis. Reliability of engineering systems. Design of engineering experiments. Experiments and tests for two or more random variables. ANOVA. Introduction to stochastic processes, random walk, Brownian motion, white noise, and colored noise processes. Stochastic differential equations, stochastic calculus, differential equations with random initial conditions, random forcing functions, random boundary conditions, random partial differential equations. New techniques for non-linear equations.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in (MATH 2041, MATH 2941, MATH 3041, or MATH 3941)

CEE 3211. Transportation Engineering. 3 Credit Hours.
The principal modes of transportation including highway, rail, and air; analysis of elements of transport technology; transportation system development, planning, design, construction, and maintenance.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 1105.

CEE 3311. Construction Engineering. 3 Credit Hours.
Contracts, construction contract documents, and construction specifications; estimating construction costs, planning and estimating earthwork, concrete formwork design and estimating; planning and scheduling construction projects, critical path method; project cash flow, funding and cost control; construction equipment: types, ownership and operating costs. Computer applications.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 2011.

CEE 3331. Soil Mechanics. 3 Credit Hours.
Soil as a multiphase material, strength and deformation properties, earth pressure, bearing capacity, stability of slopes, soils laboratory. Written reports and oral presentations required.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in ENGR 2333.

CEE 3332. Soil Mechanics Laboratory. 1 Credit Hour.
Students will work on teams, which will be responsible for performing laboratory work, analytic calculations, and report preparation associated with soil classification according to USCS and AASHTO systems and with soil compaction according to ASTM specifications.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in ENGR 2333.

CEE 3334. Structural Design of Pavements. 3 Credit Hours.
Basic characteristics of different pavement structures, various modes of failure and design of pavement structures, identification and analysis of stresses, strains and deflections in flexible and rigid pavements, computation of the traffic loading and volume for the structural design of pavements, engineering properties of pavement materials, pavement performance, distress, empirical and mechanistic-empirical approaches.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3331.

CEE 3411. Structural Analysis. 3 Credit Hours.
Elastic analysis of statically indeterminate structures using force and deformation methods. Introduction to numerical methods and computer techniques. The analysis includes determination of stresses and deflections using stiffness method, force method, and moment-distribution methods.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in ENGR 2333.

CEE 3412. Structural Analysis Laboratory. 1 Credit Hour.
Introduction to the basic theory and concepts of the Stiffness Method and the Finite Element Method. Students will gain experience in analyzing structural systems and structural mechanics by general-purpose finite element programs such as STAAD PRO and ANSYS.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in ENGR 2333.

CEE 3421. Steel Design. 3 Credit Hours.
Loadings on structures. Design criteria and procedures for steel members subjected to axial forces, bending and shear. Buckling of columns. Plastic design and load and resistances factor theories. Computer-based design methods are included.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3411.

CEE 3431. Concrete Design. 3 Credit Hours.
Load and strength factor design methods for plain and reinforced concrete elements of structural systems. Serviceability checks at service loads. Manual and computer-based design methods are included.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3411.

CEE 3441. Steel & Concrete Design. 4 Credit Hours.
The course's design objective is to develop within the student an awareness of the fundamentals that are required to produce safe, functional, and economical steel and reinforced concrete structures, which are in conformance with national building codes and with industry codes, specifications and standards and to formulate applied load criteria and make reasonable assumptions regarding structural behavior. Then through an interactive process, the student will determine the most cost-effective solution.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3411.

CEE 3611. Hydraulic Engineering. 3 Credit Hours.
The course deals with the design of hydraulic systems based on various flow regimes (laminar and turbulent). Students will learn to design pipe and network systems along with open channels. The design of various hydraulic structures such as, culverts and spillways, will be taught. Widely used software such as MWH Soft and HECRAS (US Army Corps of Engineers) will be taught and used in the class. Field studies will be conducted and students will get to experiment with various instruments used in water systems (e.g., pumps, flowmeters, diffuser, etc). NOTE: Prior to spring 2010, the course title was "Hydrology and Hydraulic Engineering."

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in ENGR 3553.

CEE 3711. Environmental Engineering. 3 Credit Hours.
Sources, effect, and control of environmental pollution. Topics include air and water pollution, solid and hazardous waste, noise, radiation and risk assessment. Effects across media, and applications to current concerns such as global warming and ozone depletion are emphasized. Course material and problem solving are reinforced through application of appropriate computer models.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1031 or CHEM 1035) and (MATH 1042, MATH 1942, or 'Y' in MATW)

CEE 3712. Environmental Fluids and Contaminant Dynamics. 3 Credit Hours.
Dynamics of fluids in motion; laminar and turbulent flow, Bernoulli's equation, friction in conduits; open-channel flow. Introduction to the processes controlling the migration and fate of chemicals in all phases of the environment, including surface and subsurface water as well as the atmosphere. Boundary layers, turbulence, mixing, convection, stratification and plumes and their impacts on contaminant dynamics will be discussed.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 2712, ENGR 2334, (MATH 2043 or MATH 2943), and (MATH 2041 (may be taken concurrently), MATH 2941 (may be taken concurrently), MATH 3041 (may be taken concurrently), or MATH 3941 (may be taken concurrently))

CEE 3715. Microbiological Principles of Environmental Engineering. 3 Credit Hours.
Introduction to underlying microbiological principles dealing with fate and transport of contaminants in the natural and built environment; reactor configurations for water and air quality control; and contaminant partitioning and contemporary environmental issues. The diverse roles of microorganisms in natural and engineered environments will be discussed.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 2712.

CEE 3717. Chemical Principles of Environmental Engineering. 3 Credit Hours.
Introduction to chemical equilibrium, thermodynamics and kinetics in water, atmosphere, and soils and sediments. The objective of this course is to develop a basis for understanding the behavior of chemical processes in the natural and built environment.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 2712.

CEE 3725. Water Quality and Analysis Lab. 1 Credit Hour.
Environmental lab methods to measure properties and characteristics of dissolved, particulate, and microbiological constituents in water, air, and soil systems.

Course Attributes: SE, SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3715 (may be taken concurrently) and CEE 3717 (may be taken concurrently)

CEE 3727. Environmental Hydrology and Stormwater Management. 3 Credit Hours.
The course covers the relationship between precipitation and runoff, unit hydrographs, flood routing, and water supply principles and applications. Impacts of improperly controlled runoff on urban streams and how the rate, volume and quality of urban stormwater runoff can be properly controlled through appropriate Best Management Practice (BMP) implementation.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 2043 or MATH 2943) and (CEE 3712 or ENGR 3553)

CEE 4040. Special Topics. 1 to 3 Credit Hour.
A course designed to present new and emerging areas of engineering. The course may also be used to present areas not normally taught in the College. Course requirements vary with the topic and instructor. Offered as needed or as appropriate.

Repeatability: This course may be repeated for additional credit.

CEE 4072. Update and Assessment. 3 Credit Hours.
The course objective is to facilitate the process of Civil Engineering, Senior-Level Students preparing for and taking the NCEES Fundamentals of Engineering (FE) Examination. Students will take in-class examinations on each review topic.

Class Restrictions: Must be enrolled in one of the following Classes: Senior 90 to 119 Credits, Senior/Fifth Year 120+ Credits.

Repeatability: This course may not be repeated for additional credits.

CEE 4201. Transportation Systems Management. 3 Credit Hours.
This course covers cost-effective techniques for the rebuilding of deteriorated transportation systems, pavement management and traffic systems management; extensive use of advanced computer software packages.

Repeatability: This course may not be repeated for additional credits.

CEE 4211. Bridge Engineering. 3 Credit Hours.
Design criteria, loads, construction techniques, state codes, superstructure components design-modeling and analysis, method, rating, computer software, detailing, new bridge, replacement, widening, rehabilitation, state codes, technical proposal, structural planning, feasibility studies, preliminary and final design, and post design services.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3441.

CEE 4221. Intelligent Transportation Systems. 3 Credit Hours.
To understand the multidimensional upgrades needed for highway and vehicles to develop intelligent transportation systems. The new system should be able to handle higher traffic safely in lesser time. Several case studies are an integral part of the course.

Repeatability: This course may not be repeated for additional credits.

CEE 4231. Airport Engineering. 3 Credit Hours.
This course deals with the various aspects of airport engineering, planning, design and development of 21st century airports. The course covers airport master and system planning, airside layout, landside access design, passenger and cargo facilities, terminal design, drainage and pavement design.

Repeatability: This course may not be repeated for additional credits.

CEE 4244. Introduction to Geosynthetics. 3 Credit Hours.
This course will enhance your critical understanding of Geosynthetic Materials used in civil engineering applications and develop the knowledge and skills required for designing and applying geosynthetic materials in civil engineering and environmental applications. Geosynthetics properties, testing of properties, design of geotextiles, geogrids, geonets, and geomembranes for applications in separation, pavement design, embankment and retaining wall reinforcement, soil stabilization, filtration, drainage and liquid barrier, construction guidelines and case histories. The module will also develop critical understanding of the processes and materials used for the manufacture of geosynthetic materials.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3331.

CEE 4301. Construction Administration. 3 Credit Hours.
The engineering and construction industry; basis of construction contracting; organizational structure and its functions; management structure and its functions, office administration, employment practices and labor relations; organizational financing and accounting; safety practices, risk management, and industrial insurance.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3311.

CEE 4302. Engineering Project Management. 3 Credit Hours.
Overview of the basic principles underlying all methods of project management, including project estimating, planning and scheduling, budgeting, cost accounting and cost control, project documentation, tracking and resource leveling. Utilization of project management software packages for selected civil engineering projects. Different types of projects, organizing the project management functions, setting up the project team, starting up and managing engineering projects and ensuring the effective completion of the project on time, within budget and meeting specifications.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3311.

CEE 4303. Construction Financial Management. 3 Credit Hours.
Overview of the basic principles underlying all methods of project management and financial accounting methods, construction cost accounting systems, construction project costing approaches, project budgeting, financial reporting procedure. Computer applications as required.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3311.

CEE 4312. Construction Equipment Management. 3 Credit Hours.
Concepts and theories of construction equipment operation and ownership costs and their relationship to production systems. Production planning and Productivity Analysis. Analysis of depreciation and fixed costs for equipment pricing on construction projects. Selection and use of construction equipment. Equipment economics and financing.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3311.

CEE 4321. Geotechnical Engineering. 3 Credit Hours.
Soil testing, site investigation, design of both shallow and deep foundations, bulkheads, soil-structure interaction and advanced topics in soil behavior and stability. Students are required to submit lab reports on the test results of various materials.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3331.

CEE 4421. Structural Dynamics. 3 Credit Hours.
Students are introduced to concepts in structural dynamics and their applications in structural engineering. Methods to determine dynamic response of single degree of freedom systems with free and forced vibrations are studied first, followed by similar concepts in multi#degree of freedom systems. Numerical methods to determine response over time will also be investigated.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3411, ENGR 2332, (MATH 2043 or MATH 2943), and (MATH 2041, MATH 2941, MATH 3041, or MATH 3941)

CEE 4431. Behavior and Design of Steel Structures. 3 Credit Hours.
Loadings on structures. Design criteria and procedures for steel members subjected to axial forces, bending and shear. Buckling of columns. Design of connections. Plastic design and load factor resistance theories. Computer-based design methods included.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3441.

CEE 4432. Behavior and Design of Reinforced Concrete Structures. 3 Credit Hours.
Behavior, analysis, and design of advanced reinforced concrete structures and components including columns subjected to flexure in one or two directions, slender columns, floor systems including two-way slabs, and analysis, design application using modern software.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3441.

CEE 4433. Behavior and Design of Masonry Structures. 3 Credit Hours.
Masonry materials, structural behavior of masonry assemblages, deformational characteristics of brick, block, and natural stone masonry. Performance of load-bearing wall systems, design of unreinforced and reinforced masonry members including beams, columns and pilasters, and walls; special design and construction topics; application of design to low and high-rise masonry buildings.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 3411.

CEE 4443. Finite Element Analysis. 3 Credit Hours.
Covers application of modern, computer-aided graphics techniques and the use of state-of-the-art, computer-aided design/drafting package(s) for finite element modeling. Includes 3-D modeling, solid modeling, shading, and rendering; and file transfer.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in (CEE 3411 and CEE 3412)

CEE 4445. Earthquake Engineering and Seismic Design. 3 Credit Hours.
Basic knowledge of and introduction to earthquake engineering, seismic design and analysis methods, and seismic design based on International Building Code (IBS), ASCE 7 - Minimum Design Loads for Buildings and Other Structures, introduction of material specific design requirement.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- in CEE 4421.

CEE 4446. Senior Design Project I for Civil Engineering. 3 Credit Hours.
This is the first course of a two-semester senior design sequence intended for civil engineering majors. Students will develop and practice skills and techniques for managing and executing engineering design projects. This includes problem identification, planning of the project, formulation of design specifications, the development and evaluation of alternative conceptual designs, the development of detailed designs and specification of manufacturing processes, prototyping of manufacturing processes, and analysis and documentation of results. At completion, students will present their design process and final design in several formats: oral presentations, poster presentations, web pages, and reports.

Field of Study Restrictions: Must be enrolled in one of the following Majors: Civil Engineering.
College Restrictions: Must be enrolled in one of the following Colleges: Engineering.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in CEE 3331, CEE 3332, ((CEE 3411 (D- or higher) and CEE 3412 (D- or higher)) or CEE 3711), ENGR 3553, and ENGR 3571.

CEE 4447. Senior Design Project I for Environmental Engineering. 3 Credit Hours.
This is the first course of a two-semester senior design sequence intended for environmental engineering majors. Students will develop and practice skills and techniques for managing and executing engineering design projects. This includes problem identification, planning of the project, formulation of design specifications, the development and evaluation of alternative conceptual designs, the development of detailed designs and specification of manufacturing processes, prototyping of manufacturing processes, and analysis and documentation of results. At completion, students will present their design process and final design in several formats: oral presentations, poster presentations, web pages, and reports.

Field of Study Restrictions: Must be enrolled in one of the following Majors: Environmental Enginrng.
College Restrictions: Must be enrolled in one of the following Colleges: Engineering.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3712, CEE 3715, CEE 3717, (CEE 3727 or CEE 4631), and CEE 4721.

CEE 4531. Life Cycle Assessment and Carbon Footprinting. 3 Credit Hours.
Life Cycle Analysis (LCA) examines the environmental impacts of products, processes and policies beyond their direct production. Cradle to grave analysis in this manner provides the full picture needed to understand the true impact. This course provides an overview of Life Cycle Assessment principles and practice in relation to environmental and energy concerns. Regulatory and economic decision support tools and software analysis packages will be included. The course is structured such that students will start an LCA from the beginning of the course and progress on it as topics are covered.

Course Attributes: SF, SP

Repeatability: This course may not be repeated for additional credits.

CEE 4622. Fate Pollutants in Subsurface Environments. 3 Credit Hours.
This course focuses on integrated chemical, physical, and microbiological principles of contaminant fate and transport processes necessary in the use of engineered approaches toward selecting and implementing subsurface cleanup options. It also covers abiotic processes, biotic processes, empirical models, and vulnerability mapping.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 4623. Contaminant Dynamics in Urban Streams. 3 Credit Hours.
Contaminant Dynamics in Urban Streams is designed to teach undergraduate students fundamental concepts of solute exchange at the air:water interface and the water:sediment interface. These systems are by definition boundary or edge systems and are therefore exceptionally important to aquatic ecosystem functioning. After briefly discussing the air:water interface in rivers and lakes, the course will focus on the water:sediment interface. It is here that steep gradients in chemical concentration can be found and significant nutrient cycling occurs. In addition, studies have shown that significant ecosystem productivity and respiration occurs within the bed sediments of flowing water. The course will discuss the concept of transient storage and hyporheic exchange; issues surrounding modeling of transient storage and hyporheic exchange; phosphorus and nitrogen biogeochemistry within the hyporheic zone; and biotic/abiotic nutrient cycling.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1031 or CHEM 1035) and (CEE 4631, CEE 4621, or CEE 3711)

CEE 4631. Environmental Hydrology. 3 Credit Hours.
A study of the physical laws affecting the occurrence, distribution, movement, storage, and contamination of water in watersheds. The physics of surface and subsurface circulation and storage of water and the transport of contaminants in watersheds, soils, aquifers, rivers, the ocean, and the atmosphere. The laws and equations which govern the recharge, flow, storage, and discharge of water in natural environments. The laws and equations governing the occurrence, absorption, propagation and fate of contaminants in natural environments. Hydrologic effects of global climate change. Engineering methods for the sustainable use of water resources. Engineering methods for the containment and treatment of surface and groundwater pollution, and the restoration of aquifers.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- (except where noted) in (MATH 2041, MATH 2941, MATH 3041, or MATH 3941) and (ENGR 3553 (C- or higher) or CEE 3712 (C- or higher))

CEE 4641. Urban Streams and Stormwater Management. 3 Credit Hours.
Stormwater management has become a significant issue in recent years. In the past, the typical thinking was 'get it out of my town' which resulted in downstream communities suffering the brunt of poor or inadequate management. In fact, only the rate of runoff was addressed, not the volume, nor the quality of that runoff. In urban areas, the volume of runoff increases significantly due to the additional impervious cover (e.g. pavement and rooftops) and urban stormwater runoff causes water quality degradation due to excess amounts of nutrients, metals, bacteria and sediment. This course will address the impacts of improperly controlled runoff on urban streams and how the rate, volume and quality of urban stormwater runoff can be properly controlled through appropriate Best Management Practice (BMP) implementation.

Field of Study Restrictions: Must be enrolled in one of the following Majors: Civil Engineering, Electrical Engineering, Environmental Enginrng, Mechanical Engineering.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CEE 2712 or CEE 3711 (may be taken concurrently))

CEE 4711. Air Pollution Control System. 3 Credit Hours.
Principles of design and operation of the major categories of air pollution control equipment. Theory and principles are presented to reinforce extensive application and design components.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in PHYS 1062 and (ENGR 3553 or CEE 3712)

CEE 4721. Water and Wastewater Systems Design. 3 Credit Hours.
Unit operations in water treatment, design objectives and parameters of water treatment; coagulation and flocculation; filtration plant design; physical unit operations; biological unit processes; design of facilities for biological treatment of waste water.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D- (except where noted) in (CEE 3711 or CEE 2712) and (ENGR 3553 (C- or higher) or CEE 3712 (C- or higher))

CEE 4722. Water/Wastewater Lab. 1 Credit Hour.
Quantitative laboratory studies of operations such as coagulation/flocculation, adsorption/ion exchange, filtration, disinfection, biological oxidation, advanced oxidation processes, and gas transfer. Laboratory safety and technical writing skills are emphasized. The course will include field trips to water and wastewater treatment plants as well as a solid waste management facility.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 4721 (may be taken concurrently)

CEE 4725. Environmental Systems Design. 3 Credit Hours.
Systems-based design and integration of various unit operations at treatment plants dealing with potable water, industrial wastewater, municipal wastewater, high purity industrial water, groundwater, and soil remediation.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CEE 3712 or ENGR 3553) and CEE 4721.

CEE 4731. Solid & Hazardous Waste Management. 3 Credit Hours.
This course covers the principles of integrated solid waste management. The planning and engineering principles needed to address the growing and increasingly intricate problem of controlling and processing the refuse (solid waste) created by urban societies. Federal regulations and management practices associated with hazardous waste are also covered. Situations dealing with real world settings are covered through worked examples and field trips to solid waste management facilities. NOTE: Prior to spring 2010, the course title was "Solid & Hazardous Waste Engineering."

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CHEM 1031.

CEE 4741. Professional Issues I. 1 Credit Hour.
This environmental engineering seminar series will focus on contemporary environmental topics, innovation, entrepreneurship, and life-long skills.

Class Restrictions: Must be enrolled in one of the following Classes: Senior 90 to 119 Credits, Senior/Fifth Year 120+ Credits.

Repeatability: This course may not be repeated for additional credits.

CEE 4742. Professional Issues II. 1 Credit Hour.
This environmental engineering seminar series will focus on contemporary environmental topics, innovation, entrepreneurship, and life-long skills.

Class Restrictions: Must be enrolled in one of the following Classes: Senior 90 to 119 Credits, Senior/Fifth Year 120+ Credits.

Repeatability: This course may not be repeated for additional credits.

CEE 4761. Environmental Chemistry. 3 Credit Hours.
This is an advanced course focusing on examination of processes that affect the behavior and fate of anthropogenic organic contaminants in aquatic environments. The lectures will begin with intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physicochemical transformation reactions of organic contaminants. From this class, students will learn to predict chemical properties and to apply the knowledge of chemical properties and transformation reactions to assess the environmental fate of organic contaminants.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CHEM 2201.

CEE 4762. Environmental Organic Chemistry. 3 Credit Hours.
This is an advanced course focusing on examination of processes that affect the behavior and fate of anthropogenic organic contaminants in aquatic environments. The lectures will focus on intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physiochemical transformation reactions of organic contaminants.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CHEM 2201.

CEE 4773. Sustainability Aspects of Water Supply and Wastewater Treatment. 3 Credit Hours.
Major environmental, economic and social trends are influencing the application of sustainability principles within the engineering profession. This course will examine the sustainability principles that will transform future engineering practice regarding drinking water supply and the treatment of wastewater. The term, wastewater, will be replaced by one more representative of the fact that 'wastewater' is in fact a largely untapped source of raw materials. It is in the areas of energy recovery, small molecule harvesting, and the water energy nexus where the next generation of environmental engineers will have a major impact on meeting societal needs regarding the provision of adequate drinking water as well as industrial requirements for this increasingly scarce resource. The course will introduce the underlying principles of sustainability directly relevant to meeting this need. Case studies will evaluate the above mentioned principles and the applicable areas of energy, chemical intermediates, and reclamation of previously used water, with a focus on dealing with emerging microconstituents in the water environment.

Course Attributes: SE, SF, SP, SS

Repeatability: This course may not be repeated for additional credits.

CEE 4775. Biological Principles of Environmental Engineering Systems. 3 Credit Hours.
Applications of biological processes in environmental engineering are historic and eminently modern, from traditional ones like activated sludge and anaerobic digestion to emerging applications like detoxification of hazardous chemical and bio-filtration of drinking water. This course is designed to identify the biological principles essential for the understanding and designing of biological processes used for environmental protection and improvement. Recent development of environmental bio-technologies such as ANAMMOX, membrane bioreactors, and algal bioreactors will be discussed in detail. This course emphasizes the comprehension of theoretical concepts and their application in a variety of situations. It covers the fundamental biological principles by their practical applications in engineered and natural environments.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 2712.

CEE 4811. Advanced Soil Mechanics. 3 Credit Hours.
Advanced concepts related to behavior of soil as an engineering material. Topics include consolidation magnitude and time rate, evaluation of secondary compression, mitigation of consolidation of settlements, shear strength of soils and other geologic materials, principles of critical state soil mechanics, and normalization of undrained shear strength.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3331.

CEE 4821. Foundation Engineering. 3 Credit Hours.
Principles of foundation engineering and design. Topics include soil stress distributions, bearing capacity of shallow (footings, mats) and deep foundations (driven piles, drilled shafts), tolerable settlements, construction techniques, and field quality control.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3331.

CEE 4822. Earth Retaining Systems. 3 Credit Hours.
Principles related to design of earth retaining systems and stability of earth slopes. Topics include lateral earth pressure theory, temporary and permanent retaining structures, in-situ reinforcement, and braced evacuations. Shear strength of cohesive and granular soils and slope stability analysis using limited equilibrium, design charts and numerical methods.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3331.

CEE 4823. Geotechnical Earthquake Engineering. 3 Credit Hours.
An introduction to seismology and earthquake hazards in geotechnical engineering. Topics include plate tectonics and earthquake faulting, strong ground motions, dynamic soil properties, and characterization of design ground motions based on deterministic and probabilistic seismic hazard analysis. Analysis of earthquake-induced ground failures, seismic design of earth retaining systems and slopes, and effects of soil-structure interaction.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in CEE 3331.

CEE 4871. Fundamentals of Engineering in Civil Engineering. 1 Credit Hour.
Review of subject areas in preparation for the Fundamentals of Engineering examination in Civil Engineering.

Repeatability: This course may not be repeated for additional credits.

CEE 4882. Independent Study in Civil Engineering. 2 to 5 Credit Hours.
Student may complete a regular course during semester the course is not offered to meet prerequisite or graduation requirements. NOTE: An instructor is assigned to supervise the student.

Repeatability: This course may be repeated for additional credit.

CEE 4883. Directed Study in Civil Engineering. 1 to 4 Credit Hour.
An opportunity to study specialized topics not covered in currently available courses and providing significant progress towards the technical/professional objectives of the program. An instructor is assigned to define the scope and direct, supervise, and evaluate student progress.

Repeatability: This course may be repeated for additional credit.

CEE 4891. Independent Research in Civil Engineering. 2 to 5 Credit Hours.
A project assigned with the approval of the department chair and conducted under the supervision of a faculty sponsor.

Repeatability: This course may be repeated for additional credit.

CEE 5048. Probability and Statistics in Engineering. 3 Credit Hours.
This course is designed to build a conceptual background in probability, statistics, and stochastic analysis. It prepares the graduate student for research in uncertainty analysis and stochastic models in engineering. It begins by building a solid integrated background on the subjects that conform uncertainty analysis in engineering: probability, statistics, and stochastic modeling. The theory is complemented with numerous exercises of application in engineering uncertainty analysis, and with computer simulations using modern computer algebra software, such as MAPLE. Students are gradually taken to more advanced subjects and eventually to the analysis of differential equations subject to random initial conditions, random forcing terms, and random parameters. Partial differential equations and nonlinear stochastic equations are treated.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5058. Probability Statistics in Engineering. 3 Credit Hours.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5110. Special Topics. 3 Credit Hours.
Special topics courses are developed to cover emerging issues or specialized content and they do not repeat material presented by regular semester courses.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 5201. Transportation Systems Management. 3 Credit Hours.
This course covers cost-effective techniques for the rebuilding of deteriorated transportation systems; pavement management and traffic systems management; extensive use of advanced computer software packages.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5202. Transportation Engineering. 3 Credit Hours.
This course focuses on the principal modes of transportation, including highway, rail, and air; analysis of elements of transport technology; and transportation system development, planning, design, construction, and maintenance.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5203. Structural Design of Pavements. 3 Credit Hours.
This course covers basic characteristics of different pavement structures; various modes of failure and design of pavement structures; identification and analysis of stresses; strains and deflections in flexible and rigid pavements; computation of traffic loading and volume for the structural design of pavements; engineering properties of pavement materials; pavement performance and distress; and empirical and mechanistic-empirical approaches.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5211. Bridge Design. 3 Credit Hours.
The course covers bridge design in structural steel and reinforced concrete; application of AASHTO bridge design specifications; and analysis techniques for complex structures. Preliminary designs include investigating alternative structural systems and materials. Final designs include preparation of design calculations and sketches.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5212. Transportation Engineering Materials. 3 Credit Hours.
Topics include physical properties of asphalt, aggregates, portland cement, portland cement concrete, and their combinations; advanced techniques in material characterization in the lab and the field; material variability, sampling, and statistical techniques; and the impact of these properties on their characterization of the design, construction, rehabilitation, and management of transportation facilities, including portland cement concrete pavements with steel reinforcement; construction methodologies, recycling, and energy consideration; and application of the state-of-the-art computer software packages.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5221. Intelligent Transportation Systems. 3 Credit Hours.
Coverage embraces the multidimensional upgrades needed for highway and vehicles for developing intelligent transportation systems. Contributions from important related fields such as telecommunications, safety, management, urban and regional planning, and economics where they interface with transport are included. Several case studies constitute an integral part of the course.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5231. Airport Engineering. 3 Credit Hours.
This course deals with the various aspects of airport engineering, planning, design and development of 21st century airports. The course covers airport master and system planning, airside layout, landside access design, passenger and cargo facilities, terminal design, drainage and pavement design.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5241. Pavement Management and Traffic Systems Management. 3 Credit Hours.
The course covers development of management methods for analysis, planning, design, construction, maintenance, and rehabilitation of pavements and traffic systems. The objective functions include creation of more efficient use of existing facilities through improved management and operation of vehicles and roadway.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5244. Introduction to Geosynthetics. 3 Credit Hours.
This course will enhance your critical understanding of Geosynthetic Materials used in civil engineering applications and develop the knowledge and skills required for designing and applying geosynthetic materials in civil engineering and environmental applications. Geosynthetics properties, testing of properties, design of geotextile, geogrids, geonets, and geomembranes for applications in separation, pavement design, embankment and retaining wall reinforcement, soil stabilization, filtration, drainage and liquid barrier, construction guidelines and case histories. The module will also develop critical understanding of the processes and materials used for the manufacture of geosynthetic materials.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5251. Pavement Rehabilitation and Maintenance. 3 Credit Hours.
The course covers fundamental behavior of materials used in building pavements. These materials include aggregate mixtures, asphalt binders and mixtures, and Portland cement concrete. The course covers methods of field construction and quality control of materials and their impact on long term performance. The course helps students understand the role of material properties in design of pavements including cost analysis. Students will learn testing methods, selection criteria, and standard specifications. Finally, the students will use accumulated knowledge through the course to understand strategies of pavement rehabilitation and maintenance. Principles of asset management will be introduced in the course to optimize maintenance and rehabilitation interventions for improving longevity.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5301. Construction Administration. 3 Credit Hours.
The course focuses on the engineering and construction industry; the basis of construction contracting; organizational structure and its functions; management structure and its functions; office administration, employment practices, and labor relations; organizational financing and accounting; and safety practices, risk management, and industrial insurance.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5302. Engineering Project Management. 3 Credit Hours.
This course provides an overview of the basic principles underlying all methods of project management, including project estimating, planning and scheduling, budgeting, cost accounting and cost control, project documentation, tracking and resource leveling. It also focuses on utilization of project management software packages for selected civil engineering projects; different types of projects; organizing the project management functions; setting up the project team; starting up and managing engineering projects; and ensuring the effective completion of the project on time, within budget, and meeting specifications.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5303. Construction Financial Management. 3 Credit Hours.
Coverage includes project development in construction, project budgeting and job costing approaches, cost management and financing alternatives, evaluation of financial and accounting objectives required with each project, forecasting cash needs and profit, and financial reporting procedures.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5312. Construction Equipment Management. 3 Credit Hours.
This course focuses on the concepts and theories of construction equipment operation, ownership costs, and their relationship to production systems; analysis of depreciation and fixed costs for equipment pricing on construction projects; selection and use of construction equipment; and equipment economics and financing.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5321. Geotechnical Engineering. 3 Credit Hours.
This course deals with soil testing, site investigation, design of shallow and deep foundations, earth retaining structures, and advanced topics in soil behavior and stability.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5411. Structural CADD Systems. 3 Credit Hours.
Topics include behavior and analysis of simple and complex structures subjected to dynamic loads; using exact and approximate analytical techniques; determination of free response and force response using modal superposition and numerical integration; review of the characteristics of earthquakes with consideration of site and structural parameters on the response of buildings; and application of analysis and design procedures required to achieve earthquake-resistant structures in accordance with building code specifications.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5421. Structural Dynamics. 3 Credit Hours.
This design course addresses developments in theory and practice of earthquake engineering. It familiarizes students with new techniques of analysis and seismic design. Students learn advanced concepts in applied mathematics, especially structural dynamics and application of seismic building and bridge codes. Familiarity with differential equations, matrix methods of analysis, non-linear equations, eigenvalue solutions, and finite elements modeling are required. Students are instructed to learn and apply new software for dynamic analysis. Laboratory work includes the study of experimental models such as for bridge piers (frames, walls, and hammerhead columns) using an MTS machine for applying dynamic loads.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5431. Behavior and Design of Steel Structures. 3 Credit Hours.
The course's design objective is to develop within the student an awareness of the fundamentals required to produce safe, functional, and economical steel structures, which are in conformance with national building codes and industry specifications and standards. This is an advanced course in structural engineering intended to develop professional-level competence in the design of steel-framed buildings, utilizing the most up-to-date design code.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5432. Structural Mechanics. 3 Credit Hours.
Topics include principles of mechanics and stress and strain at a point; analysis of statically determinate and indeterminate structures with static and moving loads using energy methods and force and deformation methods; beam theory, shear center, unsymmetrical bending, introduction to numerical methods, and computer techniques; and introduction to the use of the GT-STRUDAL and ANSYS computer programs.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5433. Behavior and Design of Masonry Structures. 3 Credit Hours.
Coverage includes the fundamental principles of masonry behavior and design. In this course, up-to-date information about material testing, research methodology in the area of masonry structures, and codes are presented. The first part of the course presents the fundamental behavior and characteristics of masonry materials and masonry assemblages, the deformational characteristics of brick and block masonry, performance of load-bearing wall systems and shear wall system, the design of unreinforced and reinforced masonry elements, and the construction details of masonry structures. The second part of the course concentrates on the seismic resistance of masonry structures, prestressed masonry, and applied design of low and high-rise buildings.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5434. Behavior and Design of Reinforced Concrete Structures. 3 Credit Hours.
Behavior, analysis, and design of advanced reinforced concrete structures and components including columns subjected to flexure in one or two direction, slender columns, floor systems including two-way slabs, and analysis, design application using modern software.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5445. Earthquake Engineering and Seismic Design. 3 Credit Hours.
Basic knowledge of and introduction to earthquake engineering, seismic design and analysis methods, and seismic design based on International Building Code (IBS), ASCE 7 - Minimum Design Loads for buildings and other structures, introduction of material specific design requirement.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5446. Advanced Concrete Technology. 3 Credit Hours.
This course focuses on theoretical and practical aspects of concrete technology. It covers the principles of cement and concrete production, concrete mixture design, strength and durability requirements (i.e., performance engineered mixture design), and environmental effect. It introduces concepts of construction with green cementitious materials (e.g., supplementary and alternative cementitious materials). Specific concepts include understanding the mechanisms, test methods, and evaluation procedures of main durability and sustainability issues in concrete infrastructure. Concrete related guidelines and specifications will be introduced.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5531. Life Cycle Assessment and Carbon Footprinting. 3 Credit Hours.
Life Cycle Assessment (LCA) examines the environmental impacts of products, processes and policies beyond their direct production. Cradle to grave analysis in this manner provides the full picture that is needed to understand the true impact. This course provides an overview of Life Cycle Assessment principles and practice in relation to environmental and energy concerns. Regulatory and economic decision support tools and software analysis packages will be included. The course is structured such that students will start an LCA from the beginning of the course and progress on it as topics are covered.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
College Restrictions: Must be enrolled in one of the following Colleges: Engineering.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5621. Engineering Hydrology. 3 Credit Hours.
Quantifying water flow in watersheds is a crucial step in the design of environmental facilities, such as drinking water treatment plants, and in delineating floodplains. This course deals with the water cycle over watersheds by addressing the motion of water masses in the atmosphere and in surface and subsurface systems. Students who successfully pass this class are able to deal with most hydrology problems treated in the industry sector.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5622. Fate of Pollutants in Subsurface Environments. 3 Credit Hours.
This course focuses on integrated chemical, physical, and microbiological principles of contaminant fate and transport processes necessary in the use of engineered approaches toward selecting and implementing subsurface cleanup options. It also covers abiotic processes, biotic processes, empirical models, and vulnerability mapping.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5623. Contaminant Dynamics in Urban Streams. 3 Credit Hours.
This course will focus on environmental systems near the air:water and water:sediment interfaces. These systems are by definition boundary or edge systems and are therefore exceptionally important to aquatic ecosystem functioning. After briefly discussing the air:water interface in rivers and lakes, the course will focus on the water:sediment interface. It is here that steep gradients in chemical concentration can be found and significant nutrient cycling occurs. In addition, studies have shown that significant ecosystem productivity and respiration occurs within the bed sediments of flowing water. The course will discuss the concept of transient storage and hyporheic exchange; issues surrounding modeling of transient storage and hyporheic exchange; phosphorus and nitrogen biogeochemistry within the hyporheic zone; and biotic/abiotic nutrient cycling.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

CEE 5631. Environmental Hydrology. 3 Credit Hours.
Topics include the physics of surface and subsurface circulation and storage of water and the transport of contaminants in watersheds, soils, aquifers, rivers, the ocean, and the atmosphere, as well as the laws and equations that govern the recharge, flow, storage, and discharge of water in natural environments. Emphasis is given to qualitative analysis and quantitative evaluation methods of the different hydrologic processes with potential applications in surface and groundwater resources engineering, and environmental analysis. Analytical and numerical procedures to solve the arising equations are presented, along with the most commonly used models to solve water resources problems. Also studied are engineering methods for the sustainable use of water resources; engineering methods for the containment and treatment of surface and groundwater pollution; and the restoration of aquifers.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5641. Urban Streams and Stormwater Management. 3 Credit Hours.
Stormwater management has become a significant issue in recent years. In the past, the typical thinking was "get it out of my town," which resulted in downstream communities suffering the brunt of poor or inadequate management. In fact, only the rate of runoff was addressed, not the volume nor the quality of that runoff. In urban areas, the volume of runoff increases significantly due to additional impervious cover (e.g., pavement and rooftops), and urban stormwater runoff causes water quality degradation due to excess amounts of nutrients, metals, bacteria, and sediment. This course addresses the impact of improperly controlled runoff on urban streams and how the rate, volume, and quality of urban stormwater runoff can be properly controlled through appropriate Best Management Practice (BMP) implementation.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5701. Physical Principals of Environmental Systems. 3 Credit Hours.
Basic principles of process engineering as they relate to pollution control are studied, including heat and mass transfer; mixing, chemical, and biological reactions; and reaction and kinetics.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5702. Chemical Principles of Environmental Systems. 3 Credit Hours.
This course focuses on the essential chemical principles necessary to understand the nature of commonly occurring pollution problems and engineering approaches to their solutions; thermodynamics, chemical equilibria, acid-base chemistry, carbonate system, Redox chemistry, and adsorption/desorption phenomena.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5703. Mathematical Modeling. 3 Credit Hours.
This introductory graduate course focuses on numerical modeling of engineering systems. It covers standard mathematical techniques, such as interpolation, numerical integration, numerical solutions of ordinary and partial differential equations, parameter estimation, and optimization. Students will have to use an algorithmic programming language, such as Matlab, Fortran, or C++.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5711. Air Pollution Control. 3 Credit Hours.
Topics include theory and principles of the design and operation of the major categories of air pollution control equipment, and an introduction to dispersion modeling. An extensive design problem is a major course component.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5721. Weather Monitoring and Forecasting. 3 Credit Hours.
This online course will offer a basic understanding of measurements of the atmosphere used for weather analysis and forecasting. Data from instruments such as weather balloons, radar, lightning mapping arrays, and satellites will be included. Special emphasis will be on interpreting satellite imagery and use in weather forecasting and warnings. Students will have the opportunity to learn to interpret real-time data online, and to make their own weather forecasts. The course will be taught primarily online, though one or two on-campus meetings may be required during the semester.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5731. Solid Wastes Engineering. 3 Credit Hours.
Coverage includes engineering principles of solid waste generation, characterization, collection and transport, separation, source reduction and recycling, and physical chemical and biological treatment strategies.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5751. Water and Wastewater Treatment. 3 Credit Hours.
This course covers the design and analysis of common unit operations at water and wastewater treatment plants such as type I-IV sedimentation, coagulation and flocculation; filtration; disinfection, and biological processes.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5761. Environmental Chemistry. 3 Credit Hours.
This is an advanced course focusing on examination of processes that affect the behavior and fate of anthropogenic organic contaminants in aquatic environments. The lectures will begin with intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physicochemical transformation reactions of organic contaminants. From this class, students will learn to predict chemical properties and to apply the knowledge of chemical properties and transformation reactions to assess the environmental fate of organic contaminants.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5762. Environmental Organic Chemistry. 3 Credit Hours.
This is an advanced course focusing on examination of processes that affect the behavior and date of anthropogenic organic contaminants in aquatic environments. The lectures will focus on intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physiochemical transformation reactions of organic contaminants.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5771. Chemistry for Environmentally Sustainable Engineering. 3 Credit Hours.
This course is a survey of environmental chemistry as it relates to the development of environmentally sustainable engineered systems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5772. Sustainable Development and Industrial Ecology. 3 Credit Hours.
As an introduction to the concepts of industrial ecology and sustainability, the course focuses on an interdisciplinary framework for the design and operation of industrial systems as living systems interdependent with natural systems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5773. Sustainability Aspects of Water Supply and Wastewater Treatment. 3 Credit Hours.
Major environmental, economic and social trends are influencing the application of sustainability principles within the engineering profession. This course will examine the sustainability principles that will transform future engineering practice regarding drinking water supply and the treatment of wastewater. The term, wastewater, will be replaced by one more representative of the fact that 'wastewater' is in fact a largely untapped source of raw materials. It is in the areas of energy recovery, small molecule harvesting, and the water energy nexus where the next generation of environmental engineers will have a major impact on meeting societal needs regarding the provision of adequate drinking water as well as industrial requirements for this increasingly scarce resource. The course will introduce the underlying principles of sustainability directly relevant to meeting this need. Case studies will evaluate the above mentioned principles and the applicable areas of energy, chemical intermediates, and reclamation of previously used water, with a focus on dealing with emerging microconstituents in the water environment.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5774. Membrane Separation in Wastewater Treatment. 3 Credit Hours.
The course describes in detail membrane separation technology for a wide range of applications including water treatment and desalination. The course covers: global water shortages and need for membrane technology, microfiltration, ultrafiltration, nanofiltration and reverse osmosis membrane processes and current applications in water treatment, operational and energy issues, limitations, fouling and membranes processes coupled with biological treatment. The course is valuable as a prerequisite to more advanced research in environmental engineering, as a technical education to stimulate graduate students' interest in environmental sustainability, and as an introduction to environmental constraints that are increasingly important to other engineering disciplines.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5792. Biological Principles of Environmental Systems. 3 Credit Hours.
Applications of biological processes in environmental engineering are historic and eminently modern, from traditional ones like activated sludge and anaerobic digestion to emerging applications like detoxification of hazardous chemical and biofiltration of drinking water. This course is designed to identify the biological principles essential for the understanding and designing of biological processes used for environmental protection and improvement. While many biological processes are being employed and developed by environmental engineers, there is no place in the standard civil engineering curriculum for detailed discussion on the underlining principles and their applications. This course emphasizes the comprehension of theoretical concepts and their application in a variety of situations. It covers the fundamental biological principles by their practical applications in engineered and natural environments.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5793. Environmental Biotechnology. 3 Credit Hours.
Biotechnology plays a central role in environmental science and engineering, including wastewater treatment, pathogen control, and biodegradation. The objective of the course is to provide environmental engineers and scientists with advanced concepts and quantitative tools that are necessary for understanding environmental processes and designing environmental protection systems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5794. Advanced Biological Wastewater Treatment. 3 Credit Hours.
Biological processes play a central role in wastewater treatment and are used in every wastewater treatment plant to remove organic compounds, nutrients, and other compounds from the water before discharging it back to the environment. The objective of the course is to provide environmental engineers and scientists with advanced concepts and quantitative tools necessary for understanding environmental processes and designing environmental treatment systems related to wastewater including advanced aerobic and anaerobic processes. The course integrates the use of microbiological principles into engineering wastewater treatment process. The course will provide a better understanding of interesting and complex environmental topics related to sustainable environmental remediation and protection. The course is valuable as a prerequisite to more advanced research in environmental engineering, as a technical education to stimulate graduate students' interest in environmental sustainability, and as an introduction to environmental constraints that are increasingly important to other engineering disciplines.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5795. Aquatic Toxicology in Environmental Engineering. 3 Credit Hours.
This course provides an introduction to the basic concepts of toxicology necessary to understand the effects of contaminants in the water environment. Specific topics include sources and classes on aquatic contaminants, environmental chemistry that influences behavior in the aquatic environment, the disposition and metabolism of these substances that affect their toxicity, and the physiological response of exposure in aquatic species and humans. The course will provide an overview of aquatic toxicity testing methods and application of toxicity data in the risk assessment of aquatic exposures to emerging contaminants, such as pesticides, pharmaceuticals, and natural products. Case studies will cover historical and contemporary examples of contaminant-driven effects.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 5799. Environmental Engineering. 3 Credit Hours.
This course focuses on the generation, transport, effects, and control of environmental pollution within and across media, as well as problem analysis and control design. Theoretical development is augmented with applications of state-of-the-art software packages. Students complete a term project.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5811. Advanced Soil Mechanics. 3 Credit Hours.
Advanced concepts related to behavior of soil as an engineering material. Topics include consolidation magnitude and time rate, evaluation of secondary compression, mitigation of consolidation of settlements, shear strength of soils and other geologic materials, principles of critical state soil mechanics, and normalization of undrained shear strength.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5821. Foundation Engineering. 3 Credit Hours.
Principles of foundation engineering and design. Topics include soil stress distributions, bearing capacity of shallow (footings, mats) and deep foundations (driven piles, drilled shafts), tolerable settlements, construction techniques, and field quality control.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5822. Earth Retaining Systems. 3 Credit Hours.
Principles related to design of earth retaining systems and stability of earth slopes. Topics include lateral earth pressure theory, temporary and permanent retaining structures, in-situ reinforcement, and braced evacuations. Shear strength of cohesive and granular soils and slope stability analysis using limited equilibrium, design charts and numerical methods.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 5823. Geotechnical Earthquake Engineering. 3 Credit Hours.
An introduction to seismology and earthquake hazards in geotechnical engineering. Topics include plate tectonics and earthquake faulting, strong ground motions, dynamic soil properties, and characterization of design ground motions based on deterministic and probabilistic seismic hazard analysis. Analysis of earthquake-induced ground failures, seismic design of earth retaining systems and slopes, and effects of soil-structure interaction.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 8302. Advanced Project Management. 3 Credit Hours.
This course covers analysis of project control, job budgeting and costing, safety and risk management, bidding strategies and management, construction information management, and case studies of construction projects and company profiles.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

CEE 8701. Advanced Physical/Chemical Treatment Processes. 3 Credit Hours.
There are numerous sites in the environment where surface water, ground water or soil is contaminated with toxic chemicals. In addition, many industrial wastewater and air emissions contain toxic chemicals which required treatment. Due to the chemical toxicity, we rely on physical and chemical processes for the decontamination of the fluid stream. Some of the commonly used treatment technologies are carbon absorption, air stripping and scrubbing. Of late, advanced oxidations processes have been examined and implemented as well. These processes are also used to produce high quality drinking water. The course deals with the analysis and design of some commonly used advanced physical/chemical processes for treatment of contaminated water and air. This course complements, and builds upon the fundamental science discussed in other courses in the curriculum on physical and chemical principles. In this course, emphasis will be placed on understanding the basic science, and the engineering design principles. Treatment of water, wastewater and air using processes such as air stripping, scrubbing, carbon absorption and advanced oxidation processes will be discussed, and design of the treatment systems will be conducted.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 8702. Advanced Chemical Principles of Environmental Systems. 3 Credit Hours.
This is an advanced course focusing on examination of processes that affect the behavior and fate of anthropogenic organic contaminants in aquatic environments. The lectures will focus on intermolecular interactions and thermodynamic principles governing the kinetics of some of the important chemical and physiochemical transformation reactions of organic contaminants.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 8703. Computer Modeling of Environmental Transport. 3 Credit Hours.
Topics include theory and computer modeling of transport and diffusion within and across media; and application of models to problems of air, water, and soil pollution with case studies.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

CEE 9182. Independent Study I. 3 Credit Hours.
Special study in a particular aspect of engineering under the direct supervision of a graduate faculty member. May be taken once by MS/MSE students and once by Ph.D. students.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9282. Independent Study II. 3 Credit Hours.
Special study in a particular aspect of engineering under the direct supervision of a graduate faculty member. May be taken once by Ph.D. students.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9991. Directed Research. 1 to 6 Credit Hour.
Under the guidance of a faculty member, the student conducts independent research on a selected topic in engineering.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9994. Preliminary Examination Preparation. 1 to 6 Credit Hour.
This course is intended for Ph.D. students who have completed their coursework but who have not yet passed both the Ph.D. Preliminary Examination.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9995. Project. 1 to 3 Credit Hour.
A project is assigned with the approval of the Civil and Environmental Engineering Graduate Committee and conducted under the supervision of a graduate faculty advisor. An oral presentation in an open seminar and a written report are required to complete the independent project. Projects related to industrial applications are encouraged. For non-thesis students only.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9996. Thesis. 1 to 3 Credit Hour.
Master's thesis. May be taken twice.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9998. Pre-Dissertation Research. 1 to 6 Credit Hour.
This course is intended for Ph.D. students who have passed both the Preliminary and Qualifying Examinations but who have not been elevated to candidacy.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

CEE 9999. Dissertation Research. 1 to 6 Credit Hour.
This course is intended only for those students who have achieved Ph.D. Candidacy status. A minimum of 6 semester hours is required for graduation.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
Student Attribute Restrictions: Must be enrolled in one of the following Student Attributes: Dissertation Writing Student.

Repeatability: This course may be repeated for additional credit.