CIVIL & ENVIRONMENTAL ENGINEERING

Courses

CEE 101. Introduction to Civil Engineering. 0-1 Hours
Introduction to the civil engineering faculty, facilities, and curriculum; to the career opportunities offered by the civil engineering profession; and to the areas of specialization within civil engineering.

CEE 198. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CEE 213. Surveying. 3 Hours
An introduction to surveying and geomatics, with emphasis to theory of measurements and computation errors, leveling and traverse computations. topographic surveys, computations of earthwork, slope staking and stake out of highway curves. First term, each year. Prerequisite(s): MTH 168.

CEE 221L. Civil Computation Laboratory. 2 Hours
Introduction to numerical methods and logical problem solving techniques commonly used in the civil engineering profession. Introduction to computer aided drawing and design and the use of popular CADD packages in the civil engineering profession.

CEE 298. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CEE 300. Professional Development Seminar. 0 Hours
Practice in the presentation and discussion of papers; lectures by staff and prominent engineers. Attendance required of all civil engineering juniors.

CEE 311L. Civil Engineering Materials Laboratory. 2 Hours
Laboratory experiments in the physical and mechanical properties of construction materials; Portland cement concrete, bituminous materials, wood, ferrous and non-ferrous metals, and masonry units; proportioning of concrete mixtures including admixtures. Prerequisite(s): EGM 303.

CEE 312. Geotechnical Engineering. 3 Hours
Principles of soil structures, classification, capillarity, permeability, flow nets, shear strength, consolidation, stress analysis, slope stability, lateral pressure, bearing capacity, and piles. Second term, each year. Prerequisite(s): EGM 303. Corequisite(s): GEO 218.

CEE 312L. Geotechnical Engineering Laboratory. 1 Hour
Laboratory tests to evaluate and identify soil properties for engineering purposes. Design problems are also included. Second term, each year. Corequisite(s): CEE 312.

CEE 313. Hydraulics. 3 Hours
Basic principles of fluid mechanics in closed conduits and open channels. Principles include fluid statics, conservation of mass, conservation of momentum, conservation of energy, and fluid dynamics. Presentation of fluid mechanics principles through the solution of practical problems and a comprehensive semester project. Prerequisites: EGM 202. Corequisites: CEE 313L.

CEE 313L. Hydraulics Laboratory. 1 Hour
Laboratory experiments and problems associated with CEE 313. Corequisite(s): CEE 313.

CEE 316. Analysis of Structures I. 3 Hours
Elastic analysis of structures; deflection, moment-area theorems; conjugate-beam; virtual work influence lines; analysis of indeterminate structures using force methods; theories of failure, stiffness matrices, and use of software to analyze structures. Prerequisite(s): EGM 303.

CEE 333. Water Resources Engineering. 3 Hours
Integrated study of the principles of water movement and management. Focus areas include hydrology, water distribution, storm water management, and waste water collection. Second semester, each year. Prerequisite(s): CEE 313.

CEE 398. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CEE 400. Professional Development Seminar. 0 Hours
Practice in the presentation and discussion of papers; lectures by staff and prominent engineers. Attendance required of all civil engineering seniors. Prerequisites: CEE 300 or COP 101.

CEE 403. Transportation Engineering. 3 Hours
Fundamentals of transportation engineering, including design, construction, maintenance, and economics of transportation facilities. Design of pavement structures and drainage systems. Prerequisites: Junior or senior status and CEE 213.

CEE 411. Design of Steel Structures. 3 Hours
Design and behavior of structural steel connections, columns, beams, and beams subjected to tension, compression, bending, shear, torsion, and composite action. Second semester, each year. Prerequisite(s): CEE 316.

CEE 412. Design of Concrete Structures. 3 Hours
Design and behavior of reinforced concrete slabs, beams, columns, walls, and footings subjected to tension, compression, bending, shear, and torsion. First semester, each year. Prerequisites: CEE 311L; CEE 312; CEE 316.

CEE 421. Construction Engineering. 3 Hours
Organization, planning, and control of construction projects, including a study of the use of machinery, methods, materials, estimates, cost controls, and fundamentals of CPM and PERT. Contracts and bonds and legal aspects of contracting. Engineering economics including present and annual worth analysis, evaluation of alternatives.

CEE 422. Design & Construction Project Management. 3 Hours
Fundamentals of project management as they relate to the design and construction professional, and the application of project management techniques to the design and construction of major projects. Departmental elective.

CEE 424. Foundation Engineering. 3 Hours
Review of soil properties, site exploration and evaluation, bearing capacity, settlements, shallow foundations, retaining structures, and deep foundations. Prerequisite(s): CEE 312.

CEE 426. Risk and uncertainty analysis for infrastructures. 3 Hours
Study of the principles of reliability, risk, and uncertainty quantification for infrastructures. It covers the methodologies for modeling risk and uncertainty in engineering practices and the analysis of its effects on infrastructure design, operation, and maintenance. Prerequisites: MTH 169.

CEE 427L. Civil Data Analytics Laboratory. 2 Hours
An introduction to data analytics most commonly used to preprocess, process, analyze, and visualize data in the context of civil engineering problems. Topics include various types of civil engineering testing, monitoring, and inspection data, methods for statistical inference and parameter estimation from observed data, linear regression, correlation analysis, classification and clustering analysis, and results visualization. Prerequisites: MTH 169; CEE 426.

CEE 430. Introduction to Environmental Engineering. 1 Hour
This is an introductory course for civil engineering students in the non-environmental track to gain a basic understanding of the physical, chemical, and biological processes of water and wastewater treatment. Prerequisites: CHM 123; CHM 123L.

CEE 433. Water Resources Engineering. 3 Hours
Integrated study of the principles of water movement and management. Focus areas include hydrology, water distribution, storm water management, and waste water collection. Second semester, each year. Prerequisites: CEE 313.

CEE 434. Water & Wastewater Engineering. 3 Hours
Problems of water pollution; development and design of public water supply and waste water treatment systems; legal, political, ethical, and moral considerations. First term, each year. Prerequisites: CHM 123. Corequisites: CEE 313, CEE 434L.

CEE 434L. Water & Wastewater Engineering Laboratory. 1 Hour
Laboratory exercises, demonstrations, and design problems associated with water and wastewater engineering. First semester, each year. Prerequisite(s): CHM 123L. Corequisite(s): CEE 434.

CEE 450. Civil Engineering Design. 3 Hours
A small group (3-5 people) design of a complete, large-scale civil engineering system. The capstone design experience draws upon knowledge acquired over a wide spectrum of civil engineering subjects including environmental, geotechnical, structural, transportation and water resources engineering as well as project management. Second semester, each year. Prerequisites: CEE 333, CEE 403, CEE 411, CEE 412, CEE 424, CEE 434, Student may take any 2 out of these 6 courses to meet the prerequisite needed for CEE 450; This is changed from the previous requirement of 4 out of these 6 courses needed prior to taking CEE 450.

CEE 451L. Capstone Design I. 2 Hours
This course is the first course in a two-course sequence that culminates the major engineering design experience in the Civil Engineering program. Students will participate in civil engineering projects; incorporate appropriate engineering standards and codes; and will address multiple realistic constraints including, but not limited to, economic, environmental and societal constraints. This is accomplished within a framework where they integrate their previously acquired fundamental engineering knowledge and benefit from guidance provided by mentors who are practicing civil engineers from industry. Students form multidisciplinary design teams, work on real-world civil engineering projects, develop multiple conceptual design solutions, and prepare a draft technical report, which includes a detailed scope of work, a poster, and an oral presentation. Prerequisites: Senior standing and have completed one area of specialty from the six civil engineering specialty areas shown below: Construction (CEE 421), Transportation (CEE 403), Geotechnical (CEE 424), Water Resources (CEE 333), Environmental (CEE 434), Structures (CEE 411 or CEE 412). Corequisites: Concurrently taking a minimum of two courses from the reminder of the six specialty areas shown above, and pursuing courses in the selected CEE or SEE minor or one approved by the chair of CEE advisor.

CEE 452L. Capstone Design II. 2 Hours
This course is the second course in a two-course sequence that culminates the major engineering design experience in the Civil Engineering Program. Students will build on the work they completed in CEE 451. Teams will finalize design solutions, evaluate cost, study constructability, and consider the safety, public health, social, environmental, and sustainable impacts of their designs. Each student will evaluate their solutions against requirements, considering risks, and making trade- offs, for the purpose of obtaining a high-quality solution under the given circumstances. An oral presentation, technical report, and technical drawings documenting the students' solution is required at the completion of the project. The primary goal of CEE 452 is to replicate the same design experience that students will encounter when they enter the workforce. Prerequisites: CEE 451L. Corequisites: Attempting the remaining courses in the selected CEE or SEE minor or one approved by the chair of CEE.

CEE 463. Hazardous Waste Treatment. 3 Hours
The fundamental principles of the design and operation of hazardous waste control and hazardous substances remediation processes. Hazardous waste regulations, risk assessment, and management. Department Elective. Prerequisite(s): CHM 124.

CEE 467. Sustainable Water and Waste Infrastructure. 3 Hours
Study of current issues and emerging approaches to provide sustainable municipal water and waste management. Includes evaluation of equitable access to these services and consequences from these practices. Prerequisite(s): (CHM 123 or ECO 203) and (MTH 129 or MTH 138 or MTH 148 or MTH 168).

CEE 493. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program.

CEE 494. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program. Prerequisite(s): CEE 493.

CEE 498. Research & Innovation Laboratory. 1-6 Hours
Students participate in (1) selection and design, (2) investigation and data collection, (3) analysis and (4) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

CEE 499. Special Problems in Civil Engineering. 1-6 Hours
Particular assignments to be arranged and approved by chairperson of the department. Departmental elective.

CEE 500. Advanced Structural Analysis. 3 Hours
Frames of variable cross-section; arches; flat and folded plates; elastic stability of columns, frames, and plates; cylindrical, spherical, and barrel shells; structural dynamics of beams and frames. Required background: CEE 317 or equivalent.

CEE 501. Structural Analysis by Computer. 3 Hours
Review of force and displacement methods. Introduction to direct element and substructure methods. Students write and execute computer programs to analyze plane and space trusses, grids, and frames. Required background: CEE 317 or equivalent.

CEE 502. Prestressed Concrete. 3 Hours
Discussion of the properties of concrete and prestressed steel. Theory and design of prestressed concrete beams, slabs, columns, frames, ties, and circular tanks. Prerequisites: UG CEE 412 GR/DO None.

CEE 503. Introduction to Continuum Mechanics. 3 Hours
Tensors, calculus of variations, Lagrangian and Eulerian descriptions of motion. General equations of continuum mechanics, constitutive equations of mechanics, thermodynamics of continua. Specialization to cases of solid and fluid mechanics. Required background: EGM 303 or equivalent.

CEE 504. Structural Dynamics. 3 Hours
The response of undamped and damped single and multi-degree-of-freedom structures subjected to harmonic, periodic, and general dynamic loadings. Special topics include nonlinear structural response, response spectra, shear buildings, and simple systems with distributed properties. Required background: CEE 316 or permission of instructor.

CEE 505. Plastic Design in Steel. 3 Hours
Analysis and design procedures based on ultimate load capacity applied to steel beams, frames, and their connections. Concept of the plastic hinge, necessary conditions for the existence of plastic moment, instability, deformations, repeated and reversed loading, and minimum weight design. Required background: CEE 411 or equivalent.

CEE 506. Design of Temporary Structures. 3 Hours
Design and analysis of temporary structures including loading, shoring, formwork, falsework, scaffolding, ground support systems, bracing, soldier beam and lagging, sheet piling, equipment bridges, and support of existing structures. Required background: Analysis of Structures Prerequisites: UG CEE 316, GR/DO None.

CEE 507. Masonry Design. 3 Hours
Properties and performance criteria of bricks, concrete blocks, mortar, and grout; codes and construction practices; design of masonry elements. Required background: CEE 316 or equivalent.

CEE 508. Design Timber Structures. 3 Hours
Study of basic wood properties and design considerations. Design and behavior of wood connectors, fasteners, beams, columns, and beam-columns. Introduction to plywood and glued laminated members. Analysis and design of structural diaphragms and shear walls. Required background: CEE 316 or permission of instructor.

CEE 509. Bridge Engineering. 3 Hours
Design and engineering of modern steel and concrete bridge structures; loading; analysis; design. Required background: CEE 316 or equivalent. Concurrency requirement: CEE 411 and CEE 412. Corequisites: CEE 411, CEE 412.

CEE 511. Experimental Stress Analysis. 3 Hours
A study of the experimental analysis of stress as an aid to design for strength and economy with emphasis on electrical strain gages. Also, photoelasticity, brittle coatings, analogies, structural similitude. Two hours lecture and one three-hour laboratory period per week. Required background: EGM 303 or equivalent.

CEE 512. Data Analytics for Engineering Applications. 3 Hours
This course is designed to provide students opportunities to learn how state-of-the-art data analytics technologies can generate useful information from data to improve cost, time, quality, and safety performances of engineering systems. Key topics that will be covered in this course include: probabilistic concepts, statistical learning, and machine learning. Basic programming for implementing data analytics algorithms is presented. Methodologies for identifying data analytics needs, evaluating its usefulness, and estimating its economic potential are also addressed. Required background: MTH 168 or equivalent courses.

CEE 513. Bayesian Learning and Engineering applications. 3 Hours
The goal of this course is to provide a broad introduction to the key ideas and concepts in Bayesian machine learning and uncertainty quantification and their applications in recent engineering research and design practices. It is aimed at advanced undergraduates or graduate students. The emphasis will be on some selected intuition and practical examples rather than heavy theoretical results, though some experience with probability, statistics, and linear algebra will be important. Through a variety of lecture examples, students will learn how to apply uncertainty quantification techniques to get the confidence intervals of the predictions from a machine learning model and how to use the results as a critical basis for the following decision-making in relevant engineering practices. Hands-on programming skills using Python packages will be covered as well. Prerequisites are basic linear algebra, calculus, or permission of instructor.

CEE 514. Design & Construction Project Management. 3 Hours
Fundamentals of project management as they relate to the design and construction professional, and the application of project management techniques to the design and construction of major construction projects. The course provides a tour of project management knowledge areas and how they are applied to successfully develop and execute a construction project.

CEE 515. Pavement Engineering. 3 Hours
Fundamental principles of flexible and rigid highway and airport pavement design, construction, and management. Prerequisites: UG CEE 403 GR/DO None.

CEE 516. Managing Construction Field Operations. 3 Hours
This course is the first of two construction management courses and covers: life-cycle of construction management efforts from pre-construction services through to project close-out; planning and managing a construction job site each day – including health, safety and quality activities; managing technical submittals and field challenges, development of construction execution strategies reflecting decisions related to approaches for and coordination among various construction disciplines (civils, steel, mechanical/HVAC, electrical); and selection of construction equipment.

CEE 517. Management of Construction Organization. 3 Hours
This course is the second of two graduate construction management courses and covers: planning and managing construction labor productivity, construction, quality, health, safety, security, and environmental topics; organizational development (including management of labor force); administering contracts; cash flow forecasting, construction accounting principles, managing information, and communications; and effective operations reporting.

CEE 518. Procurement & Contract Management for Construction Projects. 3 Hours
This course covers the fundamentals of procurement and contracting management as they relate to the construction professional. Topics include procurement and contract strategy, use of standard contract models such as AIA, EJCDC, Consensus Docs in the United States and NEC, FIDIC, JCT outside of the United States, principles in the allocation of risks between owner and contractor, review and use of key provisions in design and construction contracts, construction contractor's use of purchase orders and subcontracts, and dealing with changes, disputes, and claims. The course will also cover use of design-build contracts and CMAR (construction management at risk) for construction projects.

CEE 519. Risk Management for Construction Projects. 3 Hours
This course covers the fundamentals of risk management for construction projects, with an emphasis on qualitative and quantitative risk analysis as well as treatment of these risks. The first portion of the course will concentrate on qualitative risk analysis and cover the development of risk management plan, identification, and prioritization of risks, development of risk registers, and probability-impact matrices. The second portion of the course will focus on quantitative risk analysis and cover the development of cost and schedule models, conducting a Monte Carlo simulation of these models, and interpreting the results. The third and last portion of the course will discuss the treatment of risks, including the development of risk mitigation strategies and risk response plans. The course will include use of risk simulation software.

CEE 520. Advanced Geotechnical Engineering. 3 Hours
Advanced study of Geotechnical engineering principles and study. Stress-strain characteristics; constitutive relationships; failure theories; dynamic soil properties; difficult soils; soil improvement; stability of earth slopes. Required background: CEE 312 or equivalent.

CEE 522. Subsurface Investigations. 3 Hours
Soil & rock classification; Geophysical methods; subsurface explorations; soil sampling; van shear, standard penetration, cone penetration, pressuremeter, dilatometer, and plate load testing; in-situ measurements; field instrumentation. Prerequisites: UG CEE 312 GR/DO None.

CEE 524. Foundation Engineering. 3 Hours
Application of Geotechnical engineering principles of analysis and design of shallow and deep foundations and earth retaining structures. Topics include site exploration and characterization, foundation types, bearing capacity, settlement analysis, shallow foundation design, earth pressures theories, design of retaining walls, flexible retaining structures and braced excavations, design of pile foundations and drilled piers. Prerequisites: UG CEE 312 GR/DO None.

CEE 525. Soil Improvement. 3 Hours
Principles of various mechanisms and technologies for improving soils in situ, design consideration and design methods, construction technologies, including construction equipment and construction process, performance specifications, quantity and cost estimate, sustainability consideration, quality assurance, and acceptance criteria, decision making, and construction optimization, case studies. Required background: CEE 312 or equivalent.

CEE 526. Retaining Structures & Slopes. 3 Hours
Earth pressure theories; design of earth retaining structures, such as rigid walls, anchored sheet pile walls, and reinforced soil structures; stability of excavation, cut, and natural slopes; slope stabilization methods. Prerequisites: UG CEE 312 GR/DO None.

CEE 528. Soil Dynamics & Earthquake Engineering. 3 Hours
Soil behavior under dynamic loading conditions; foundation design for vibratory loadings; introductory earthquake engineering; field and laboratory techniques for determining dynamic soil properties and liquefaction potential. Prerequisites: UG CEE 312 GR/DO None.

CEE 533. Theory of Elasticity. 3 Hours
Three-dimensional stress and strain at a point; equations of elasticity in Cartesian and curvilinear coordinates; methods of formulation of equations for a solution, plane stress, and plane strain, energy formulations, numerical solution procedures. Required background: EGM 303 or equivalent. Corequisites: EGM 503.

CEE 534. Theory of Plates & Shells. 3 Hours
Theory of plates; small and large displacement theories of thin plates; shear deformation; buckling; sandwich plate theory. Thin shell theory; theory of surfaces; thin shell equations in orthogonal curvilinear coordinates; bending, membrane, and shallow shell theories. Required background: EGM 533 or equivalent.

CEE 535. Advanced Mechanical Vibrations. 3 Hours
Review of undamped, damped, natural, and forced vibrations of one and two degrees of freedom systems. Lagrange's equation, eigenvalue/eigenvector problem, modal analysis for discrete and continuous systems. Computer application for multi-degree of freedom, nonlinear problems. Required background: MEE 319 or equivalent; computer programming.

CEE 539. Theory of Plasticity. 3 Hours
Fundamentals of plasticity theory including elastic, viscoelastic, and elastic-plastic constitutive models; plastic deformation on the macroscopic and microscopic levels; stress-strain relations in the plastic regime; strain hardening; limit analysis; numerical procedures. Required background: EGM 503 or EGM 533 or equivalent.

CEE 540. Composites Design. 3 Hours
Design with fiber-reinforced composite materials. Fiber and resin selection, laminate design, bending and torsion of stiffening elements, open and filled holes, joining methods, fatigue, damage tolerance, building-block approach, design allowables. Required background: EGM 303 or equivalent.

CEE 541. Mechanics of Composite Materials. 3 Hours
Introduction to the mechanical response of fiber-reinforced composite materials with emphasis on the development of experimental methodology. Analytical topics include stress-strain behavior of anisotropic materials, laminate mechanics, and strength analysis. Theoretical models are applied to the analysis of experimental techniques used for characterizing composite materials. Lectures are supplemented by laboratory sessions in which characterization tests are performed on contemporary composite materials. Required background: EGM 303 or equivalent.

CEE 543. Analytical Mechanics Composite Materials. 3 Hours
Analytical models are developed for predicting the mechanical and thermal behavior of fiber-reinforced composite materials as a function of constituent material properties. Both continuous and discontinuous fiber-reinforced systems are considered. Specific topics include basic mechanics of anisotropic materials, micro-mechanics and lamination theory, free-edge effects, and failure criteria. Required background: EGM 303 or equivalent.

CEE 546. Finite Element Analysis I. 3 Hours
Fundamental development of the Finite Element Method (FEM), and solution of field problems and comprehensive structural problems. Variational principles and weak, forms; finite element discretization; shape functions; finite elements for field problems; bar, beam, plate, and shell elements; isoparametric finite elements, stiffness, nodal force, and mass matrices; matrix assembly procedures; computer coding techniques; modeling decisions; program output interpretation. Emphasis on a thorough understanding of FEM theory and modeling techniques. Required background: CEE 503 or CEE 533 or equivalent.

CEE 550. Highway Geometric Design. 3 Hours
Advanced topics in horizontal and vertical alignment design controls and criteria, sight distance, intersection, and interchange design. Prerequisites: UG CEE 403 GR/DO None.

CEE 551. Traffic Engineering. 3 Hours
Characteristics of traffic, including the road user, vehicle, traffic control devices, accident analysis, signal operations, and design and the fundamentals of signal system progression. Prerequisites: UG CEE 403 GR/DO None.

CEE 552. Intelligent Transportation Systems. 3 Hours
Fundamentals of planning, design, deployment, and operations of ITS. Integrated application of ITS architecture, traffic flow principles, advanced equipment, communications technologies, and management strategies to provide traveler information and increase the safety and efficiency of the surface transportation system. Prerequisites: UG CEE 403 GR/DO None.

CEE 553. Travel Demand Modeling. 3 Hours
Introduction to the theory, concepts, and methods underlying the practice of urban travel demand modeling. The course involves model data inputs, model development, forecasting applications, and model evaluation techniques. Prerequisites: UG CEE 403, GR/DO None.

CEE 554. Urban Public Transportation. 3 Hours
Planning and analysis of urban public transportation service and operations with a focus on bus and rail modes. Provides fundamental knowledge and methods for route and network planning, service planning and analysis, performance monitoring, operations control, and frequency and headway determination. Prerequisites: UG CEE 403, GR/DO None.

CEE 555. Highway Traffic Safety. 3 Hours
Issues involved in transportation safety, strategic highway safety planning at state and local levels. The extent of the highway safety problem, elements of traffic accidents, common accident countermeasures, collection and analysis of accident data, evaluation of safety-related projects and programs, and litigation issues. Prerequisites: UG CEE 403, GR/DO None.

CEE 558. Traffic Engineering Research. 3 Hours
Practical problems in control or capacity restraints based on studies of actual local situations. Prerequisites: UG CEE 403, GR/DO None.

CEE 560. Biological Processes in Wastewater Engineering. 3 Hours
Measuring the characteristics of wastewater produced from domestic and industrial sources. Principles of designing and operating microbiological processes for the treatment of wastewater. Mechanisms and kinetics of biological reactions are emphasized. Prerequisites: UG College level general chemistry, GR/DO None.

CEE 562. Physical & Chemical Water & Wastewater Treatment Processes. 3 Hours
Principles and design of physical and chemical unit processes to treat water and wastewater. Industry pretreatment technologies and the basis for their development. Prerequisites: UG CHM 124; CEE 434 or CME 406, GR/DO None.

CEE 563. Hazardous Waste Engineering. 3 Hours
The fundamental principles of the design and operation of hazardous waste control and hazardous substances remediation processes. Hazardous waste regulations, risk assessment, and management. Prerequisites: UG College level chemistry, GR/DO None.

CEE 564. Solid Waste Engineering. 3 Hours
Characterizing solid waste. Managing solid waste collection, transport, minimization, and recycling. The design of solid waste disposal and resource recovery facilities.

CEE 574. Fundamentals of Air Pollution Engineering I. 3 Hours
Air pollution, combustion fundamentals, pollutant formation and control in combustion, pollutant formation and control methods in internal combustion engines, particle formation in combustion. Required background: CME 311 or MEE 301 or equivalent; CME 324 or MEE 410 or equivalent or permission of instructor.

CEE 575. Fundamentals of Air Pollution Engineering II. 3 Hours
Review of the concepts of air pollution engineering; aerosols; removal of gaseous pollutants from effluent streams; optimal air pollution control strategies. Required background: CME 574 or equivalent or permission of instructor.

CEE 576. Environmental Engineering Separation Processes. 3 Hours
Discussion of the unit operations associated with environmental engineering separation processes of solid-liquid, liquid-liquid, and gas-liquid systems; general use, principles of operation, and design procedures for specific types of equipment. Instructor permission is required.

CEE 580. Hydrology & Seepage. 3 Hours
A detailed study of the hydrologic cycle with a focus on rainfall/runoff generation techniques. The practical application of hydrologic fundamentals is demonstrated through the design of urban stormwater systems. Introduction to sub-surface hydrology and groundwater modeling. Prerequisites: UG CEE 312; CEE 333 GR/DO None.

CEE 582. Advanced Hydraulics. 3 Hours
Detailed examination of unsteady flow in closed conduits and open channels. Practical methods for solving water hammer and flood routing problems are presented. Physical modeling integrated with dimensional analysis and similitude is presented. Prerequisites: UG CEE 313; CEE 333 GR/DO none.

CEE 584. Open Channel Flow. 3 Hours
Open channel flow in its various forms will be studied. Major topics to be covered include energy and momentum principles, uniform and gradually varied flow. This course will concentrate on one-dimensional steady-state flow with an emphasis on the use of widely-used computer simulation models to determine water surface profiles and to examine flooding in urban areas. Erodible and non-erodible channel design is also covered. Prerequisites: UG CEE 313; CEE 333 GR/DO None.

CEE 585. Advanced Open Channel Flow. 3 Hours
This course builds upon concepts presented in CEE 584 with a special emphasis on one-dimensional and two-dimensional unsteady flow in open channels. Other topics to be covered include modeling hydraulic structures including bridges, culverts, in-line structures, and lateral structures. Widely used computer simulation models will be used to solve practical problems associated with advanced open channel flow. Required background: CEE 584 or equivalent. Prerequisites: CEE 584.

CEE 590. Selected Readings in Civil Engineering. 3 Hours
Directed readings in a designated area arranged and approved by the student's faculty advisor and the department chair. May be repeated.

CEE 595. Special Problems in Civil Engineering. 0-3 Hours
Special assignments in civil engineering subject matter to be arranged and approved by the student's advisor and the department chair.

CEE 598. Project. 3 Hours
Project in Civil and Environmental Engineering.

CEE 599. Thesis. 1-6 Hours
Thesis in Civil and Environmental Engineering.