CEE - Civil and Environmental Engineering

CIVIL AND ENVIRONMENTAL ENGINEERING Courses

CEE 111. Information Literacy and Research. 2 Credits.
This course will introduce students to the needs, access, evaluation, use, impact and ethical/legal aspects of information, as well as to the application of information literacy and research in the fields of civil and environmental engineering. Prerequisite: ENGN 110.

CEE 195. Topics in Civil and Environmental Engineering. 1-3 Credits.
Special topics in civil and/or environmental engineering at the introductory level. Prerequisite: Permission of the department chair.

CEE 204. Statics. 3 Credits.
Introduction to engineering problems and their solutions through a study of the statics of particles and rigid bodies. Pre- or corequisite: PHYS 231N. Prerequisite: MATH 211 with a C or higher.

CEE 205. Engineering Dynamics. 3 Credits.
This course is designed to assist engineering students in acquiring a more thorough knowledge and proficiency in engineering mechanics. The course follows CEE 204 in the mechanics sequence. In this course, kinematics of particles and rigid bodies, mass moments of inertia, acceleration, work, energy, power, and special applications in the civil engineering field, such as inertia problems in vehicle collisions, rumdiments of wave dynamics, etc. are included. Prerequisite: CEE 204 with a grade of C or better.

CEE 219. Surveying for Engineers. 1 Credit.
This course will provide an introduction to Land Surveying theory and practices as they relate to Civil Engineering. Upon successful completion of this course, prospective engineers will have a working knowledge of: survey computations; survey field methods; survey benchmarks and data; survey elements of land development; and survey legal issues.

CEE 220. Mechanics of Deformable Bodies. 3 Credits.
This course provides fundamental theories to understand the strength of materials focused on civil engineering applications. It will cover stress-strain relationship, equilibrium of deformable bodies and behavior of axially loaded members. It will also analyze for stresses, strains, and deformation of members subjected to torsions in both elastic and inelastic ranges. Other topics, such as buckling and stability of columns, Mohr circle, and energy methods will also be discussed. Prerequisites: CEE 204 with a grade of C or better.

CEE 240. Geographic Information Systems in Civil and Environmental Engineering. 3 Credits.
Geographic Information Systems as they apply to civil and environmental engineering. Spatial data acquisition, generation and analysis methods from terrestrial, aerial and satellite sources. Modeling of terrain, land, and hydrographic information using CADD. Use of GIS software in the creation and application of GIS spatial data bases to engineering problems. Prerequisite: MATH 212, sophomore standing or higher.

CEE 295. Topics in Civil and Environmental Engineering. 1-3 Credits.
Topics in civil and/or environmental engineering at the basic engineering level. Prerequisite: Permission of the department chair.

CEE 304. Probability Statistics and Risk in Civil and Environmental Engineering. 3 Credits.
CEE infrastructure systems definitions and methodology. CEE economics basics and use. Probability theory and applications. Statistics parameters, functions, variance, regression, and correlation analysis. Professional practice issues of ethics, licensure, procurement of work, and professional interaction. Prerequisite: junior standing in CEE.

CEE 305. Civil and Environmental Computations. 4 Credits.
Introduction to selected numerical methods and their specific application to solving problems in many of the areas of civil and environmental engineering. Further development of computer programming proficiency. Prerequisites: junior standing and MATH 307.

CEE 310. Structures I. 3 Credits.
Analysis of statically determinate structures. Influence lines and structural design. Displacement calculations. Introduction to analysis of indeterminate structures. Prerequisites: CEE 220 with a grade of C or better.

CEE 320. Civil Engineering Materials. 3 Credits.
Properties of steel, portland cement concrete, bituminous concrete, aggregates, and timber. Prerequisites: CEE 220.

CEE 323. Soil Mechanics. 3 Credits.
Fundamental engineering properties of soil and their application to earth structures and foundations. Topics include seepage, compaction, strength, and deformation characteristics of soils. Corequisite: CEE 324. Prerequisite: CEE 220.

CEE 324. Soil Mechanics Laboratory. 1 Credit.
Performance of various soil mechanics tests, including gradation, index testing, compaction, density, permeability, consolidation, shear tests for soils are conducted for students to gain hands-on experiences. The relevant principles are covered in CEE 323. Corequisite: CEE 323. Prerequisites: Junior standing.

CEE 330. Hydromechanics. 3 Credits.
Fluid properties, fluid statics and fundamentals of fluid kinematics. Steady, incompressible conservation laws for mass, momentum and energy including real fluid energy losses. Turbulent, incompressible fluid flows in closed conduits and with a free surface. Introduction to thermodynamics. Prerequisites: MATH 212 and CEE 205 or MAE 205.

CEE 340. Hydraulics and Water Resources. 3 Credits.
Analysis of closed-conduit flow and open-channel flow. Principles of surface water hydrology and groundwater hydraulics. Economics and probability concepts in water resources planning. Corequisite: CEE 341. Prerequisites: CEE 304; CEE 330 with a grade of C or better.

CEE 341. CE Hydraulics and Water Resources Laboratory. 1 Credit.
Performing various labs and experiments for hydraulics, hydrology, and water resources for students to gain hands-on experiences. The relevant principles are covered in CEE 340. Corequisite: CEE 340. Prerequisites: Junior standing.

CEE 350. Environmental Pollution and Control. 3 Credits.
Introduction to the fundamental principles of environmental engineering. Topics in water quality, water and wastewater treatment, air quality, and solid waste and landfills are discussed. Prerequisites: CHEM 121N-CHEM 122N, MATH 211, PHYS 231N.

CEE 367. Cooperative Education. 1-3 Credits.
May be repeated for credit. Available for pass/fail grading only. Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and Career Development Services prior to the semester in which the work experience is to take place. Prerequisites: approval by the department and Career Development Services prior to the semester in which the work experience is to take place.

CEE 368. Internship. 1-3 Credits.
May be repeated for credit. Available for pass/fail grading only. Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students to gain short duration career-related experience. Prerequisites: approval by department and Career Development Services.

CEE 369. Practicum. 1-3 Credits.
May be repeated for credit. Available for pass/fail grading only. Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students to gain short duration career-related experience. Prerequisites: approval by department and Career Development Services.
CEE 370. Transportation Fundamentals. 3 Credits.
This course surveys the current practice of transportation engineering in the United States. It focuses on various ground transportation modes and covers policy, institutional planning and operational issues. Students are introduced to planning models, capacity analysis, and traffic impact analysis. Prerequisite: Junior standing.

CEE 395. Topics. 1-3 Credits.
Topics in civil and/or environmental engineering. Prerequisite: permission of the instructor.

CEE 401. Civil Engineering Design Project and Professional Practice I. 3 Credits.
The course is an introduction to the design process used for the development of contract documents for the construction of infrastructure. It involves applying the theory of multiple disciplines of civil engineering to the design of a sustainable project. It introduces the skills necessary to plan, manage and prepare construction drawings, technical specifications, cost estimates and bid schedules necessary to prepare design and construction documents needed for bidding projects. Prerequisites: Senior standing.

CEE 402. Professional Practice of Engineering. 1 Credit.
The course will cover the practice and business aspects of engineering including concepts in management, business, public policy, and leadership. It will also cover public and private procurement of work, project management and execution, responsibility to clients, contracting, project finances, professional liability, and public safety. Prerequisite: Senior standing.

CEE 403W. Civil Engineering Design Project and Professional Practice II. 3 Credits.
For graduating seniors only. Group design project of civil engineering systems requiring synthesis, data gathering, preliminary investigation, master planning, conceptual designs, layouts, support studies, cost estimates and report writing. Emphasis will be on alternatives, constraints, economics, ethics and professional practice, business and project management, public policy and leadership. This is a writing intensive course. Prerequisites: grade of C or better in CEE 401, ENGL 211C or ENGL 221C or ENGL 231C.

CEE 410. Concrete Design. 3 Credits.
Fundamental concepts of reinforced concrete analysis and design by ultimate strength and working stress methods. Prerequisites: CEE 310 with a grade of C or better.

CEE 412/512. Computational Methods in Structures. 3 Credits.
Analysis of 2-D and 3-D determinate and indeterminate truss/beam/frame structures by the unified direct stiffness matrix method, for both hand-calculation and computer implementation. Popular commercialized (NASTRAN) software will also be discussed. Prerequisites: CEE 310.

CEE 414/514. Masonry Structures Design. 3 Credits.
Masonry materials, reinforced beams and lintels, walls, columns and pilasters, shear walls, and buildings. Prerequisite: CEE 310.

CEE 415/515. Steel Structures Design. 3 Credits.
Load and resistance factor design methods for steel structures. Prerequisite: CEE 310.

CEE 416/516. Wood Structures Design. 3 Credits.
Design of wood structures based on national design specification and load and resistance factor design. Prerequisite: CEE 310.

CEE 430/530. Foundation Engineering. 3 Credits.
Subsurface exploration, site preparation, design of shallow and deep foundations, and retaining structures. Prerequisites: CEE 323 with a grade of C or better.

CEE 431/531. Earth Structures Design with Geosynthetics. 3 Credits.
Seepage and stability analysis and design of manmade and natural slopes and retaining structures. Applications of geosynthetic material to seepage control, reinforcement of earth works, and containment of hazardous materials. Prerequisite: CEE 323.

CEE 432/532. Introduction to Earthquake Engineering. 3 Credits.
An overview of earthquake processes and details of the characteristics of destructive ground motion; the effects of such motion on civil engineering structures; reviews of current design practice in mitigating earthquake hazards for various civil engineering structures such as buildings, bridges, dams, lifelines, ports and harbors, etc. Prerequisites: senior standing and permission of the instructor.

CEE 433/533. Geomaterials Stabilization. 3 Credits.
This course studies soil and aggregate's physical, chemical and biological stabilization procedures. Students are introduced to chemical stabilization analysis and design using materials such as cement, lime, and fly ash. Prerequisites: CEE 323.

CEE 440/540. Hydraulic Engineering. 3 Credits.
Hydraulic transients; flow control structures; computer analysis of hydraulic systems; design of pipelines, open channels and culverts. Prerequisite: CEE 340.

CEE 446/546. Urban Stormwater Hydrology. 3 Credits.
Storm rainfall analysis, design rainfall hyetographs, runoff calculation procedures, detention basins, use of mathematical models to analyze and design urban storm drainage systems. Prerequisite: CEE 340.

CEE 447/547. Groundwater Hydraulics. 3 Credits.
Description of well hydraulics in single and multiple well systems. Determination of aquifer parameters from pumping tests. Use of computer models to determine drawdowns due to multiple well systems. Prerequisite: CEE 340.

CEE 450/550. Water Distribution and Wastewater Collection System Design. 3 Credits.

CEE 451. Water and Wastewater Treatment. 3 Credits.
Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment facilities. Prerequisites: CEE 330, CEE 350.

CEE 452/552. Air Quality. 3 Credits.
Study of air quality management standards and regulations and pollutant dynamics. Design and operation of emission control equipment for mobile and stationary sources of air pollution. Prerequisite: CEE 350.

CEE 454/554. Hazardous Waste Treatment. 3 Credits.
Study of sources, generation rates and characteristics of hazardous wastes and their regulation, handling, and design of treatment and disposal facilities. Prerequisite: CEE 350.

CEE 455/555. Pollution Prevention and Green Engineering. 3 Credits.

CEE 458/558. Sustainable Development. 3 Credits.
Overview of social, economical, technical environmental aspects of regional, national and international efforts to achieve sustainable development. Discussion of the integration of industrial activity and ecological concerns utilizing principles of zero emissions, pollution prevention and design for the environment. Prerequisite: junior standing or permission of instructor. (WEB Based, On-Line Course).
CEE 459/559. Biofuels Engineering. 3 Credits.
Course covers the overview of renewable energy sources; fundamentals of biofuels; biomass and types of biomass (e.g., woody biomass, forest residues, agricultural residues, energy crops); composition of lignocelluloses (cellulose, hemicellulose, and lignin); biomass conversion technologies; thermochemical, supercritical water, and biochemical conversion processes; types of biofuels from biomass; liquid fuels (bioethanol, bio-oil, biodiesel, and hydrocarbons); gaseous fuels (synthesis gas, hydrogen, biodiesel); solid fuels (biochar, torrefied biomass); biodiesel from vegetable oils, algae to biofuels; value-added processing of biofuel residues; economic and environmental assessments; policies and future R&D. Prerequisite: permission of the instructor.

CEE 471/571. Transportation Operations I, 3 Credits.
This is the first course in transportation operations and traffic flow theory. Topics include traffic engineering studies, capacity analysis, intersection control, traffic flow models, shockwave analysis, signal warrant analysis, and safety analysis. Course includes applications of modeling and simulation to isolated intersections. Prerequisite: CEE 370.

CEE 474/574. Transportation Data Analytics, 3 Credits.
This course presents the basic techniques for transportation data analytics. It will discuss statistical modeling, prominent algorithms, and visualization approaches to analyze both small- and large-scale data sets generated from transportation systems. Practices of using different data for various real-world traffic/transportation applications and decision making will also be discussed. Prerequisites: Basic probability and statistics (e.g., STAT 330); any programming language such as C, Python or Java is beneficial but not required.

CEE 482/582. Introduction to Coastal Engineering, 3 Credits.
Classical small amplitude wave theory, wave transformations in shallow water, shoaling, refraction, diffraction, reflection, breaking. Wave induced near shore currents and sediment transport processes. Alternatives to mitigate coastal erosion processes. Introduction to coastal structures. Prerequisites: CEE 330 and permission of the instructor.

CEE 495/595. Topics in Civil and Environmental Engineering, 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in civil and/or environmental engineering. Prerequisite: Permission of the department chair.

CEE 497. Independent Study in Civil and Environmental Engineering, 1-3 Credits.
Individual analytical, experimental and/or design study selected by the student and supervised by the advisor. Prerequisites: approval of the advisor.

CEE 512. Computational Methods in Structures, 3 Credits.
Analysis of 2-D and 3-D determinate and indeterminate truss/beam/frame structures by the unified direct stiffness matrix method, for both hand-calculation and computer implementation. Popular commercialized (NASTRAN) software will also be discussed. Prerequisites: CEE 310.

CEE 514. Masonry Structures Design, 3 Credits.
Masonry materials, reinforced beams and lintels, walls, columns and pilasters, shear walls, and buildings. Prerequisites: CEE 310.

CEE 515. Steel Structures Design, 3 Credits.
Load and resistance factor design methods for steel structures. Prerequisites: CEE 310.

CEE 516. Wood Structures Design, 3 Credits.
Design of wood structures based on national design specification and load and resistance factor design. Prerequisites: CEE 310.

CEE 530. Foundation Engineering, 3 Credits.
Subsurface exploration, site preparation, design of shallow and deep foundations, and retaining structures. Prerequisites: CEE 323 with a grade of C or better.

CEE 531. Earth Structures Design with Geosynthetics, 3 Credits.
Seepage and stability analysis and design of manmade and natural slopes and retaining structures. Applications of geosynthetic material to seepage control, reinforcement of earth works, and containment of hazardous materials. Prerequisites: CEE 323.

CEE 532. Introduction to Earthquake Engineering, 3 Credits.
An overview of earthquake processes and details of the characteristics of destructive ground motion; the effects of such motion on civil engineering structures; reviews of current design practice in mitigating earthquake hazards for various civil engineering structures such as buildings, bridges, dams, lifelines, ports and harbors. Prerequisites: permission of the instructor.

CEE 533. Geomaterials Stabilization, 3 Credits.
This course studies soil and aggregate's physical, chemical and biological stabilization procedures. Students are introduced to chemical stabilization analysis and design using materials such as cement, lime, and fly ash. Physical ground modification, compaction methods and mechanical stabilization analysis and design are also studied. Prerequisite: CEE 323.

CEE 540. Hydraulic Engineering, 3 Credits.
Hydraulic transients; flow control structures; computer analysis of hydraulic systems; design of pipelines, open channels and culverts. Prerequisites: CEE 340.

CEE 546. Urban Stormwater Hydrology, 3 Credits.
Storm rainfall analysis, design rainfall hyetographs, runoff calculation procedures, detention basins, use of mathematical models to analyze and design urban storm drainage systems. Prerequisites: CEE 340.

CEE 547. Groundwater Hydraulics, 3 Credits.
Description of well hydraulics in single and multiple well systems. Determination of aquifer parameters from pumping tests. Use of computer models to determine drawdowns due to multiple well systems. Prerequisites: CEE 340.

CEE 550. Water Distribution and Wastewater Collection System Design, 3 Credits.
Design of water distribution systems, sanitary sewer systems and appurtenances. Prerequisites: CEE 330. Pre- or corequisite: CEE 340.

CEE 552. Air Quality, 3 Credits.
Study of air quality management standards and regulations and pollutant dynamics. Design and operation of emission control equipment for mobile and stationary sources of air pollution. Prerequisites: CEE 350.

CEE 554. Hazardous Waste Treatment, 3 Credits.
Study of sources, generation rates and characteristics of hazardous wastes and their regulation, handling, and design of treatment and disposal facilities. Prerequisites: CEE 350.

CEE 555. Pollution Prevention and Green Engineering, 3 Credits.

CEE 558. Sustainable Development, 3 Credits.
Overview of social, economical, technical environmental aspects of regional, national and international efforts to achieve sustainable development. Discussion of the integration of industrial activity and ecological concerns utilizing principles of zero emissions, pollution prevention and design for the environment. Prerequisites: permission of instructor.

CEE 559. Biofuels Engineering, 3 Credits.
Course covers the overview of renewable energy sources; fundamentals of biofuels; biomass and types of biomass (e.g., woody biomass, forest residues, agricultural residues, energy crops); composition of lignocelluloses (cellulose, hemicellulose, and lignin); biomass conversion technologies; thermochemical, supercritical water, and biochemical conversion processes; types of biofuels from biomass; liquid fuels (bioethanol, bio-oil, biocrude, and hydrocarbons); gaseous fuels (synthesis gas, hydrogen, biodiesel); solid fuels (biochar, torrefied biomass); biodiesel from vegetable oils, algae to biofuels; value-added processing of biofuel residues; economic and environmental assessments; policies and future R&D. Prerequisite: permission of the instructor.
CEE 571. Transportation Operations I. 3 Credits.
This is the first course in transportation operations and traffic flow theory. Topics include traffic engineering studies, capacity analysis, intersection control, traffic flow models, shockwave analysis, signal warrant analysis, and safety analysis. Course includes applications of modeling and simulation to isolated intersections. Prerequisite: CEE 370.

CEE 574. Transportation Data Analytics. 3 Credits.
This course presents the basic techniques for transportation data analytics. It will discuss statistical modeling, prominent algorithms, and visualization approaches to analyze both small- and large-scale data sets generated from transportation systems. Practices of using different data for various real-world traffic/transportation applications and decision-making will also be discussed. Prerequisites: Basic probability and statistics (e.g., STAT 330); any programming language such as C, Python or Java is beneficial but not required.

CEE 582. Introduction to Coastal Engineering. 3 Credits.
Classical small amplitude wave theory, wave transformations in shallow water, shoaling, refraction, diffraction, reflection, breaking. Wave induced near shore currents and sediment transport processes. Alternatives to mitigate coastal erosion processes. Introduction to coastal structures. Prerequisites: permission of the instructor.

CEE 595. Topics in Civil and Environmental Engineering. 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in civil and/or environmental engineering. Prerequisites: Permission of the instructor.

CEE 667. Cooperative Education. 1-3 Credits.
Available for pass/fail grading only. May be repeated for credit. Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and Career Development Services prior to the semester in which the work experience is to take place. Prerequisites: approval by the department and Career Development Services in accordance with the policy for granting credit for cooperative education programs.

CEE 668. Internship. 1-3 Credits.
Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students an opportunity to gain short duration career-related experience. Prerequisites: Approval by Department and Career Development Services.

CEE 669. Practicum. 1-3 Credits.
Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students an opportunity to gain short duration career-related experience. Prerequisites: Approval by Department and Career Development Services.

CEE 695. Topics in Civil and Environmental Engineering. 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in civil and/or environmental engineering. Prerequisites: Permission of the instructor.

CEE 697. Independent Study in Civil and Environmental Engineering. 1-3 Credits.
Individual analytical, experimental and/or design study selected by the student. Approved and supervised by the advisor. Prerequisites: Permission of the instructor.

CEE 698. Master’s Project. 1-3 Credits.
Individual project, investigation under the direction of the student’s major professor.

CEE 699. Thesis. 1-6 Credits.
Research leading to the Master of Science thesis.

CEE 700. Civil and Environmental Engineering Experimental Design. 3 Credits.
Graduate-level overview of engineering experimental design and analysis with emphasis on statistical methods; practical and proper statistical methods applicable to multidisciplinary, real-world civil and environmental engineering problems.
CEE 725. Smart Structures. 3 Credits.
This course covers structural systems integrated with sensing, data processing, and control devices, which control and reduce the vibration of structures. Students will learn about basic theories of smart structures, smart materials, sensors, structural health monitoring (SHM) as well as their application to civil infrastructures.

CEE 730. Advanced Foundation Engineering. 3 Credits.
Advanced analysis and design of shallow and deep foundations and retaining structures. Prerequisites: CEE 430/CEE 530.

CEE 731. Advanced Soil Mechanics. 3 Credits.
Detailed study of shear strength of soils and its application to slope stability and embankment design and analysis. Advanced laboratory shear tests are included. Prerequisites: CEE 323.

CEE 732. Engineering Behavior of Soils. 3 Credits.
Detailed study of physicochemical behavior of soils, fabric, rheology, effective stress path, and their applications to various geotechnical engineering problems. Prerequisites: CEE 323.

CEE 733. Soil Dynamics. 3 Credits.
Study of soil behavior under dynamic loadings. Laboratory and field techniques for determining soil properties and liquefaction potential. Design examples. Prerequisites: CEE 323.

CEE 741. Open Channel Flow. 3 Credits.
Momentum and energy principles, design of open channels, use of mathematical models for flow calculations in rivers, introduction to unsteady open channel flow. Prerequisites: CEE 340.

CEE 747. Groundwater Flow. 3 Credits.

CEE 751. Physicochemical Treatment Processes. 3 Credits.
Physical and chemical processes used in the treatment of water and waste water are covered. Separation, isolation and reaction processes are characterized as well as reactor engineering. Prerequisites: CEE 350.

CEE 752. Biological Wastewater Treatment. 3 Credits.
The use of microorganisms to treat domestic and industrial waste waters for organics and nutrient removal are studied. Characteristics of individual waste water components and the appropriate treatment processes to remove these components are covered. Prerequisites: CEE 350.

CEE 753. Advanced Processes for Water and Wastewater Treatment. 3 Credits.
Theory, operation and application of advanced water and waste water treatment systems, including land application, dissolved solids, organic contaminant and nutrient removal processes. Emphasis on system development for waste water reclamation/recycling. Prerequisites: CEE 751 and CEE 752.

CEE 754. Environmental Engineering Microbiology. 3 Credits.
A lecture and laboratory course dealing with the study of the principles and applications of microbiology in waste water treatment, water treatment, stream self-purification and their effects in environmental engineering. Prerequisites: CEE 350.

CEE 755. Water Quality Management. 3 Credits.
Characterization of water quality in natural systems and the human activities that result in contaminant input to these systems are studied. Management practices for minimizing contaminant input and for restoring contaminated waters are discussed.

CEE 756. Water Quality Modeling. 3 Credits.
Formulation of mathematical equations to describe the fate and transport of aqueous contaminants in dynamic surface water systems. Use of water quality computer models to predict various contamination scenarios. Prerequisites: MATH 307, CEE 340, CEE 350 or permission of the instructor.

CEE 759. Carbon-Free Clean Energy. 3 Credits.
The course presents an overview of carbon-free energy sources (nuclear, wind, solar, hydropower, and geothermal). The current status, conversion processes, economics, and environmental issues of these forms of energy will be discussed.

CEE 760. Managing Phosphorous in Circular Economy. 3 Credits.
This course is focused on the importance of management of phosphorous in preserving sustainable environments. The objectives of the course are to provide an overview of different phosphorous management/recovering/recycling strategies; basics of circular economy; role of microalgae in recovery and recycling of phosphorous; phosphorous recovery from wastewater; and application of the principles of circular economy towards global and regional phosphorous management.

CEE 761. Water Resources Processes and Analysis Methods. 3 Credits.
This course examines interactive hydrologic processes in water resource; modifications of climate change to these processes; and modern simulation and systematic analysis methods incorporating the modifications into practices of water resource planning, utilization, protection, and engineering.

CEE 762. Aquatic Chemistry in Environmental Engineering. 3 Credits.
Chemical reactions in natural and engineered systems are studied with emphasis placed on developing kinetic expressions and assessing chemical equilibrium. Kinetic and equilibrium expressions are applied to engineering problems to predict the reaction time and products of specific reactions. Prerequisites: CHEM 123N.

CEE 770. Transportation Safety. 3 Credits.
This course focuses on major transportation safety issues including transportation safety goals, safety of various transportation modes, identification of problematic locations, selection of safety countermeasures and their evaluation, safety data and modeling issues. Prerequisite: CEE 471/CEE 571.

CEE 771. Transportation Operations II. 3 Credits.
This is the second course in transportation operations and traffic flow theory. Topics covered include design of progressive signal systems, queueing theory, car following models, and applications of microscopic traffic simulation to corridor studies. Prerequisite: CEE 471/CEE 571.

CEE 772. Intelligent Transportation Systems. 3 Credits.
This course examines how ITS can be used to enhance mobility and safety. The topics covered in the course include systems engineering approach to ITS, traveler response to technologies and information, ITS planning and evaluation, and ITS deployment and operational performance. Prerequisite: CEE 370.

CEE 773. Transportation Planning. 3 Credits.
This course covers transportation planning processes that include policy direction, transportation data, travel demand forecasting models, and decision-making/stakeholders issues.

CEE 774. Transportation Network Flow Models. 3 Credits.
This course provides a rigorous introduction to transportation network modeling, with special emphasis on network equilibrium problems. Topics include: elementary graph theory, shortest path problem nonlinear optimization, optimization of univariate functions, deterministic and stochastic user equilibrium. Prerequisite: CEE 370 or equivalent.

CEE 775. Transportation Network Algorithms. 3 Credits.
Fundamental models and algorithms in optimization, stochastic modeling and parallel computing will be discussed and illustrated with transportation applications.

CEE 776. Simulation in Transportation Networks. 3 Credits.
CxEE 777. Econometric Modeling in Transportation. 3 Credits.
The class focuses on the development of econometric modeling and its
application in the field of transportation engineering. Topics to be covered
include statistical inference, linear regression, count data models, discrete
choice models, survival analysis, time series modeling, spatial modeling,
panel data analysis, and structural equation modeling. Students will have
a better understanding of the concepts and theories of econometrics and
will be equipped with well-suited modeling and analysis techniques.
Prerequisites: Graduate student status.

CxEE 782. Design of Coastal Structures. 3 Credits.
Nonlinear wave theories; wave forces on slender piles and seawalls; design of
rubblemound structures; design philosophy, initial costs, maintenance
costs, optimized design using stochastic methods; design of renourished
beaches. Advanced alternative solutions for shore protection. Prerequisites:
CxEE 482/CxEE 582.

CxEE 787. Dredging and Beach Engineering. 3 Credits.
Types of dredges, factors affecting dredge performance; hydraulic dredges
(cutter, hopper) and mechanical dredges systems (bucket, clamshell,
etc.); shoaling rate determination; inlet sand bypassing systems; beach
renourishment schemes. Design of beach renourishment/projects.
Prerequisites: CxEE 330.

CxEE 788. Coastal Hydrodynamics and Sediment Processes. 3 Credits.
This course discusses the hydrodynamics of the coastal environment and
reviews waves, low-frequency motions, and coastal responses, including
sediment processes and beach evolution. Specific topics to be covered
include: review of linear wave theory; introduction to nonlinear waves;
wave-averaged motions and radiation stresses; wave and current boundary
layers; wave setup, longshore current, rip current, undertow, and nearshore
circulation; wave dissipation mechanisms; and fluid-sediment interaction.
An introduction to cohesive sediments, sediment concentration and transport
models, and beach morphology will also be addressed. Prerequisites:
CxEE 482/CxEE 582.

CxEE 789. Computational Environmental Fluid Dynamics. 3 Credits.
Fluid dynamics conservation laws as transport phenomena. Classical,
finite-difference models for advection, diffusion and combined fluid flows.
Explicit and implicit schemes to solve unsteady, free-surface fluid flow and
dispersion (dispersion) problems in one and multi-dimensions. Turbulence
models. Prerequisites: CxEE 330.

CxEE 795. Topics in Civil and Environmental Engineering. 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in
civil and/or environmental engineering. Prerequisites: Permission of the
instructor.

CxEE 797. Independent Study. 1-3 Credits.

CxEE 800. Civil and Environmental Engineering Experimental Design. 3
Credits.
Graduate-level overview of engineering experimental design and analysis
with emphasis on statistical methods; practical and proper statistical
methods applicable to multidisciplinary, real-world civil and environmental
engineering problems.

CxEE 801. Applied Mathematics for Civil and Environmental Engineers.
3 Credits.
An examination of numerical and approximate mathematical methods for
civil and environmental engineers with applications; finite-difference and
finite-integral techniques for single and simultaneous ordinary differential
equations; classical and finite-difference solutions of partial differential
equations such as heat, wave, Laplace, and plate equation; and finite element
applications selected from geotechnical, environmental, hydraulics/water
resources, ocean, transportation, and structural engineering.

CxEE 810. Structural Dynamics. 3 Credits.
Free and forced vibration of discrete and continuous systems; elastic and
inelastic response of structures under dynamic loads.

CxEE 811. Finite Element Analysis. 3 Credits.
To provide an understanding of the finite element method (FEM) as derived
from an integral formulation perspective. To demonstrate the solutions of (1-
D and 2-D) continuum mechanics problems such as solid mechanics, fluid
mechanics and heat transfer.

CxEE 812. Advanced Reinforced Concrete. 3 Credits.
Ultimate-strength theory, yield line methods, limit design, and other relevant
advanced topics in the theory and design of concrete structures.

CxEE 813. Prestressed Concrete. 3 Credits.
Analysis and design of prestressed concrete members and structures.
Shrinkage, creep and losses, shear, bond and anchorages are discussed.

CxEE 814. Advanced Structural Analysis. 3 Credits.
Elastic analysis of framed structures using matrix and numerical techniques.

CxEE 815. Engineering Optimization I. 3 Credits.
Formulation and solution algorithms for Linear Programming (LP)
problems. Unconstrained and constrained nonlinear programming (NLP)
problems. Optimum solution for practical engineering systems. (Cross-listed
with MAE 715/MAE 815).

CxEE 817. Bridge Structures Design. 3 Credits.
Design of steel, concrete, and composite bridges using modern techniques
and current specifications. Prerequisites: CxEE 410 and CxEE 415/CxEE 515 or
equivalent.

CxEE 818. Flood Resistant Structural Design. 3 Credits.
Analysis and design of flood protective shields for residential and
commercial buildings, floodwalls and gates under hydrostatic,
hydrodynamic, and floating debris impact forces, safety of dams and levees,
sea-level rise issues for buildings and bridges, ASCE, IBC, and FEMA
guidelines for flood resistant structural design, case histories.

CxEE 819. Inelastic Structures. 3 Credits.
Inelastic analysis and behavior of framed structures.

CxEE 820. Structural Stability. 3 Credits.
Fundamentals of elastic and inelastic stability of beams, columns and
frames.

CxEE 821. Plates. 3 Credits.
Classical and modern methods for the solution of plates of various shapes
and boundary conditions, continuous and axially loaded plates and plates on
elastic supports. Design examples.

CxEE 822. Cluster Parallel Computing. 3 Credits.
Detailed numerical step-by-step procedures to exploit parallel and
sparse computation under MPI (Message, Passing, Interface) computer
environments are explained. Large-scale engineering/science applications
are emphasized. Simultaneous linear equations are discussed.

CxEE 823. Seismic Design of Steel Structures. 3 Credits.
Analysis and design of steel structures under seismic loading conditions,
introduction to design specifications for steel structures. Prerequisites:
CxEE 310 or equivalent.

CxEE 824. Retrofitting Methods for Bridges and Buildings. 3 Credits.
Retrofitting methods for bridges and buildings combined with related
advanced structural analysis and design techniques. Prerequisites: CxEE 310 or
equivalent.

CxEE 825. Smart Structures. 3 Credits.
This course covers structural systems integrated with sensing, data
processing, and control devices, which control and reduce the vibration
of structures. Students will learn about basic theories of smart structures,
smart materials, sensors, structural health monitoring (SHM) as well as their
application to civil infrastructures.

CxEE 830. Advanced Foundation Engineering. 3 Credits.
Advanced analysis and design of shallow and deep foundations and retaining
structures. Prerequisites: CxEE 430/CxEE 530.

CxEE 831. Advanced Soil Mechanics. 3 Credits.
Detailed study of shear strength of soils and its application to slope stability
and embankment design and analysis. Advanced laboratory shear tests are
included. Prerequisites: CxEE 323.

CxEE 832. Engineering Behavior of Soils. 3 Credits.
Detailed study of physicochemical behavior of soils, fabric, rheology,
effective stress path, and their applications to various geotechnical
engineering problems. Prerequisites: CxEE 323.
CEE 833. Soil Dynamics. 3 Credits.
Study of soil behavior under dynamic loadings. Laboratory and field techniques for determining soil properties and liquefaction potential. Design examples. Prerequisites: CEE 323.

CEE 841. Open Channel Flow. 3 Credits.
Momentum and energy principles, design of open channels, use of mathematical models for flow calculations in rivers, introduction to unsteady open channel flow. Prerequisites: CEE 340.

CEE 847. Groundwater Flow. 3 Credits.

CEE 851. Physiochemical Treatment Processes. 3 Credits.
Physical and chemical processes used in the treatment of water and waste water are covered. Separation, isolation and reaction processes are characterized as well as reactor engineering. Prerequisites: CEE 350.

CEE 852. Biological Wastewater Treatment. 3 Credits.
The use of microorganisms to treat domestic and industrial waste waters for organics and nutrient removal are studied. Characteristics of individual waste water components and the appropriate treatment processes to remove these components are covered. Prerequisites: CEE 350.

CEE 853. Advanced Processes for Water and Wastewater Treatment. 3 Credits.
Theory, operation and application of advanced water and waste water treatment systems, including land application, dissolved solids, organic contaminant and nutrient removal processes. Emphasis on system development for waste water reclamation/recycling. Prerequisites: CEE 751 and CEE 752.

CEE 854. Environmental Engineering Microbiology. 3 Credits.
A lecture and laboratory course dealing with the study of the principles and applications of microbiology in waste water treatment, water treatment, stream self-purification and their effects in environmental engineering. Prerequisites: CEE 350.

CEE 855. Water Quality Management. 3 Credits.
Characterization of water quality in natural systems and the human activities that result in contaminant input to these systems are studied. Management practices for minimizing contaminant input and for restoring contaminated waters are discussed.

CEE 856. Water Quality Modeling. 3 Credits.
Formulation of mathematical equations to describe the fate and transport of aqueous contaminants in dynamic surface water systems. Use of water quality computer models to predict various contamination scenarios. Prerequisites: MATH 307, CEE 340, CEE 350 or permission of the instructor.

CEE 859. Carbon-Free Clean Energy. 3 Credits.
The course presents an overview of carbon-free energy sources (nuclear, wind, solar, hydropower, and geothermal). The current status, conversion processes, economics, and environmental issues of these forms of energy will be discussed.

CEE 860. Managing Phosphorous in Circular Economy. 3 Credits.
This course is focused on the importance of management of phosphorous in preserving sustainable environments. The objectives of the course are to provide an overview of different phosphorous management/recycling/recovery strategies; basics of circular economy; role of microalgae in recovery and recycling of phosphorous; phosphorous recovery from wastewater; and application of the principles of circular economy towards global and regional phosphorous management.

CEE 861. Water Resources Processes and Analysis Methods. 3 Credits.
This course examines interactive hydrologic processes in water resource; modifications of climate change to these processes; and modern simulation and systematic analysis methods incorporating the modifications into practices of water resource planning, utilization, protection, and engineering.

CEE 862. Aquatic Chemistry in Environmental Engineering. 3 Credits.
Chemical reactions in natural and engineered systems are studied with emphasis placed on developing kinetic expressions and assessing chemical equilibrium. Kinetic and equilibrium expressions are applied to engineering problems to predict the reaction time and products of specific reactions. Prerequisites: CHEM 123N.

CEE 870. Transportation Safety. 3 Credits.
This course focuses on major transportation safety issues including transportation safety goals, safety of various transportation modes, identification of problematic locations, selection of safety countermeasures and their evaluation, safety data and modeling issues. Prerequisite: CEE 471/CEE 571.

CEE 871. Transportation Operations II. 3 Credits.
This is the second course in transportation operations and traffic flow theory. Topics covered include design of progressive signal systems, queuing theory, car following models, and applications of microscopic traffic simulation to corridor studies. Prerequisite: CEE 471/CEE 571.

CEE 872. Intelligent Transportation Systems. 3 Credits.
This course examines how ITS can be used to enhance mobility and safety. The topics covered in the course include systems engineering approach to ITS, traveler response to technologies and information, ITS planning and evaluation, and ITS deployment and operational performance. Prerequisite: CEE 370.

CEE 873. Transportation Planning. 3 Credits.
This course covers transportation planning processes that include policy direction, transportation data, travel demand forecasting models, and decision-making/stakeholders issues.

CEE 874. Transportation Network Flow Models. 3 Credits.
This course provides a rigorous introduction to transportation network modeling, with special emphasis on network equilibrium problems. Topics include: elementary graph theory, shortest path problem nonlinear optimization, optimization of univariate functions, deterministic and stochastic user equilibrium.

CEE 875. Transportation Network Algorithms. 3 Credits.
Fundamental models and algorithms in optimization, stochastic modeling and parallel computing will be discussed and illustrated with transportation applications.

CEE 876. Simulation in Transportation Networks. 3 Credits.

CEE 877. Econometric Modeling in Transportation. 3 Credits.
The class focuses on the development of econometric modeling and its application in the field of transportation engineering. Topics to be covered include statistical inference, linear regression, count data models, discrete choice models, survival analysis, time series modeling, spatial modeling, panel data analysis, and structural equation modeling. Students will have a better understanding of the concepts and theories of econometrics and will be equipped with well-suited modeling and analysis techniques. Prerequisites: Graduate student status.

CEE 882. Design of Coastal Structures. 3 Credits.
Nonlinear wave theories; wave forces on slender piles and seawalls; design of rubble mound structures; design philosophy, initial costs, maintenance costs, optimized design using stochastic methods; design of renourished beaches. Advanced alternative solutions for shore protection. Prerequisites: CEE 482/CEE 582.

CEE 887. Dredging and Beach Engineering. 3 Credits.
Types of dredges, factors affecting dredge performance; hydraulic dredges (cutter, hopper) and mechanical dredges systems (bucket, clamshell, etc.); shoaling rate determination; inlet sand bypassing systems; beach renourishment schemes. Design of beach renourishment/projects. Prerequisites: CEE 330.
CEE 888. Coastal Hydrodynamics and Sediment Processes. 3 Credits.
This course discusses the hydrodynamics of the coastal environment and reviews waves, low-frequency motions, and coastal responses, including sediment processes and beach evolution. Specific topics to be covered include: review of linear wave theory; introduction to nonlinear waves; wave-averaged motions and radiation stresses; wave and current boundary layers; wave setup, longshore current, rip current, undertow, and nearshore circulation; wave dissipation mechanisms; and fluid-sediment interaction. An introduction to cohesive sediments, sediment concentration and transport models, and beach morphology will also be addressed. Prerequisites: CEE 482/CEE 582.

CEE 889. Computational Environmental Fluid Dynamics. 3 Credits.

CEE 892. Doctor of Engineering Project. 1-12 Credits.
Directed individual study applying advanced level technical knowledge to identify, formulate, and solve a complex, novel problem in Civil and Environmental Engineering.

CEE 895. Topics in Civil and Environmental Engineering. 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in civil and/or environmental engineering. Prerequisites: Permission of the instructor.

CEE 897. Independent Study. 1-3 Credits.
Individual analytical, experimental and/or design study selected by the student. Approved and supervised by the advisor. Prerequisites: permission of the instructor.

CEE 899. Dissertation Research. 1-9 Credits.
Research for the dissertation.

CEE 998. Master's Graduate Credit. 1 Credit.
This course is a pass/fail course for master's students in their final semester. It may be taken to fulfill the registration requirement necessary for graduation. All master's students are required to be registered for at least one graduate credit hour in the semester of their graduation.

CEE 999. Doctoral Graduate Credit. 1 Credit.
This course is a pass/fail course doctoral students may take to maintain active status after successfully passing the candidacy examination. All doctoral students are required to be registered for at least one graduate credit hour every semester until their graduation.