

CIVIL ENGINEERING (CEEN)

CEEN 5311 GIS for Civil Engineering

3 Semester Credit Hours (3 Lecture Hours)

This course is focused on the advanced applications of GIS methods in civil engineering. The main topics include data acquisition, vector analysis, raster analysis, geospatial data visualization, utility network analysis, spatial statistics, space-time pattern mining, WebGIS, and programming for geospatial analysis.

Prerequisite: CEEN 3330.

CEEN 5321 Structural Engineering

3 Semester Credit Hours (3 Lecture Hours)

Matrix force and displacement methods of structural analysis; virtual work theorem and principles, virtual forces and displacements; computation of element stiffness matrices and load vectors; introduction to finite element analysis and structural stability. Applications in structural design.

CEEN 5322 Optimization

3 Semester Credit Hours (3 Lecture Hours)

This course focuses on problem formulation, software technologies and analytical methods for optimization serving as an introduction to a wide variety of optimization problems and techniques including dynamic programming, network flows, integer programming, heuristic approaches, Markov chains, game theory, and decision analysis. This course provides tools to formulate engineering problems as the optimization of some function under some set of constraints. As such operations research is a quantitative discipline that deals with the application of advanced analytical methods to help make better decisions. This course employs techniques from other mathematical sciences, such as mathematical modeling, statistical analysis, and mathematical optimization and provides optimal or near-optimal solutions to complex decision-making problems. (Cross-listed with IEEN 5313 Optimization.)

Prerequisite: ENGR 5302.

CEEN 5323 Sustainable Infrastructure Engineering

3 Semester Credit Hours (3 Lecture Hours)

This course aims at providing students with simple scientific techniques for the optimum design of materials to improve its performance while minimizing cost and environmental impacts. The course aims at providing students with metrics of sustainability, principles of design for the environment, methods for pollution prevention, and use of mass and energy balances in the design of sustainable systems. In addition, concepts of Life-Cycle Assessment (LCA) and cost analysis are introduced to students. The concepts of carbon footprint and embodied energy of construction materials will be introduced to the students. The course will include new technologies, materials, and design processes for sustainable infrastructure; energy management and renewable energy and efficiency in structures; and connections between societal needs and infrastructure development.

Prerequisite: CEEN 5321 and 5331.

CEEN 5331 Water Resources Engineering

3 Semester Credit Hours (3 Lecture Hours)

This course is focused on the advanced extension of the principles of hydraulics and hydrology to applications in water resources systems. The main topics include water supply systems, stormwater systems, wastewater systems, irrigation systems, water conservation, watershed analysis and simulation, system reliability and resilience, and integrated water resources management.

Prerequisite: CEEN 4312.

CEEN 5332 Environmental Fluid Mechanics

3 Semester Credit Hours (3 Lecture Hours)

This course is focused on applications of fluid mechanics that provide insight into the physics and transport in environmental systems. The major topics include: the development of basic transport equations of unsteady fluid flow including continuity, Navier-Stokes, and energy equations; Lagrangian and turbulent transport; scaling principles; analysis of viscous incompressible flows, stratified flows and flows with vorticity, and geophysical flows; jets and plumes; sediment transport; interactions between air and water systems.

Prerequisite: ENGR 3315.

CEEN 5333 Environmental Engineering

3 Semester Credit Hours (3 Lecture Hours)

This course is focused on the advanced extension of the fundamentals of environmental engineering. The main topics include water and wastewater treatment systems, solid waste management, air pollution management, environmental systems analysis, system sustainability and resilience, and other selected topics.

CEEN 5341 Transportation Engineering

3 Semester Credit Hours (3 Lecture Hours)

Planning, design, staging, construction, test, and maintenance of the public works and facilities for air, water, rail, and highway transit systems. Introduction to concepts from traffic engineering including traffic flow theory and capacity and quality of traffic flow.

CEEN 5351 Geotechnical Engineering

3 Semester Credit Hours (3 Lecture Hours)

Soil dynamics, ground improvement, soil and foundation systems; problems of dynamic soil-structure interaction. Elasticity and plasticity models; stress-strain relations for soils; failure criteria. Site preparation and improvement; flexible retaining structures, pile foundations, and other foundational structures such as caissons, pile foundations, and drilled shafts.

CEEN 5361 Advanced Concrete Materials

3 Semester Credit Hours (3 Lecture Hours)

This course delves into the science of advanced concrete materials, including cement production, clinker formation, hydration chemistry, and the microstructure of cementitious materials and their effects on concrete properties. Using a multiscale approach, students will assess the mechanical behavior of cement-based materials, examining how composition and microstructure influence strength, toughness, and elasticity. The course addresses durability challenges by explaining underlying mechanisms and evaluating their impact on concrete performance. Students will learn to design and optimize advanced concrete types, such as self-consolidating and ultra-high-performance concretes, and master advanced characterization and testing methods. This course prepares students for advanced study or professional practice in concrete technology.

Prerequisite: ENGR 3322 and CEEN 4304.