

CIVIL AND ENVIRONMENTAL ENGINEERING (CIV ENGR)

CIV ENGR 1 – COOPERATIVE EDUCATION PROGRAM

1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career.

Requisites: Sophomore standing

Course Designation: Workplace - Workplace Experience Course

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Identify and respond appropriately to real-life engineering ethics cases relevant to co-op work

Audience: Undergraduate

2. Synthesize and apply appropriate technical education to real world technical work

Audience: Undergraduate

3. Communicate effectively in writing and speaking with a range of audiences in the workplace, including those without disciplinary expertise

Audience: Undergraduate

4. Develop professional and transferable habits like time management skills, collaborative problem-solving skills, and research skills for learning new information

Audience: Undergraduate

CIV ENGR 121 – SUSTAINABILITY ENGINEERING FOR NON-ENGINEERS

3 credits.

Interdisciplinary contexts of sustainability, including environment, economy, and society. History of sustainability in engineering, sustainability engineering tools, and contemporary applications of sustainability in a wide range of fields.

Requisites: Satisfied Quantitative Reasoning (QR) A requirement

Course Designation: Gen Ed - Quantitative Reasoning Part B

Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Elementary

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Synthesize how the evolution of sustainability engineering has influenced its application today

Audience: Undergraduate

2. Apply the concepts and tools of sustainability engineering to a modern-day problem or challenge

Audience: Undergraduate

CIV ENGR 150 – INTRODUCTION TO ARCHITECTURAL THEORY

3 credits.

A survey of architectural design theory through research analysis and criticism of works and ideas of significant architects and architectural theorists.

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Examine architectural design as a theoretical practice and the use of visual representation to successfully communicate ideas.

Audience: Undergraduate

2. Effectively communicate in a group and participate in constructive criticism and discussion about the presented ideas and work.

Audience: Undergraduate

3. Demonstrate comprehension of historical, philosophical, theoretical, and an aesthetic perspective commonly used in the discussion of architecture.

Audience: Undergraduate

4. Apply knowledge of artistic/design principles, conventions, methods, and practices through the creation of works of art/design.

Audience: Undergraduate

5. Compare and contrast the expressive and formal features of different artistic media and/or cultural traditions through both analytical studies and original artistic/design work.

Audience: Undergraduate

CIV ENGR 151 – ARCHITECTURAL MAKING I

3 credits.

Introduction to architecture and architectural making. 2D and 3D form and space tested through the theoretical, pragmatic, and contextual issues that influence architecture.

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Demonstrate knowledge of basic concepts in architecture and related disciplines.

Audience: Undergraduate

2. Strategize a solution to a fundamentally simple design problem based on a design precedent.

Audience: Undergraduate

3. Research design methodology for proposed a program and employ skills in scale and proportion, composition and form in 2D imagery.

Audience: Undergraduate

4. Employ skills in scale and proportion, composition and form in 3D.

Audience: Undergraduate

5. Demonstrate diagramming and journaling skills based on course content.

Audience: Undergraduate

CIV ENGR 152 – ARCHITECTURAL MAKING II

3 credits.

Survey and application of twentieth century design techniques in architecture.

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Demonstrate knowledge of basic concepts in architecture and related disciplines.

Audience: Undergraduate

2. Strategize a solution to a fundamentally simple design problem based on a design precedent.

Audience: Undergraduate

3. Research design methodology for a proposed program and employ skills in scale and proportion, composition and form in 2D imagery.

Audience: Undergraduate

4. Employ skills in scale and proportion, composition and form in 3D.

Audience: Undergraduate

5. Demonstrate diagramming and journaling skills based on course content.

Audience: Undergraduate

CIV ENGR 155 – ARCHITECTURAL THINKING

3 credits.

Canonical buildings since 1800 alongside their accompanying theoretical texts are evaluated within the discipline and allied fields of inquiry.

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Visually recognize and identify major architectural modes of representation.

Audience: Undergraduate

2. Using formal and technical vocabulary, describe the defining characteristics of buildings.

Audience: Undergraduate

3. Distinguish and develop a working knowledge of significant developments in architectural thinking across time and in a cross-cultural context.

Audience: Undergraduate

4. Apply critical thinking to ideas and theories in the history of architecture.

Audience: Undergraduate

CIV ENGR 159 – CIVIL ENGINEERING GRAPHICS

2 credits.

Graphical communication including lettering, drawing equipment and techniques; geometric constructions, orthographic projections, technical sketching, isometric views, descriptive geometry, and computer-aided design drawing, with applications specific to civil engineering.

Requisites: Not open to students with credit for M E 170.

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Use basic drafting tools to create scaled images of civil and environmental engineering designs

Audience: Undergraduate

2. Use computer-aided design tools to create scaled images of civil and environmental engineering designs

Audience: Undergraduate

CIV ENGR 250 – ARCHITECTURAL VISUALIZATION

3 credits.

Development of precise standards of drawing and the history and techniques of descriptive and analytical drawing.

Requisites: None**Repeatable for Credit:** No**Last Taught:** Fall 2025**Learning Outcomes:** 1. Strategically deploy representational strategies with a range of tools available.

Audience: Undergraduate

2. Explain techniques of 2D and 3D representation.

Audience: Undergraduate

3. Explain history, theory, and contemporary application of representation strategies.

Audience: Undergraduate

4. Explain the techniques and tools available to produce them.

Audience: Undergraduate

CIV ENGR/G L E 291 – PROBLEM SOLVING USING COMPUTER TOOLS

4 credits.

Introduction to engineering computations with emphasis on computer tools and computer based measurement, data collection, and processing. Tools will include computer aided design, spreadsheets, other engineering computation tools, and hardware and software for laboratory and spatial measurements.

Requisites: MATH 222 or member of Engineering Guest Students**Repeatable for Credit:** No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Use spreadsheet software to perform fundamental civil, environmental, and geological engineering calculations, analyze datasets using logical filters, and interpret numeric data meant to represent time and text values

Audience: Undergraduate

2. Use computer programming as a tool to streamline engineering data analysis tasks, create visualizations, obtain numerical approximations, and retrieve data from local and remote (web-based) data sources

Audience: Undergraduate

3. Use automatic levels, total stations, and aerial photography to conduct land surveying operations and collect the type of geospatial data required for creating drawings that support engineering design

Audience: Undergraduate

4. Explain how measuring devices (data acquisition systems and sensors) work, use measuring devices to record/monitor the physical properties of a system, and use sensor readings as the foundation to control devices in the physical world

Audience: Undergraduate

CIV ENGR 299 – INDEPENDENT STUDY

1-3 credits.

Under faculty supervision.

Requisites: Consent of instructor**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2016**Learning Outcomes:** 1. Conduct and report on independent civil or environmental engineering research

Audience: Undergraduate

CIV ENGR 310 – FLUID MECHANICS

3 credits.

Fluid statics and dynamics, dimensional analysis, flow of an ideal fluid, flow of a real fluid--including laminar and turbulent flow, applications to engineering problems.

Requisites: (MATH 234 or 375) and (E M A 202 or M E 240), graduate/professional standing, or member of Engineering Guest Students**Repeatable for Credit:** No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Recall properties of fluids in relation to natural and engineered flows

Audience: Undergraduate

2. Explain how pressure varies in static and moving fluids

Audience: Undergraduate

3. Use conservation of mass, momentum, angular momentum, and energy to analyze flows in natural and engineered settings

Audience: Undergraduate

4. Use dimensional analysis to reduce the number of parameters in analysis of flows and to develop prototype-model relationships

Audience: Undergraduate

5. Assess the functioning of natural and engineered flow systems and determine appropriate analysis tools to achieve desired outcomes

Audience: Undergraduate

6. Design and conduct experiments to understand fluid flows and determine quantitative relationships between dimensionless variables

Audience: Undergraduate

CIV ENGR 311 – HYDROSCIENCE

3 credits.

Introduction to the water cycle, its relationship to the environment and human attempts to conserve, control, and utilize water judiciously. Fundamentals of hydrology, hydraulics, coastal engineering and water resources engineering.

Requisites: MATH 222, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. List and explain the fundamental processes of the hydrologic cycle

Audience: Both Grad & Undergrad

2. Explain the importance of hydrology and water resources in society

Audience: Both Grad & Undergrad

3. Use hydrologic principles to address engineering problems related to water supply, flooding, and environmental quality

Audience: Both Grad & Undergrad

4. Derive and use quantitative relationships to describe hydrologic behavior

Audience: Both Grad & Undergrad

5. Examine the causes of and solutions for the sustainability challenge of water availability under conditions of changing land use, climate, and demand and environmental issues.

Audience: Both Grad & Undergrad

6. Describe the social, economic, and environmental dimensions of the sustainability challenges of water management and identify potential tradeoffs and interrelationships among these dimensions

Audience: Both Grad & Undergrad

7. Synthesize the connections to and importance of hydrological processes and methods in broader contemporary interdisciplinary water resources and environmental issues

Audience: Graduate

CIV ENGR 320 – ENVIRONMENTAL ENGINEERING

3 credits.

Fundamental sanitary aspects of environmental engineering. Role of the engineer in the control of the environment; water supply and wastewater problems; solid waste disposal; air pollution; and administration in environmental engineering.

Requisites: CHEM 104, 109, 116, graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Identify major issues pertaining to water and air quality, and general ecosystem quality

Audience: Undergraduate

2. Describe the roles and responsibilities of environmental engineers and scientists in society

Audience: Undergraduate

3. Carry out material and energy balances within a standard problem solving framework

Audience: Undergraduate

4. Derive and solve mathematical expressions to describe simple transformation and transport process that occur in environmental media

Audience: Undergraduate

5. Perform computations related to concepts and processes within the fields of water supply, wastewater treatment, solid waste, and air quality engineering

Audience: Undergraduate

CIV ENGR 322 – ENVIRONMENTAL ENGINEERING PROCESSES

3 credits.

Combination of theory and laboratory practice to study basic unit operations and processes in environmental engineering. Emphasis on water and wastewater treatment processes, such as coagulation/flocculation, chemical precipitation, filtration, adsorption, activated sludge, anaerobic digestion, and substrate utilization kinetics.

Requisites: CIV ENGR 320, CBE 250, BSE 249, graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Conduct experiments appropriate to environmental engineering

Audience: Undergraduate

2. Use statistics to analyze uncertainties and interpret experimental results

Audience: Undergraduate

3. Design an experiment to test a specific hypothesis

Audience: Undergraduate

4. Design an experiment to establish engineering design criteria (e.g., estimate a required chemical dose, estimate a required reactor size)

Audience: Undergraduate

5. Function in an environmental engineering team to conduct experiments and interpret results

Audience: Undergraduate

6. Organize and deliver effective written and graphical communications

Audience: Undergraduate

CIV ENGR 324 – ENVIRONMENTAL ENGINEERING THERMODYNAMICS

3 credits.

A systematic introduction to the application of the first and second laws of thermodynamics to systems relevant to environmental engineering.

Energy balances used to solve environmental engineering problems in flowing and non-flowing systems. Examines the relationship between energy, heat and work using theoretical and practical models. Chemical reactions as well as gas and fluid mixing from a thermodynamics perspective. Performance limits imposed by the second law of thermodynamics on devices used in power generation, fluid flow, refrigeration, and air conditioning.

Requisites: (CHEM 104 or 109), MATH 234, and (E M A 201, PHYSICS 201 or 207), or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe the first and second laws of thermodynamics and their applications to environmental engineering problems

Audience: Undergraduate

2. Formulate energy balances to solve environmental engineering problems in flowing and non-flowing systems

Audience: Undergraduate

3. Apply the relationship between energy, heat and work to environmental engineering problems

Audience: Undergraduate

4. Conduct performance and design calculations based upon thermodynamic principles

Audience: Undergraduate

CIV ENGR 325 – ENVIRONMENTAL ENGINEERING MATERIALS

3 credits.

Properties and tests of materials used in the treatment and conveyance of water and air. Introduction to laboratory and field measurement techniques to assess material performance capabilities. Technical report preparation.

Requisites: CIV ENGR 320 and E M A 201, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Apply knowledge of materials behavior to select, specify, and monitor materials used in the treatment and conveyance of water and air

Audience: Undergraduate

2. Conduct and/or monitor standardized testing protocols, interpreting test results, and preparing technical reports

Audience: Undergraduate

3. Conduct forensic studies to determine role of material properties in treatment or conveyance failures

Audience: Undergraduate

4. Practice skills in teamwork and communication relevant to materials selection and monitoring

Audience: Undergraduate

CIV ENGR/G L E 330 – SOIL MECHANICS

3 credits.

Basic principles of soil mechanics and fundamentals of application in engineering practice; soil composition and texture; classification; permeability and seepage; consolidation; settlement; shear strength; lateral earth pressures and retaining structures, shallow and deep foundations, slope stability; subsurface exploration; laboratory characterization of physical and engineering properties of soils.

Requisites: E M A 303 or M E 306, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the physicochemical characteristics of soils and their importance to the engineering behavior of soils.

Audience: Both Grad & Undergrad

2. Define the factors which control the physical, mechanical and hydraulic behavior of soils.

Audience: Both Grad & Undergrad

3. Run the laboratory tests used for the determination of physicochemical properties of soils, the engineering classification of soils, hydraulic properties, and the stiffness and shear strength properties.

Audience: Both Grad & Undergrad

4. Perform analyses in each area described in the course and understand the limitations to these analyses.

Audience: Both Grad & Undergrad

5. List basic problems in Soil Mechanics design and describe how these problems are tackled.

Audience: Both Grad & Undergrad

6. Experimentally assess the interaction of multiple parameters controlling the physical, mechanical and hydraulic behavior of soils; perform more advanced 2D or 3D analyses in one area described in the course and understand the limitations of these analyses; or summarize the state of the art in one research or engineering-applied area described in the course.

Audience: Graduate

CIV ENGR 340 – STRUCTURAL ANALYSIS I

3 credits.

Analysis of statically determinate and indeterminate beams, trusses, and rigid frames; deflections by virtual-work, moment-area; influence lines; force methods; structural design loads, introduction to structural design, approximate methods.

Requisites: (E M A 303 or M E 306) and M E/E M A 307, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Compute the internal forces (axial, shear, and moment) applied to determinate structural systems

Audience: Both Grad & Undergrad

2. Construct shear and moment influence lines for patterned loads

Audience: Both Grad & Undergrad

3. Compute the deflections of a linear elastic structural system

Audience: Both Grad & Undergrad

4. Compute the internal forces (axial, shear, and moment) applied to simple indeterminate structural systems

Audience: Both Grad & Undergrad

5. Compute the internal forces (axial, shear, and moment) applied to any indeterminate structural system by computer code-based matrix method.

Audience: Graduate

CIV ENGR 352 – FRANK LLOYD WRIGHT - DESIGN SEMINAR

3 credits.

Introduction to the design language of Frank Lloyd Wright. Beginning understanding of his architectural design process, his methods, tools and processes in building design and construction.

Requisites: None

Repeatable for Credit: No

Last Taught: Spring 2023

Learning Outcomes: 1. Demonstrate knowledge of Human Cultures and the Natural World by studying the arts and sciences of other cultures.

Audience: Undergraduate

2. Apply Critical and Creative Thinking Skills, including inquiry, problem solving, and qualitative reasoning.

Audience: Undergraduate

3. Demonstrate effective Communication Skills in reading, visual communication, and information literacy.

Audience: Undergraduate

CIV ENGR 360 – CONSTRUCTION SYSTEMS

3 credits.

Introduction to the parts and pieces of a building at the construction level. How a building is built from start to finish, and how the individual building systems affect one another. Systems, how they interact, design and construction, cost implications, schedule implications.

Requisites: E M A 201, PHYSICS 201, 207, 247, graduate/professional standing, or member of Engineering Guest Students. Not open to students with credit in CIV ENGR 290.

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Learning Outcomes: 1. Explain many different design and construction of building systems

Audience: Both Grad & Undergrad

2. Identify types of systems visually on site

Audience: Both Grad & Undergrad

3. Evaluate which type of each system may be best for the design

Audience: Both Grad & Undergrad

4. Evaluate the cost, schedule, and procurement implications of designs

Audience: Both Grad & Undergrad

5. Work effectively in a design team and create an operations plan for a project

Audience: Both Grad & Undergrad

6. Analyze systems more deeply through research

Audience: Graduate

CIV ENGR 370 – TRANSPORTATION ENGINEERING

3 credits.

Characteristics of transportation supply and demand; measuring and estimating demand; social and environmental impacts; planning of transportation systems; characteristics of transportation modes; interaction between modes; mode interfaces; transportation technology; economics; public policy, implementation and management.

Requisites: STAT 311, 324 or concurrent enrollment, graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Identify and describe the basic elements of the transportation delivery system

Audience: Undergraduate

2. Use quantitative and computerized techniques for planning, designing, and operating transportation systems

Audience: Undergraduate

3. Describe and critique theoretical design and operations issues

Audience: Undergraduate

4. Explain the need for highway design standards and how the political process, economics, and new technologies affect transportation decision making

Audience: Undergraduate

5. Explain how travel mode characteristics influence demand and mode choice; and how multiple modes of transportation interact

Audience: Undergraduate

6. Use the principles of transportation engineering and highway design standards to solve a specific problem

Audience: Undergraduate

7. Examine, design, optimize, simulate, and present, in both written and oral formats, a thorough description of their analysis procedure

Audience: Undergraduate

CIV ENGR/BSE/SOIL SCI 372 – ON-SITE WASTE WATER TREATMENT AND DISPERSAL

2 credits.

On-site treatment and dispersal of waste water from homes, commercial sources and small communities. Sources, pretreatment units, nutrient removal units, constructed wetlands, surface and soil dispersal systems, recycle and reuse systems, regulations, alternative collection systems.

Requisites: CHEM 103, 109, or 115

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Identify, formulate, solve complex wastewater management and engineering problems by applying engineering and science principles to design a complete residential onsite wastewater treatment system.

Audience: Undergraduate

2. Use engineering design to produce wastewater management solutions that meet treatment goals with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Audience: Undergraduate

3. Communicate effectively with the instructor and other students during in-class discussions.

Audience: Undergraduate

4. Recognize ethical and professional responsibilities in onsite wastewater management and engineering situations and make informed design assumptions/judgments, which must consider the impact of wastewater management solutions in global, economic, environmental, and societal context.

Audience: Undergraduate

5. Analyze and interpret data related to wastewater flow, source, and characteristics, soil/site characteristics, and use engineering judgement to select appropriate design solutions.

Audience: Undergraduate

6. Acquire and apply new knowledge regarding advanced treatment processes for residential wastewater treatment.

Audience: Undergraduate

CIV ENGR/ENVIR ST/GEOG 377 – AN INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS

4 credits.

Design, implementation and use of automated procedures for storage, analysis and display of spatial information. Covers data bases, information manipulation and display techniques, software systems and management issues. Case studies.

Requisites: Sophomore standing, member of Engineering Guest Students, or declared in Capstone Certificate in GIS Fundamentals

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the basic structures, concepts, and theories of GIS.

Audience: Both Grad & Undergrad

2. Conduct daily routines of GIS operations.

Audience: Both Grad & Undergrad

3. Make connections to the broader literature in GIS

Audience: Graduate

CIV ENGR 392 – BUILDING INFORMATION MODELING (BIM)

3 credits.

An introduction to the use of Building Information Modeling (BIM) technology in the construction industry. Gain experience in using 3D 4D modeling software to model and coordinate building designs.

Requisites: CIV ENGR 159, M E 160, 231, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Identify concepts and principles of building information modeling

Audience: Undergraduate

2. Explain construction management with 3-dimensional (3D) and 4D building information models

Audience: Undergraduate

3. Use computer tools to model a building

Audience: Undergraduate

4. Use communication and teamwork skills in multi-disciplinary building design modeling

Audience: Undergraduate

5. List, examine, and critique modeling challenges

Audience: Graduate

6. Develop innovative solutions to modeling challenges so that construction inefficiencies are minimized

Audience: Graduate

CIV ENGR/E M A 395 – MATERIALS FOR CONSTRUCTED FACILITIES

3 credits.

Properties and tests of materials used in the initial construction or repair of facilities (including buildings, transportation systems, utility systems, and reinforced earth). Introduction to laboratory and field measurement techniques to assess material performance capabilities. Technical report preparation.

Requisites: (E M A 303 or M E 306), graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Use knowledge of construction materials behavior to select and specify materials for construction of civil engineering facilities

Audience: Undergraduate

2. Use knowledge of construction materials behavior to monitor construction of civil engineering facilities

Audience: Undergraduate

3. Conduct experiments with standardized testing protocols, interpret test results, and communicate results and interpretation in technical reports

Audience: Undergraduate

4. Design and conduct forensic studies to determine the role of material properties or construction methods in facility failures

Audience: Undergraduate

5. Use teamwork and communication skills relevant to the selection, specification, monitoring, and testing of construction materials

Audience: Undergraduate

CIV ENGR 410 – HYDRAULIC ENGINEERING

3 credits.

Engineering approaches to measurement, control and conveyance of water and wastewater flows, emphasizing analysis, design, characteristics and selection of: measurement devices, distribution and collection pipe systems, and pumps and turbines with consideration of plant, quality, economic, reliability, and security aspects.

Requisites: CIV ENGR 310, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Quantitatively and qualitatively assess, estimate, and communicate the hydraulic performance of pressure-flow conveyance systems, including pumps, pipes, pipe grids, valves, storage tanks, and flow meters

Audience: Both Grad & Undergrad

2. Select a pipe material and pipe diameter to meet a specified objective

Audience: Both Grad & Undergrad

3. Describe the purpose of different valve types and select a valve to meet a specified objective

Audience: Both Grad & Undergrad

4. Select a pump and pump material to meet a specified objective

Audience: Both Grad & Undergrad

5. Estimate the performance of a pump operated at different speeds and against changing resistance to flow

Audience: Both Grad & Undergrad

6. Use hydraulic modeling software to simulate a drinking water distribution grid and to evaluate alternative solutions to meet changing objectives

Audience: Both Grad & Undergrad

7. Describe alternative ways of recovering energy from hydraulic systems and estimate return on investment for such systems

Audience: Graduate

CIV ENGR 411 – OPEN CHANNEL HYDRAULICS

3 credits.

Analysis and characteristics of flow in open channels (natural and artificial); channel design considerations including uniform flow (rivers, sewers), flow measuring devices (weirs, flumes), gradually varied flow (backwater and other flow profiles, flood routing), rapidly varied flow (hydraulic jump, spillways), and channel design problems (geometric considerations, scour, channel stabilization, sediment transport).

Requisites: CIV ENGR 310, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Explain the characteristics of open channel flows.

Audience: Both Grad & Undergrad

2. Describe free surface flow profile and quantify mass, energy, and momentum of open channel flows.

Audience: Both Grad & Undergrad

3. Apply fundamental principles governing open channel hydraulics to the design of engineering or nature-based systems.

Audience: Both Grad & Undergrad

4. Explain a solution to an engineering problem that relies on open channel hydraulic principles.

Audience: Both Grad & Undergrad

5. Synthesize scientific literature related to open channel flows.

Audience: Graduate

CIV ENGR 412 – GROUNDWATER HYDRAULICS

3 credits.

Engineering fundamentals of groundwater flow. Focus is on developing and implementing 2-D, steady-state, analytical models of groundwater flow. Also introduces transient groundwater flow modeling, hydraulic testing methods, and numerical modeling.

Requisites: CIV ENGR 311, GEOSCI/G L E 627, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Conceptualize groundwater flow systems

Audience: Both Grad & Undergrad

2. Develop and apply 2-D, steady-state, analytical models of groundwater flow

Audience: Both Grad & Undergrad

3. Explain and use equations describing transient groundwater flow

Audience: Both Grad & Undergrad

4. Apply hydraulic testing methods

Audience: Both Grad & Undergrad

5. Develop and use a basic numerical model of groundwater flow

Audience: Both Grad & Undergrad

6. Explain contemporary groundwater issues and their societal relevance

Audience: Graduate

CIV ENGR 414 – HYDROLOGIC DESIGN

3 credits.

An introduction to the design of engineering structures which control and/or utilize runoff, emphasizing the sizing of structures to meet hydrologic uncertainty. Applies principles and techniques from several disciplines, including hydrology, hydraulics, probability and statistics. Specific techniques include flood frequency analysis; risk analysis; design storm and historic storm techniques; rainfall-runoff modeling.

Requisites: G L E/CIV ENGR 291 and CIV ENGR 311, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Summer 2025

Learning Outcomes: 1. Explain the rationale for NRCS hydrologic methods and apply these methods to quantify the increase in runoff resulting from urbanization of a plot of land.

Audience: Both Grad & Undergrad

2. Describe contemporary low impact development practices and specific best management practices that help mitigate the adverse effects of urbanization on stormwater quantity and quality.

Audience: Both Grad & Undergrad

3. Utilize modeling software common to water resource engineering practice to design urban stormwater conveyance system components and best management practices.

Audience: Both Grad & Undergrad

4. Explain the key steps and considerations in the permitting, design, and management of stormwater infrastructure.

Audience: Both Grad & Undergrad

5. Estimate flood probabilities and risk, and describe strategies for managing the risk.

Audience: Both Grad & Undergrad

6. Describe contemporary stormwater and flooding issues and their impact on society and the natural environment.

Audience: Graduate

CIV ENGR 415 – HYDROLOGY

3 credits.

Water cycle as related to air mass properties and movement, precipitation, evaporation, snowmelt, infiltration, streamflow, watershed dynamics, and hydrologic extremes. Physics-based representations of hydrological processes. Basics of hydrologic modeling including calibration and validation.

Requisites: MATH 221, 217, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Differentiate between representations of runoff, streamflow, evapotranspiration, precipitation, infiltration, soil moisture, and snowpack based on physical principles and empirical simplifications

Audience: Both Grad & Undergrad

2. Derive quantitative relationships describing terrestrial water and energy fluxes

Audience: Both Grad & Undergrad

3. Formulate mathematical models of the water terrestrial water cycle at point and watershed scales

Audience: Both Grad & Undergrad

4. Identify the strengths and weaknesses of hydrologic predictions for addressing real-world water resources challenges, including in a changing climate

Audience: Both Grad & Undergrad

5. Contrast water resources engineering methods with more complex hydrologic and hydraulic methods

Audience: Undergraduate

6. Identify the geophysical conditions under which specific hydrologic assumptions are valid

Audience: Graduate

CIV ENGR 416 – WATER RESOURCES SYSTEMS ANALYSIS

3 credits.

Water supply and demand are increasingly stressed by climate, population, land-use, policy, etc. Presents a variety of systems analysis techniques for water resources planning and management. Deterministic and stochastic optimization and simulation models will be developed and applied.

Problems addressed include water supply, water quality, and river basin development.

Requisites: CIV ENGR 311, graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Characterize planning, design, and management objectives in water systems

Audience: Undergraduate

2. Formulate, design and solve optimization models of water systems

Audience: Undergraduate

3. Integrate systems outputs into decision-making models

Audience: Undergraduate

4. Apply basic fundamentals of economic theory to water resources problems

Audience: Undergraduate

5. Articulate current issues in water resource management

Audience: Undergraduate

6. Write codes to perform statistical analyses

Audience: Undergraduate

7. Determine multiple performance metrics and subsequently draw suitable conclusions

Audience: Undergraduate

CIV ENGR/G L E 421 – ENVIRONMENTAL SUSTAINABILITY ENGINEERING

3 credits.

Uses the three paradigms of sustainability (environmental, social, and economic) for strategic environmental initiatives in an engineering setting. Proactive environmental management opportunities, including practices of pollution prevention, industrial ecology, and design for the environment. A systems approach to manufacturing, examining the life cycle of products, incorporating total cost accounting, extended producer responsibility, and design for end-of-life.

Requisites: (MATH 217 or 221) and (CHEM 104 or 109), or graduate/professional standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Articulate why sustainability is important and relevant within the practice of engineering

Audience: Both Grad & Undergrad

2. Apply sustainability tools such as industrial ecology, life cycle assessment, economic assessment, material flow analysis, and criticality to inform engineering decisions

Audience: Both Grad & Undergrad

3. Analyze sustainability issues and/or practices using a systems-based approach

Audience: Both Grad & Undergrad

4. Describe the social, economic, and environmental dimensions of engineering and identify potential trade-offs and interrelationships among these dimensions at a level appropriate to the course

Audience: Both Grad & Undergrad

5. Identify and critique recent peer reviewed sustainability literature

Audience: Graduate

CIV ENGR 422 – ELEMENTS OF PUBLIC HEALTH ENGINEERING

3 credits.

Overview of the public health profession and the role of environmental sanitary engineers in public health. Introduction to chemical and microbial contaminants of public health concern - their routes of exposure and development of regulatory standards for drinking water, air, hazardous wastes, and industrial workplaces. Introduction to occurrence, toxicity, and virulence as components of public health risk and the engineer's role in identifying occurrence and design of engineering controls for public health protection.

Requisites: CIV ENGR 320, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

Learning Outcomes: 1. Describe methods used to characterize risks associated with chemical toxins and microbial pathogens

Audience: Both Grad & Undergrad

2. Describe the contributions of exposure and potency/virulence to risk and calculate risks

Audience: Both Grad & Undergrad

3. List alternative routes of exposure and estimate the contribution of different sources to overall exposure

Audience: Both Grad & Undergrad

4. Explain how regulatory standards are derived from risk estimates

Audience: Both Grad & Undergrad

5. List the technologies that environmental engineers can design, build, and operate to limit exposure to a specified chemical toxin or microbial pathogen

Audience: Both Grad & Undergrad

6. Connect the topics of this course with their graduate research work

Audience: Graduate

CIV ENGR 423 – AIR POLLUTION EFFECTS, MEASUREMENT AND CONTROL

3 credits.

The influence of man-caused pollution on the atmosphere, globally and locally. Evaluation of human health, economic, and aesthetic effects of air pollution. Techniques for measurement of atmosphere pollutant concentrations and determination of local and regional air quality. Detailed presentation of air pollution sources and methods for their control. The role of local, state and federal government in air pollution control.

Requisites: Senior standing and declared in Biomed, Biological Sys, Chemical, Civil, Computer, Electrical, Environmental, Geological, Industrial, Mechanical or Nuclear Egr, Mat Sci & Egr, Egr Physics, Egr Mechanics, grad/prof standing or member of Egr Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the roles of engineers and scientists in managing air quality

Audience: Both Grad & Undergrad

2. Classify the breadth of air pollution problems into the following scales: indoor residential air quality, indoor industrial air quality, urban air pollution, regional air pollution, and global climate change

Audience: Both Grad & Undergrad

3. Describe the sources, transformations, fates, and impacts of key priority air pollutants at the scales noted above

Audience: Both Grad & Undergrad

4. Derive and use mass balance and reactor model calculations to estimate concentrations, and to identify fates and sources of air pollution at the scales noted above

Audience: Both Grad & Undergrad

5. Estimate transport and thermodynamic properties related to the formation, destruction, and removal of air pollutants

Audience: Both Grad & Undergrad

6. Explain the key technologies and processes used to prevent air pollution formation, transform air pollutants and remove air pollutants

Audience: Both Grad & Undergrad

7. Develop a basic design to mitigate an air pollution problem

Audience: Graduate

**CIV ENGR 425 – ENVIRONMENTAL ENGINEERING
MICROBIOLOGY**

3 credits.

Microbial interactions in soils, water, extreme environments and biofilms. Modern methods for studying microbial ecology. Role of microbes in nutrient cycles and biogeochemistry. Use of microbes for mitigating human-made environmental problems of industrial, agricultural, and domestic origin. Emphasis on engineered systems.

Requisites: MICROBIO 303 or graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Predict which kinds of organisms will be found in different ecosystems using quantitative reasoning when possible

Audience: Both Grad & Undergrad

2. Describe research tools and applications in environmental microbiology as well as their limitations

Audience: Both Grad & Undergrad

3. Critically evaluate published research carried out in the field and think creatively about new potential research questions and applications

Audience: Both Grad & Undergrad

4. Work collaboratively in a team to enhance learning and solve complex problems

Audience: Both Grad & Undergrad

5. Synthesize and condense complex concepts into a form that is accessible to peers

Audience: Graduate

CIV ENGR 426 – DESIGN OF WASTEWATER TREATMENT PLANTS

3 credits.

Unit operations in wastewater treatment; physical, chemical, and biological processes for treatment of wastewater; sludge treatment and disposal; design of a wastewater treatment plant; site visits to wastewater treatment plants.

Requisites: Senior standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Find regulatory requirements for effluent permits, design, and operation of wastewater treatment plants and incorporate them as constraints when developing design solutions

Audience: Both Grad & Undergrad

2. Develop technically feasible alternative solutions, compare the alternative solutions, and recommend one of the solutions

Audience: Both Grad & Undergrad

3. Create plans and specifications that allow construction of a portion of the recommended solution

Audience: Both Grad & Undergrad

4. Design experiments necessary to gather data and create information for use in design

Audience: Both Grad & Undergrad

5. Implement measures to consider risk, reliability, and uncertainty in wastewater treatment

Audience: Both Grad & Undergrad

6. Use the skills and expertise of multiple disciplines on a design team to address complex engineering problems

Audience: Both Grad & Undergrad

7. Apply sustainability principles and/or frameworks to addressing the challenge of wastewater treatment

Audience: Both Grad & Undergrad

8. Explain the social, economic, and/or environmental dimensions of the sustainability challenge(s) of wastewater treatment

Audience: Both Grad & Undergrad

9. Manage a group of undergraduate students through the design process

Audience: Graduate

CIV ENGR 427 – SOLID AND HAZARDOUS WASTES ENGINEERING

3 credits.

Basic concepts in designing, evaluating, and operating solid wastes storage, collection, and disposal systems; waste reduction, resource recovery, incineration and land disposal methods; hazardous wastes engineering; legal, political, and administrative considerations.

Requisites: Senior standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Find regulatory requirements for design and operation in solid and hazardous waste engineering and incorporate them as constraints when developing design solutions

Audience: Both Grad & Undergrad

2. Develop technically feasible alternative solutions, compare the alternative solutions, and recommend one of the solutions

Audience: Both Grad & Undergrad

3. Create plans and specifications that allow construction of a portion of the recommended solution

Audience: Both Grad & Undergrad

4. Address professional and ethical issues in environmental engineering

Audience: Both Grad & Undergrad

5. Implement measures to consider risk, reliability, and uncertainty in hazardous waste management

Audience: Both Grad & Undergrad

6. Use the skills and expertise of multiple disciplines on a design team to address complex engineering problems

Audience: Both Grad & Undergrad

7. Apply sustainability principles and/or frameworks to address energy and resource use in solid and hazardous waste engineering design and operation

Audience: Both Grad & Undergrad

8. Explain the social, economic, and/or environmental dimensions of the sustainability challenge(s) of solid and hazardous wastes engineering

Audience: Both Grad & Undergrad

9. Manage a group of undergraduate students through the design process

Audience: Graduate

CIV ENGR 428 – WATER TREATMENT PLANT DESIGN

3 credits.

Preliminary studies and design of water treatment processes and subordinate plant facilities; project control of design project; unit operations in water treatment; groundwater treatment; preliminary cost estimates; introduction of computer-aided design concept; site visits to water treatment plants.

Requisites: Senior standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Find regulatory requirements for water quality, operation, and design, and incorporate them as constraints when developing design solutions

Audience: Both Grad & Undergrad

2. Develop technically feasible alternative solutions, compare the alternative solutions, and recommend one of the solutions

Audience: Both Grad & Undergrad

3. Create plans and specifications that allow construction of a portion of the recommended solution

Audience: Both Grad & Undergrad

4. Implement measures to consider risk, reliability, and uncertainty in water treatment plant design

Audience: Both Grad & Undergrad

5. Apply sustainability principles and/or frameworks to addressing the challenge of drinking water treatment

Audience: Both Grad & Undergrad

6. Explain the social, economic, and/or environmental dimensions of the sustainability challenge(s) of drinking water treatment

Audience: Both Grad & Undergrad

7. Manage a group of undergraduate students through the design process

Audience: Graduate

CIV ENGR/G L E 430 – INTRODUCTION TO SLOPE STABILITY AND EARTH RETENTION

1 credit.

Introduction to theory and approaches commonly used in geotechnical engineering practice for design and analysis of slopes and earth retaining structures.

Requisites: CIV ENGR/G L E 330, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Calculate the factor of safety of natural or engineered slopes

Audience: Both Grad & Undergrad

2. Design simple earth retaining structures

Audience: Both Grad & Undergrad

3. Perform additional design strategies to design complex slope or retaining structures

Audience: Graduate

4. Lead a team of undergraduate students for the final design project exercise

Audience: Graduate

CIV ENGR/G L E 432 – INTRODUCTION TO SHALLOW AND DEEP FOUNDATION SYSTEMS

1 credit.

Introduction to theory and approaches commonly used in geotechnical engineering practice for design and analysis of slopes and earth retaining structures.

Requisites: CIV ENGR/G L E 330, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Apply methods and requirements of a subsurface investigation program

Audience: Both Grad & Undergrad

2. Collect sufficient information to design basic shallow or deep foundation systems

Audience: Both Grad & Undergrad

3. Fulfill the design criteria for different structures and facilities

Audience: Both Grad & Undergrad

4. Design shallow and deep foundation structures

Audience: Both Grad & Undergrad

5. Perform additional design strategies to design the foundation of a soil retaining structure

Audience: Graduate

CIV ENGR/G L E 434 – INTRODUCTION TO UNDERGROUND OPENINGS ENGINEERING

1 credit.

Subsurface stress; rock failure criteria; openings in competent rock; openings in layered rocks; plastic behavior around openings in weak rock; stereographic projections and stereonet; block theory; rock bolts; stabilization methods and design.

Requisites: CIV ENGR/G L E 330, GEOSCI/CIV ENGR/G L E/ M S & E 474 or concurrent enrollment, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Predict stress concentrations around underground openings

Audience: Both Grad & Undergrad

2. Identify weak points around underground openings in conjunction with the rock mass type information

Audience: Both Grad & Undergrad

3. Design openings to minimize hazard

Audience: Both Grad & Undergrad

4. Design reinforcement strategies

Audience: Both Grad & Undergrad

5. Perform advanced design strategies

Audience: Graduate

CIV ENGR 440 – STRUCTURAL ANALYSIS II

3 credits.

Analysis of structures by displacement methods with computer solutions. Slope deflection and moment distribution methods. Derivation of stiffness matrices for two-dimensional frames. Introduction to commercial structural analysis software. Shear deformations.

Requisites: CIV ENGR 340, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Model a structure, including boundary conditions and loading, for analysis using the stiffness method

Audience: Both Grad & Undergrad

2. Solve for unknown joint displacements, reactions, and member actions using the stiffness method

Audience: Both Grad & Undergrad

3. Use energy concepts for the determination of deflections, member stiffness/flexibility matrices, and equivalent joint loads

Audience: Both Grad & Undergrad

4. Account for material and geometric nonlinearities in the analysis of simple two-dimensional frame structures

Audience: Graduate

CIV ENGR/ENVIR ST/G L E/GEOSCI 444 – PRACTICAL APPLICATIONS OF GPS SURVEYING

2 credits.

Global positioning system surveying for field applications. Signals. Coordinate systems. Datums. Cartographic projections. Satellite orbits. Choosing hardware. Strategies for data collection and analysis. Assessing uncertainty. Geocoding satellite images. Integrating data with Geographic Information Systems. Emerging technologies.

Requisites: MATH 211, 217, 221, or graduate/professional standing, or member of Engineering Guest Students

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the current abilities, future potential, and limiting factors of GPS surveys.

Audience: Both Grad & Undergrad

2. Assess the tradeoff between accuracy and cost.

Audience: Both Grad & Undergrad

3. Summarize examples of applications of GPS surveying.

Audience: Both Grad & Undergrad

4. Design and implement a small field project using GPS surveying.

Audience: Both Grad & Undergrad

5. Assess quantitatively statistical precision and calibrated accuracy.

Audience: Graduate

CIV ENGR 445 – STEEL STRUCTURES I

3 credits.

Design loads, codes, specifications and standards; philosophies of design; load and resistance factor design (LRFD); allowable stress design (ASD); properties and types of structural steel; residual stresses; behavior and LRFD design criteria for tension members, compression; laterally braced and unbraced beams; essentials of bolted and welded connections.

Requisites: CIV ENGR 340, graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Demonstrate a working knowledge of the typical strength limit states of a tension member and simple bolted tension connection, including gross yielding, fracture of an effective net section, and block shear

Audience: Undergraduate

2. Demonstrate a working knowledge of the typical strength limit states of a compression member, including gross yielding, elastic and inelastic flexural buckling, and local web buckling

Audience: Undergraduate

3. Demonstrate a working knowledge of the typical strength limit states of a flexural member, including yielding, elastic and inelastic lateral-torsional buckling, and local flange buckling

Audience: Undergraduate

4. Demonstrate a working knowledge of the typical strength limit states of a member subjected to the combined effects of flexure and axial force, including yielding, lateral-torsional buckling, and local buckling

Audience: Undergraduate

5. Check, proportion and design structural steel members subjected to tension, compression, or/and flexure to satisfy the requirements of the AISC Specification for Structural Steel Buildings using the Load and Resistance Factor Design method

Audience: Undergraduate

6. Develop technically feasible alternative solutions to a problem, compare the alternative solutions, and recommended one of the solutions as the preferred option

Audience: Undergraduate

CIV ENGR 447 – CONCRETE STRUCTURES I

3 credits.

Behavior of reinforced concrete structural elements; concepts of design and proportioning sections for strength and serviceability; background of specification requirements; strength design applied to beams, columns, and members under combined axial load and bending; continuous beams.

Requisites: CIV ENGR 340, graduate/professional standing, or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Compute required strengths for flexure, shear, and axial load, as well as moment and shear envelopes of design using the load factors and load combinations specified by the current building code requirements for structural concrete

Audience: Undergraduate

2. Perform a structural analysis and design of reinforced concrete members with rectangular and T-shaped sections subjected to flexure and shear (beams)

Audience: Undergraduate

3. Perform a structural analysis and design of reinforced concrete members subjected to combined flexure and axial loads (columns)

Audience: Undergraduate

4. Develop technically feasible alternative solutions to a problem, compare the alternative solutions, and recommend one of the solutions as the preferred option

Audience: Undergraduate

5. Compute required and design strengths for flexure, shear, and axial load for reinforced concrete members using commonly available structural analysis and design software

Audience: Undergraduate

CIV ENGR 451 – ARCHITECTURAL DESIGN

3 credits.

Introduction to building design, its methods, tools and processes and the interface with other professionals in building design and construction.

Buildings as an integrated system of components, assemblies and sub-systems, including: structure, enclosure, internal finish and furnishing, circulation, conveyance and mechanical systems. Pragmatic design elements that make a project sustainable, energy efficient and comfortable, including; fenestration options, daylighting, passive heating and cooling, energy efficiency and other lower impact approaches identified in LEED standards.

Requisites: None

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Identify the social, formal and spatial context of buildings and urban sites and how they are used to configure building design solutions.

Audience: Undergraduate

2. Use architectural precedent (formal, spatial, organizational, typological and historical) for design direction on current project.

Audience: Undergraduate

3. Identify a building's integrated system of components, assemblies and sub-systems, including: structure, enclosure, internal finishing and furnishing, circulation and conveyance and environmental control and servicing.

Audience: Undergraduate

4. Identify and incorporate in design projects, critical health and life safety concerns and as exemplified in (building and zoning) codes, including; egress / exiting, accessibility, construction type, fire resistance and separation / isolation.

Audience: Undergraduate

5. Apply appropriate software to the architectural design process to develop, assemble, dimension and annotate a comprehensive set of architectural design documents in conventional formats.

Audience: Undergraduate

CIV ENGR 465 – DATA SENSING AND ANALYSIS IN CONSTRUCTION

3 credits.

Introduction to data sensing and analysis technologies for the onsite data capture, analysis and visualization in construction projects. Experience of using close range remote sensors and computing tools to facilitate construction engineering and management tasks. Focus on 1) project 3D as-built modeling and documentation, 2) visual detection, tracking and activity recognition of construction equipment and personnel, and 3) virtual construction inspection and site tour in mixed reality.

Requisites: G L E/CIV ENGR 291, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe challenges related to data sensing and analysis in construction

Audience: Both Grad & Undergrad

2. Use computer tools to analyze and visualize construction project data and models

Audience: Both Grad & Undergrad

3. Identify, formulate and solve construction engineering and management problems with remote sensors

Audience: Both Grad & Undergrad

4. Critically evaluate sensing technologies and actively develop innovative solutions to improve construction safety, productivity and quality

Audience: Graduate

CIV ENGR/G L E/GEOSCI/M S & E 474 – ROCK MECHANICS

3 credits.

Classification of rock masses, stress and strain in rock, linear and non-linear behavior of rock, failure mechanisms, state of stress in rock masses, lab testing, geological and engineering applications.

Requisites: E M A 201, PHYSICS 201, 207, or 247, or graduate/professional standing, or member of Engineering Guest Students

Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Measure basic index properties for rock mass classification

Audience: Both Grad & Undergrad

2. Describe stress and strain in continuums

Audience: Both Grad & Undergrad

3. Describe the factors which control the mechanical behavior of rocks

Audience: Both Grad & Undergrad

4. Apply basic concepts of rock mechanics and rock physics to analyze basic geomechanical engineering problems

Audience: Both Grad & Undergrad

5. Prepare rock samples for mechanical testing, conduct experiment, and analyze experimental data to obtain rock strength properties

Audience: Both Grad & Undergrad

6. Describe analytically time-dependent rock behaviors

Audience: Graduate

CIV ENGR 489 – HONORS IN RESEARCH

1-3 credits.

Undergrad honors research projects supervised by faculty members.

Requisites: Consent of instructor

Course Designation: Honors - Honors Only Courses (H)

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Conduct and report on independent civil or environmental engineering research

Audience: Undergraduate

2. Independently develop civil or environmental engineering research questions

Audience: Undergraduate

3. Appropriately use online and library resources

Audience: Undergraduate

CIV ENGR 491 – LEGAL ASPECTS OF ENGINEERING

3 credits.

Legal principles and institutions germane to engineering practice; formation and performance of engineer-client and owner-contractor relationships; preparation of technical specifications; surety bonds and insurance; construction liens; contract administration; construction contract remedies; intellectual property of engineers; engineers' obligations to society and their fellow engineers.

Requisites: Senior standing or member of Engineering Guest Students

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Recognize the core components of the legal process and describe those components, including the nature of disputes, remedies, rules of law, and rules of contract interpretation affecting performance, termination, and completion of construction projects
Audience: Undergraduate

2. Identify the legal relationships between owners and design professionals
Audience: Undergraduate

3. Identify the legal relationships between owners and construction contractors
Audience: Undergraduate

4. Recognize core contract administration procedures and explain the purpose of each procedure
Audience: Undergraduate

5. Evaluate the procedures for interpreting contracts and contract clauses
Audience: Undergraduate

6. Use basic legal rules to resolve contract disputes
Audience: Undergraduate

CIV ENGR 492 – INTEGRATED PROJECT ESTIMATING AND SCHEDULING

3 credits.

Principles of estimating and scheduling for the construction industry, engineer's preliminary and final estimates' quantity take offs and cost and duration determinations for major items related to a construction project; use manual and computer techniques.

Requisites: Junior standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Recognize and describe the core components of construction estimating, planning, and scheduling
Audience: Both Grad & Undergrad

2. List the steps needed to develop a cost estimate for a real-life project, then create a construction cost estimate using industry-appropriate software
Audience: Both Grad & Undergrad

3. List the steps needed to develop a time schedule for a real-life project, then create a construction schedule with a critical path plan using industry-appropriate software
Audience: Both Grad & Undergrad

4. Interpret construction blueprints
Audience: Both Grad & Undergrad

5. Integrate estimating and scheduling as a function of construction planning
Audience: Both Grad & Undergrad

6. Prepare and develop a contractor's bid document and deliver quantitative information in an organized manner to clients
Audience: Graduate

7. Work in a collaborative environment; lead and guide undergraduate students throughout the development of a scheduling and estimating project
Audience: Graduate

CIV ENGR 494 – CIVIL AND ENVIRONMENTAL ENGINEERING DECISION MAKING

3 credits.

Planning, designing, and managing civil and environmental engineering systems. Fundamentals of the systems approach; marginal analysis; optimization techniques; decision analysis; economic analysis; cost-effectiveness analysis. Case study applications.

Requisites: MATH 217, 221, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Summarize planning, design, and management objectives in civil and environmental systems

Audience: Both Grad & Undergrad

2. Describe and solve fundamental engineering economics problems

Audience: Both Grad & Undergrad

3. Explain optimization concepts and modeling

Audience: Both Grad & Undergrad

4. Formulate, design, and solve linear optimization models

Audience: Both Grad & Undergrad

5. Describe and execute scheduling and critical paths methods

Audience: Both Grad & Undergrad

6. Explain decision theory, methods, and criteria

Audience: Both Grad & Undergrad

7. Define ethical responsibility in engineering

Audience: Both Grad & Undergrad

8. Analyze sustainability issues and/or practices using a systems-based approach

Audience: Both Grad & Undergrad

9. Explain the social, economic, and/or environmental dimensions of the sustainability challenges of engineering decision making

Audience: Both Grad & Undergrad

10. Apply tools and methods to research analysis

Audience: Graduate

CIV ENGR 495 – SUSTAINABLE BUILDING AND MATERIALS

3 credits.

Concepts of sustainability in Civil Engineering with an emphasis on construction materials. Introduction to life-cycle assessment approach to evaluating the impact of infrastructure development. Current sustainable practices in construction projects. Connecting values to clients, stakeholders, and societal needs. Sustainability rating programs, such as LEED, Envision, and INVEST.

Requisites: CIV ENGR 325, E M A/CIV ENGR 395, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Explain the social, economic, and/or environmental dimensions of the sustainability challenges of building and infrastructure projects to the general public

Audience: Both Grad & Undergrad

2. Describe the social, economic, and environmental dimensions of material use in construction and identify potential trade-offs and interrelationships among these dimensions at a level appropriate to the course

Audience: Both Grad & Undergrad

3. Explain the principles and functions of common sustainability rating programs used for construction projects

Audience: Both Grad & Undergrad

4. Analyze sustainability issues and/or practices using a systems-based approach.

Audience: Graduate

CIV ENGR 496 – ELECTRICAL SYSTEMS FOR CONSTRUCTION

3 credits.

Basic electricity, utility systems, standards and codes, electrical construction materials, branch circuit design, motor branch circuit design, feeder and service design, estimating and management concepts in electrical contracting, grounding, lighting, telecommunications.

Requisites: PHYSICS 202, 208, 248, graduate/professional standing, or member of engineering guest students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Interpret electrical construction documents
Audience: Both Grad & Undergrad

2. Find project-specific requirements in the National Electrical Code and interpret differences between common codes and standards used for electrical design of commercial, industrial, and institutional building systems
Audience: Both Grad & Undergrad

3. Design layouts for lighting and power devices
Audience: Both Grad & Undergrad

4. Size electrical feeders and building services using appropriate calculations, then draft and interpret electrical drawings based on these calculations
Audience: Both Grad & Undergrad

5. Describe key design considerations for fire alarm, telecommunications, and security systems
Audience: Both Grad & Undergrad

6. List advantages and disadvantages of different electrical construction materials according to their intended use
Audience: Both Grad & Undergrad

7. Perform quantity takeoffs and cost estimates of electrical components in construction
Audience: Graduate

CIV ENGR 497 – MECHANICAL SYSTEMS FOR CONSTRUCTION

3 credits.

Introduction to building mechanical systems. Plumbing, heating, ventilation, air conditioning, fire protection, automation/controls and process systems. Introduction to mechanical systems design and cost estimating. Mechanical system management.

Requisites: PHYSICS 202, 208, 248, graduate/professional standing, or member of engineering guest students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Explore the Building Information Modeling (BIM) interface and BIM360 interface
Audience: Both Grad & Undergrad

2. Draft a 3D building model to explain how information is inter-related throughout the BIM model
Audience: Both Grad & Undergrad

3. Develop a project which includes stairs and "feature architectural designs", structural and MEP (Mechanical, Electrical, and Plumbing) components to strengthen BIM modeling skill sets
Audience: Both Grad & Undergrad

4. Integrate architectural, structural and MEP building components into a 3D model and avoid clashes between the building systems
Audience: Both Grad & Undergrad

5. Extract construction document sheets from the 3D model
Audience: Both Grad & Undergrad

6. Collaborate with multiple users across a wide area network and save their work to a central file
Audience: Graduate

7. Streamline data management and work from remote locations using a local server
Audience: Graduate

CIV ENGR 498 – CONSTRUCTION PROJECT MANAGEMENT

3 credits.

Characteristics of Construction Industry; project organizations; the design and construction process; labor, material, and equipment utilization; cost estimation; construction pricing and contracting; construction planning; cost control, monitoring accounting; and management systems construction.

Requisites: Junior standing or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Define "ethical management practice", "personal development" and describe their personal commitment to each

Audience: Undergraduate

2. Define the terms "empathy" and "human capital" and describe their personal commitment to having empathy for human capital

Audience: Undergraduate

3. List and describe the core competencies of leadership and describe their personal commitment to leadership principles

Audience: Undergraduate

4. Identify and manage uncertainty and change in construction project management

Audience: Undergraduate

5. Use fundamentals of construction project management and its processes and/or components to solve real-life complex problems; define and distinguish construction project delivery systems and successful outcomes

Audience: Undergraduate

6. Use basic construction planning, cost management and contracts assessment skills

Audience: Undergraduate

CIV ENGR 500 – WATER CHEMISTRY

3 credits.

Elements of fresh and marine water chemistry; acid-base, precipitation, complexation, oxidation-reduction, adsorption, and biochemical reactions in natural waters and water treatment processes.

Requisites: CHEM 104, 109, 116, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Identify important types of aqueous-phase chemical reactions

Audience: Both Grad & Undergrad

2. Use thermodynamic concepts to determine whether aqueous-phase chemical reactions can proceed and, if so, the extent to which they can proceed

Audience: Both Grad & Undergrad

3. Use graphical methods to solve ionic equilibrium problems

Audience: Both Grad & Undergrad

4. Use modern numerical tools to solve water chemistry problems

Audience: Both Grad & Undergrad

5. Explain the relevance of water chemistry concepts to their thesis research

Audience: Graduate

CIV ENGR 501 – WATER ANALYSIS-INTERMEDIATE

3 credits.

Principles and applications of chemical and instrumental methods for the chemical analysis of water.

Requisites: CHEM 104, 109, 116, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2020

Learning Outcomes: 1. Explain the need for progressive development of water quality analyses to respond to emerging water quality issues

Audience: Both Grad & Undergrad

2. Describe principles of physical, chemical and biological techniques for assessing water quality and discuss analytical procedures, results, and interpretations of data

Audience: Both Grad & Undergrad

3. Use knowledge of water quality analyses to assess real-world environmental issues

Audience: Both Grad & Undergrad

4. Evaluate raw data to progressively determine factors influencing water quality in contrasting environments

Audience: Both Grad & Undergrad

5. Use appropriate techniques to address drinking water and wastewater engineering issues

Audience: Both Grad & Undergrad

6. Take on leadership roles in group projects and discussions relevant to pertinent water quality issues

Audience: Graduate

CIV ENGR/E M A/M E 508 – COMPOSITE MATERIALS

3 credits.

Physical properties and mechanical behavior of polymer, metal, ceramic, cementitious, cellulosic and biological composite systems; micro- and macro-mechanics; lamination and strength analyses; static and transient loading; fabrication; recycling; design; analytical-experimental correlation; applications.

Requisites: (E M A 303 or M E 306), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. List the different types of composite materials and describe their manufacturing processes

Audience: Both Grad & Undergrad

2. Describe the mechanical behavior of various composite materials under different types of loading conditions

Audience: Both Grad & Undergrad

3. Derive mathematical models and solve them for engineering stresses and deformations in a composite structure

Audience: Both Grad & Undergrad

4. Describe special theories for heterogeneous and non-isotropic materials and solve boundary value problems associated with composite structures

Audience: Both Grad & Undergrad

5. Use the knowledge acquired in this class to design and conduct a complex analysis, design, and/or experiment to address key challenges relevant to composite materials

Audience: Graduate

CIV ENGR/G L E 511 – MIXING AND TRANSPORT IN THE ENVIRONMENT

3 credits.

Application of fluid mechanics to understand the mixing and transport of contaminants, pollutants, and other solutes in the environment. Introduction to chemical and biochemical transformation processes as well as boundary interactions at the air-water and sediment-water interfaces. Transport phenomena: diffusive processes, advective processes, turbulent diffusion, and shear flow dispersion. Introduction to both analytical and computational solutions with applications to mixing and transport in rivers, lakes, the atmosphere, and coastal waters.

Requisites: (CIV ENGR/G L E 291, COMP SCI 220, or E C E 203) and (CIV ENGR 310 or M E 363), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2024

Learning Outcomes: 1. Recall the principles of conservation of mass, advective mass flux and Fick's law for diffusive mass flux

Audience: Both Grad & Undergrad

2. Apply the fundamental solution to the diffusion equation and use the principle of superposition to construct new solutions

Audience: Both Grad & Undergrad

3. Calculate the diffusivity given data of concentration distribution over time, and conversely, calculate the concentration distribution over time given the diffusivity

Audience: Both Grad & Undergrad

4. Calculate new solutions to advection-diffusion equation by modifying known solutions to include first-order reactions

Audience: Both Grad & Undergrad

5. Explain the differences between molecular diffusion, turbulent diffusion and shear flow dispersion

Audience: Both Grad & Undergrad

6. Apply models of mass transfer at boundaries to compute interfacial mass exchange between air-water and sediment-water interfaces

Audience: Both Grad & Undergrad

7. Evaluate the importance of mixing and transport processes in environmental processes and assess the utility of different types of solutions.

Audience: Graduate

CIV ENGR 514 – COASTAL ENGINEERING

2-3 credits.

The effect of natural forces associated with storms, hurricanes, and water-level variations on the coastal zone, and efforts made to combat these forces. Wave and storm-surge prediction, the change of waves as they approach shore, and wave forces on the shore; shore erosion and littoral drift; nearshore pollution in lakes and oceans; harbor, breakwater, and revetment design.

Requisites: CIV ENGR 311, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Explain the physical processes that are important for coastal environments.

Audience: Both Grad & Undergrad

2. Apply engineering principles to solve the coastal engineering issues such as coastal flooding, shoreline erosion, navigation sedimentation, and water quality pollution.

Audience: Both Grad & Undergrad

3. Explain coastal engineering problems and solutions to a non-technical audience.

Audience: Both Grad & Undergrad

4. Explain the social, economic, and/or environmental dimensions of the sustainability challenge(s) of coastal communities.

Audience: Both Grad & Undergrad

5. Apply sustainability principles and/or frameworks to addressing the challenge of sustainable coastal cities and communities under changing climate.

Audience: Both Grad & Undergrad

6. Synthesize scientific literature related to coastal engineering.

Audience: Graduate

CIV ENGR 515 – HYDROCLIMATOLOGY FOR WATER RESOURCES MANAGEMENT

3 credits.

Introduction to various strategies for integrating climate science into water resources, specifically addressing climatic influences on hydrologic variables, the prospects for prediction, and the implications on water management and development. Consider both space and time variability of hydrological processes in the context of sub-seasonal, seasonal, and climate change time-scales.

Requisites: CIV ENGR 415 and (STAT 224, 311, or 324), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Identify present to future and local to global hydroclimatic challenges

Audience: Both Grad & Undergrad

2. Perform diagnostics and attribution regarding the influence of climatic variables and phenomena on hydrologic variables

Audience: Both Grad & Undergrad

3. Design and verify probabilistic statistical and dynamical hydroclimatic forecasts

Audience: Both Grad & Undergrad

4. Explain the complexities of forecast communication

Audience: Both Grad & Undergrad

5. Explain the state and complexities of climate change science and modeling as it relates to water management

Audience: Both Grad & Undergrad

6. Write codes to perform statistical analyses

Audience: Graduate

7. Use multiple performance metrics and subsequently draw suitable conclusions

Audience: Graduate

CIV ENGR 516 – HYDROLOGIC DATA ANALYSIS

3 credits.

Introduction to probability and statistics and application to the analysis and modeling of real-world problems in hydrology, water resources engineering, and environmental data analysis.

Requisites: (MATH 221 or 217) and (STAT 311, 324, 340, MATH/STAT 309, 431, B M E 325, or E C E 331), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Demonstrate data literacy in the context of temporal and geospatial hydrologic and environmental datasets

Audience: Both Grad & Undergrad

2. Employ modern statistical software to analyze and model hydrologic and other environmental phenomena

Audience: Both Grad & Undergrad

3. Detect trends, relationships, and patterns in temporal and spatial hydrologic and environmental datasets using regression, extreme value analyses, and other popular hydrologic statistical techniques

Audience: Both Grad & Undergrad

4. Derive and interpret predictions, parameters, confidence levels, uncertainties, and sensitivities in the context of common hydrologic applications such as rainfall/flood frequency, hydropower, streamflow forecasting, and water quality

Audience: Both Grad & Undergrad

5. Identify applications of data analysis methods to specific water resources engineering and other civil and environmental engineering applications

Audience: Undergraduate

6. Identify and apply appropriate statistical analysis methods to novel environmental datasets and problems

Audience: Graduate

CIV ENGR/G L E 520 – REACTIVE PROCESSES FOR SUSTAINABLE ENERGY AND RESOURCE PRODUCTION

3 credits.

Key scientific concepts related to fossil and renewable energy resources. Apply the fundamentals of thermodynamics and chemical kinetics at solid interfaces to better understand the science behind using fossil and renewable energy resources. Evaluate the impacts of existing and emerging energy technologies on the environment.

Requisites: Senior standing, (MATH 211, 217, or 221), (CHEM 103, 104, or 109), and CIV ENGR 320, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Learning Outcomes: 1. Identify major issues pertaining to energy and environmental science and engineering, and evaluate the sustainability of technologies grounded in the science of material and energy balances and reaction kinetics

Audience: Both Grad & Undergrad

2. Derive and solve mathematical expressions to describe energy and material transformations

Audience: Both Grad & Undergrad

3. Critically evaluate and present their analysis and synthesis of literature in this area of energy and environment

Audience: Both Grad & Undergrad

4. Evaluate and propose novel technological solutions grounded in the fundamentals of thermodynamics of kinetics

Audience: Graduate

5. Analyze and defend emerging technologies in the area of energy and environment

Audience: Graduate

CIV ENGR 521 – MEMBRANE SCIENCE AND TECHNOLOGY

3 credits.

Membrane-based technology used in water/wastewater treatment and seawater/brackish water desalination. Theoretical and practical knowledge of the membrane-based technology applied in a variety of water treatment processes. Specific topics such as membrane transport theory, types and principles of the membrane, process design and operation, and pre- and post-treatment requirements. Challenges and future development of membrane technology.

Requisites: (CIV ENGR 310 and 320), CBE 320, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe membrane separation mechanisms, membrane transport theory, concentration polarization, membrane types and modules, and membrane-based processes

Audience: Both Grad & Undergrad

2. Apply transport models for the calculation of membrane permeability, flux, and the extent of separation for various membrane separation systems

Audience: Both Grad & Undergrad

3. Determine the types of experimental data needed for calculation of membrane permeability parameters

Audience: Both Grad & Undergrad

4. Calculate membrane process performance and analyze membrane separation characteristics

Audience: Both Grad & Undergrad

5. Write Python codes for basic membrane process models and conduct calculations on energy consumption

Audience: Graduate

CIV ENGR 522 – HAZARDOUS WASTE MANAGEMENT

3 credits.

Environmental regulations, remediation site characterization, contaminant characterization, detailed engineering and management considerations related to the design and operation of hazardous waste remediation systems involving water pollution, air pollution, solid waste, and groundwater pollution.

Requisites: Senior standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Find regulatory requirements for hazardous waste management, remediation, and water quality, and incorporate them as constraints when developing design solutions

Audience: Both Grad & Undergrad

2. Develop technically feasible alternative solutions, compare the alternative solutions, and recommend one of the solutions

Audience: Both Grad & Undergrad

3. Create plans and specifications that allow construction of a portion of the recommended solution

Audience: Both Grad & Undergrad

4. Design experiments necessary to gather data and create information for use in design

Audience: Both Grad & Undergrad

5. Implement measures to consider risk, reliability, and uncertainty in hazardous waste management

Audience: Both Grad & Undergrad

6. Use the skills and expertise of multiple disciplines on a design team to address complex engineering problems

Audience: Both Grad & Undergrad

7. Apply sustainability principles and/or frameworks to addressing the challenge of energy and resource use in hazardous waste remediation

Audience: Both Grad & Undergrad

8. Explain the social, economic, and/or environmental dimensions of the sustainability challenge(s) of hazardous waste management

Audience: Both Grad & Undergrad

9. Manage a group of undergraduate students through the design process

Audience: Graduate

CIV ENGR 525 – CASE STUDIES EXPLORING INFRASTRUCTURE SUSTAINABILITY AND CLIMATE CHANGE

3 credits.

Critical evaluation of the sustainability of engineering projects, considering roles as designers, citizens, and collaborators in creating the infrastructure of the future. Consider the impact of climate change on sustainability, an urgent topic, through case studies in water supply, flood management, water quality, materials recovery and recycling, mobility, buildings and structures, and energy generation and distribution.

Requisites: Junior standing and (MATH 217 or 221), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Demonstrate a working knowledge of relevant sustainability principles and definitions

Audience: Both Grad & Undergrad

2. Critically evaluate the application and achievement of sustainability goals by real-world project case studies in the context of natural resource capacity and limits

Audience: Both Grad & Undergrad

3. Demonstrate how engineers can apply authentic sustainability goals into both large and small engineered works

Audience: Both Grad & Undergrad

4. Describe how engineers can act as citizens in developing sustainability policy as well as engineers designing a sustainable project

Audience: Both Grad & Undergrad

5. Critically evaluate the sufficiency of the sustainability goals that were defined for a project

Audience: Graduate

CIV ENGR/G L E 530 – SEEPAGE AND SLOPES

3 credits.

Practical aspects of seepage effects and ground water flow. Stability of natural and man-made slopes under various loading conditions. Design and construction of earth dams and embankments. Flow net and its use; wells; filters; total and effective stress methods of slope analysis; selection of pertinent soil parameters.

Requisites: CIV ENGR/G L E 330, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Characterize and classify slope failure

Audience: Both Grad & Undergrad

2. Identify stability risk factors in generalized slope design

Audience: Both Grad & Undergrad

3. Apply soil and rock mechanics and strength principles in the context of slope stability investigation and design

Audience: Both Grad & Undergrad

4. Determine strength parameters of soil materials under saturated and unsaturated conditions

Audience: Both Grad & Undergrad

5. Understand pore fluid pressure in underground environments and its effect on manmade structures integrated within the soil as well as the failure potential of differing geometries

Audience: Both Grad & Undergrad

6. Design slope remedial plans for earth structures subjected to varying physical properties, overburden and pore pressures, and restrictive geometries

Audience: Both Grad & Undergrad

7. Act as leaders of the small groups they have been assigned for the mini design project

Audience: Graduate

CIV ENGR/G L E 532 – FOUNDATIONS

3 credits.

Shallow and deep foundations. Analysis and design of footings, mats, piers and piles, and related fill and excavation operations. Consolidation settlement, time rate of settlement, stress distribution, elastic (immediate) settlement, load bearing capacity; methods to reduce settlements and increase shear strength; the selection of a foundation system.

Requisites: CIV ENGR/G L E 330, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Provide examples of when and where to consider shallow foundation systems in lieu of deep foundation systems and where stone columns or rammed aggregate piers are appropriate

Audience: Both Grad & Undergrad

2. Scope and Prepare a Foundation Investigation, including the equipment and standards used for subsurface exploration and the advantages/disadvantages therein

Audience: Both Grad & Undergrad

3. Calculate Allowable Bearing Pressure using (a) presumptive values, (b) the bearing capacity equation and (c) in situ approaches

Audience: Both Grad & Undergrad

4. Design a safe spread foundation system where structural capacity exceeds demand

Audience: Both Grad & Undergrad

5. Design a drilled shaft and a driven pile for axial loading considering vertical loading and a settlement estimate

Audience: Both Grad & Undergrad

6. Prepare a bid sheet, plan set, and set of specifications for a successful foundation design

Audience: Both Grad & Undergrad

7. Use soil moduli in the application of a laterally loaded deep-foundation system using an appropriate software program with a hand-calculated backcheck

Audience: Graduate

CIV ENGR/G L E 534 – NONDESTRUCTIVE EVALUATION

3 credits.

Practical aspects of nondestructive evaluation (NDE) techniques for identifying physical properties and damage within civil and geologic materials and structures. Data analyses and data science for wave propagation, arrival picking, distributed fiber optic sensing, and visualization tools such as augmented/mixed/virtual reality.

Requisites: E M A 201, PHYSICS 201, 207, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe multiple nondestructive evaluation (NDE) testing methods and their applications

Audience: Both Grad & Undergrad

2. Characterize flaws within Civil and Geological Engineering materials

Audience: Both Grad & Undergrad

3. Determine source locations of flaws or damage within a structure based on NDE data

Audience: Both Grad & Undergrad

4. Characterize both active and passive elastic wave observations in rock

Audience: Both Grad & Undergrad

5. Apply seismological principles to observed acoustic emissions for determining source locations of microcracks and infer the mechanism of failure

Audience: Both Grad & Undergrad

6. Analyze fiber optic distributed acoustic sensing (DAS) to find earthquake events within timeseries data

Audience: Both Grad & Undergrad

7. Apply artificial intelligence techniques to analyze fiber optic sensing data

Audience: Graduate

CIV ENGR/G L E 535 – WIND ENERGY BALANCE-OF-PLANT DESIGN

3 credits.

Wind Energy Development and Balance-of-Plant Design. Up-front coverage includes the science and mechanics of wind energy including turbine basics, wind resource assessment, energy production, and economic return. Balance-of-plant design aspects include site layout and micro-siting, foundation systems, collector systems and interconnection, site civil and electrical infrastructure, and structural tower analysis. Development includes environmental due diligence and permitting, stakeholder engagement, energy policy and markets, and levelized cost of energy (LCOE).

Requisites: PHYSICS 201, 207, 247, E M A 201, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Provide the necessary steps to evaluate the wind resource at a prospective site by characterizing and correlating (vertically and horizontally) the wind speed distribution functions

Audience: Both Grad & Undergrad

2. Translate (forward and backward) wind power: kinetic to mechanical to electrical and select appropriate wind turbine given site wind resource and turbine power curve

Audience: Both Grad & Undergrad

3. Demonstrate knowledge of the mechanics and principles of the tower load document, shallow and deep foundation designs, transportation logistics, geotechnical investigation and reporting, thermal resistivity and collection system design, and interconnection

Audience: Both Grad & Undergrad

4. Develop civil balance-of-plant engineering calculation design bases for access roads, stormwater control, turbine foundations, and crane pads and electrical balance-of-plant engineering calculation design bases for the collection system, grounding, substation design, and interconnection

Audience: Both Grad & Undergrad

5. Analyze sustainability issues and/or practices using a systems-based approach.

Audience: Both Grad & Undergrad

6. Describe the social, economic, and environmental dimensions of wind energy and identify potential tradeoffs and interrelationships among these dimensions at an intermediate level.

Audience: Both Grad & Undergrad

7. Prepare an economic Pro Forma for a successful distributed wind project and calculate Levelized Cost of Energy (LCOE) and environmental Life Cycle Assessments (LCAs) of green-house gasses, water use, and CO₂ per kW h.

Audience: Graduate

CIV ENGR 545 – STEEL STRUCTURES II

3 credits.

Composite construction; composite vs. non-composite behavior; shored vs. unshored construction; stability of frames; elastic analysis of frames including second order effects; strength of members subject to combined flexure and axial compression; plate girders; vertical flange buckling; flexural and shear strength; flexure and shear interaction; stiffener requirements.

Requisites: CIV ENGR 445, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Check, proportion, and design structural steel built-up plate girders to satisfy the requirements of the AISC Specification for Structural Steel Buildings using the Load and Resistance Factor Design method

Audience: Both Grad & Undergrad

2. Demonstrate a working knowledge of the Direct Analysis Method and the Advanced Analysis Method in the AISC Specification for Structural Steel Buildings to obtain the capacities of structural steel systems accounting for second order effects, geometric imperfections, and residual stresses

Audience: Both Grad & Undergrad

3. Check, proportion, and design for strength and stability limit states of structural steel braced and moment frames to satisfy the requirements of the AISC Specification for Structural Steel Buildings using the Load and Resistance Factor Design method

Audience: Both Grad & Undergrad

4. Check, proportion, and design composite structural steel and concrete beams to satisfy the requirements of the AISC Specification for Structural Steel Buildings using the Load and Resistance Factor Design method

Audience: Both Grad & Undergrad

5. Check and proportion a steel member subjected to an advanced topic loading which may include torsion, seismic, fire, or advanced topic scenario which may include slender members or connections, or another acceptable advanced topic

Audience: Both Grad & Undergrad

6. Critique current research and issues discussed in the professional literature of the discipline related to course topics

Audience: Graduate

CIV ENGR 547 – CONCRETE STRUCTURES II

3 credits.

Deflections under short duration and sustained loads; compression members with emphasis on stability and secondary bending moments; two-way slab systems; prestressed concrete including prestress losses; design of shear walls, special topics in strut and tie modelling, compression field theory and design for torsion may be covered; flexure analysis; design of sections; and shear strength.

Requisites: CIV ENGR 447, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Compute required strengths for flexure, shear, and axial load using the load factors and load combinations specified by current building code requirements for structural concrete

Audience: Both Grad & Undergrad

2. Compute bar development lengths of straight and hooked bars to determine bar cutoff locations in reinforced concrete beams and slabs

Audience: Both Grad & Undergrad

3. Compute immediate and long-term deflections under sustained loads for beams and slabs of reinforced concrete

Audience: Both Grad & Undergrad

4. Perform a structural analysis and design of slab structural systems of reinforced concrete including flat plates, flat slabs, and two-way slabs

Audience: Both Grad & Undergrad

5. Develop technically feasible alternative solutions to a problem, compare the alternative solutions, and recommend one of the solutions as the preferred option

Audience: Graduate

6. Compute required and design strengths for flexure, shear, and axial load for reinforced concrete members using available structural analysis and design software

Audience: Graduate

CIV ENGR/ENVIR ST/LAND ARC 556 – REMOTE SENSING DIGITAL IMAGE PROCESSING

3 credits.

Techniques of enhancement and quantification of remote sensing imagery. Emphasis on processing and analyzing data gathered by airborne and satellite sensors. Techniques to quantitatively analyze data from photography, electro-optical scanners, satellite systems, and radar and passive microwave systems. Applications to: agriculture and forestry, geology and soils, water quality, and urban and regional planning.

Requisites: LAND ARC/ENVIR ST/G L E/GEOG/GEOSCI 371, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

CIV ENGR/A A E/ENVIR ST/URB R PL 561 – ENERGY MARKETS

3 credits.

Energy resources are an essential element of the world's business, political, technical and environmental landscape. Analytic tools provided by the discipline of economics expands our understanding of this critical issue. Energy supply markets reviewed include both fossil fuels and renewable resources. Energy demand sectors include residential, commercial, industrial and transportation. Electricity represents an intermediate energy market. The interactions among these markets participants indicate how scarce resources are allocated among competing needs in the world economy.

Requisites: A A E 101 (215 prior to Fall 2024), ECON 101, 111, or graduate/professional standing

Course Designation: Breadth - Social Science

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

CIV ENGR 570 – CONNECTED AND AUTOMATED TRANSPORTATION SYSTEMS

3 credits.

Connected vehicle and automated vehicle technologies; comprehensive studies of sensing, trajectory planning, and vehicle control within the context of the automated vehicle; consideration of pertinent development and technologies in this field.

Requisites: CIV ENGR 370 and (STAT 324, E C E 331, STAT/MATH 431, or STAT 311), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Communicate using connected vehicle (CV) and automated vehicle (AV) technology terms and concepts
Audience: Both Grad & Undergrad

2. Design operations of traffic containing connected autonomous vehicles (CAVs)
Audience: Both Grad & Undergrad

3. Incorporate CAVs in planning
Audience: Both Grad & Undergrad

4. Identify policy issues related to connected and automated vehicles
Audience: Both Grad & Undergrad

5. Demonstrate an advanced understanding of the underlying traffic principles and CAVs' implications in real-world scenarios
Audience: Graduate

6. Quantitatively analyze CAV models based on real trajectory data
Audience: Graduate

CIV ENGR 571 – URBAN TRANSPORTATION PLANNING

3 credits.

Principles of planning, evaluation, selection, adoption, financing, and implementation of alternative urban transportation systems; formulation of community goals and objectives, inventory of existing conditions; transportation modeling--trip generation, distribution, modal choice, assignment, technological characteristics and operation of modern transit and other movement systems.

Requisites: CIV ENGR 370, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Describe principles of planning, evaluation, selection, adoption, financing, and alternative urban transportation systems

Audience: Both Grad & Undergrad

2. Formulate community goals and objectives, inventory of existing conditions

Audience: Both Grad & Undergrad

3. Implement algorithms of transportation modeling--trip generation, distribution, and modal choice

Audience: Both Grad & Undergrad

4. Describe technological characteristics and operation of modern transit and other movement systems

Audience: Graduate

CIV ENGR 572 – TRANSPORTATION OPERATIONS

3 credits.

Introduction to assessment tools of transportation operations and fundamental concepts in flow theory, flow control, observation and measurement techniques, and scheduled transportation. Applied to various modes of transportation. Emphasis on logic rather than recipe-oriented practice.

Requisites: CIV ENGR 370 and (E C E 331, STAT/MATH 431, or STAT 311), graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Analyze operational characteristics of transportation systems using graphical tools (time-space diagram and cumulative curve)

Audience: Both Grad & Undergrad

2. Analyze vehicular traffic flow using advanced traffic models in different analysis scales: microscopic (vehicle-level), macroscopic (aggregate-level), and network-level scales

Audience: Both Grad & Undergrad

3. Characterize uncertainty in transportation systems

Audience: Both Grad & Undergrad

4. Analyze transportation data based on probability and statistics theories

Audience: Both Grad & Undergrad

5. Design traffic control strategies considering various uncertainties in traffic flow

Audience: Graduate

CIV ENGR 573 – GEOMETRIC DESIGN OF TRANSPORT FACILITIES

3 credits.

Problems in ground transportation facility design; generation, capacity, location and design; rural and urban at-grade intersection design; grade separations; interchanges; parking lots and terminals.

Requisites: CIV ENGR 370, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Identify and characterize the key attributes of the vehicles, operators, and highway systems that affect geometric design
Audience: Both Grad & Undergrad

2. Describe human behavior and accommodation of driver attributes in design
Audience: Both Grad & Undergrad

3. Describe highway design objectives, constraints, and controlling factors

Audience: Both Grad & Undergrad

4. Identify the basic parameters and constraints for the design of rural and urban alignments, vertical profiles, cross sections, and intersections
Audience: Both Grad & Undergrad

5. Design a highway from terrain to complete highway in a 3D computer-aided design package
Audience: Both Grad & Undergrad

6. Use design theory concepts and highway design knowledge in a real-world design project
Audience: Both Grad & Undergrad

7. Explain the social, economic, and/or environmental dimensions of the sustainability challenge(s) of highway design
Audience: Both Grad & Undergrad

8. Apply sustainability principles and/or frameworks to addressing the challenge of building highways in urban and rural areas
Audience: Both Grad & Undergrad

9. Describe highway design theory concepts regarding your area of research
Audience: Graduate

CIV ENGR 574 – TRAFFIC CONTROL

3 credits.

Traffic data collection studies; measures of effectiveness and evaluation of traffic system performance; design and application of traffic control devices; design of traffic signal systems; operational controls and traffic management strategies.

Requisites: CIV ENGR 370, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Explain the principles of intersection traffic operations, traffic data collection methods, traffic control devices, and analysis techniques.
Audience: Both Grad & Undergrad

2. Utilize quantitative and computerized techniques for designing and optimizing signalization at intersections.
Audience: Both Grad & Undergrad

3. Use software packages to solve traffic engineering problems.
Audience: Both Grad & Undergrad

4. Explain the fundamental differences between different software packages used to solve traffic engineering problems.
Audience: Both Grad & Undergrad

5. Present solutions to a traffic engineering problem, in both written and oral formats.
Audience: Both Grad & Undergrad

6. Synthesize the literature that is foundational to traffic engineering theory and apply this theory through the design and simulation of transportation systems.
Audience: Graduate

CIV ENGR 575 – ADVANCED HIGHWAY MATERIALS AND CONSTRUCTION

3 credits.

Soils, soil stabilization, aggregates, bituminous materials and mixtures, general highway materials and construction of rigid and flexible pavements.

Requisites: E M A/CIV ENGR 395, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Summer 2025

Learning Outcomes: 1. Use knowledge of highway materials behavior to select and specify materials used for highway construction

Audience: Both Grad & Undergrad

2. Interpret results of standardized and advanced testing of highway materials

Audience: Both Grad & Undergrad

3. Use material properties to optimize pavement layer thicknesses according to commonly used design methodologies

Audience: Both Grad & Undergrad

4. Identify and describe requirements for inspection and Quality Control/Quality Assurance of highway materials

Audience: Graduate

CIV ENGR 576 – ADVANCED PAVEMENT DESIGN

3 credits.

Covers the principles of stress and strain analyses in typical highway pavement structures due to loading from traffic and climate. Also covers the most commonly used analysis and design procedures/software to determine thickness of pavement layers and prediction of performance.

Requisites: E M A/CIV ENGR 395, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Use knowledge of mechanics of materials and structural analysis of pavements to determine stresses and strains in highway pavements caused by traffic and climate changes

Audience: Both Grad & Undergrad

2. Use knowledge of highway materials behavior for selecting materials to meet damage resistance requirements and estimate service life of pavements

Audience: Both Grad & Undergrad

3. Conduct life cycle cost analysis of pavements and provide methodologies for maintenance and rehabilitation of pavements

Audience: Both Grad & Undergrad

4. Use best practices to monitor pavement surface and structural conditions to enhance pavement service life

Audience: Graduate

CIV ENGR 577 – TRAFFIC FLOW THEORY

3 credits.

Comprehensive overview of vehicular traffic flow theory and its use in evaluating congestion and determining control strategies. Starting from the basic concepts defining traffic streams, existing theories are presented at different scales, including car-following (microsimulation) models, lane-changing models, cellular automata models, the kinematic wave model, and macroscopic/network fundamental diagram. Techniques for empirical analysis. Connected and automated vehicles.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Learning Outcomes: 1. Analyze vehicular traffic flow using advanced models and numerical techniques in different analysis scales: microscopic (vehicle-level), mesoscopic (platoon-level), macroscopic (aggregate-level), and network-level scales

Audience: Graduate

2. Design traffic control strategies to improve efficiency and/or stability of traffic flow

Audience: Graduate

3. Design traffic control strategies considering various uncertainties in traffic flow

Audience: Graduate

CIV ENGR 578 – SENIOR CAPSTONE DESIGN

4 credits.

The application of theoretically and academically acquired knowledge to a civil and environmental engineering problem in as near "real-world" as possible.

Requisites: Declared in Civil Engineering BS or Environmental Engineering BS and (CIV ENGR 414, 426, 427, 428, 442, 445, 447, 522, 573, 574, 576, G L E/CIV ENGR 530, 532, or 535)

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Integrate and apply the knowledge gained in prior coursework into a simulated real-world design environment

Audience: Undergraduate

2. Use open-ended problem-solving skills

Audience: Undergraduate

3. Work effectively in a multidisciplinary team environment

Audience: Undergraduate

4. Use oral and written communication skills to articulate proposed and completed work

Audience: Undergraduate

5. Explain basic concepts in management, business, and public policy

Audience: Undergraduate

6. Explain the importance of professional licensure

Audience: Undergraduate

7. Identify common failure mechanisms of a component, process, or system and their causes and prevention

Audience: Undergraduate

CIV ENGR 579 – SEMINAR-TRANSPORTATION ENGINEERING

1 credit.

Current problems and research developments in transportation, highways, traffic engineering, and transportation planning and systems analysis.

Requisites: Senior standing or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Demonstrate awareness of historic and/or current advances in transportation engineering research, practice, policy and/or professional conduct

Audience: Both Grad & Undergrad

2. Connect the topics of this course with their graduate research work

Audience: Graduate

CIV ENGR 609 – SPECIAL TOPICS IN WATER CHEMISTRY

1-3 credits.

Topics vary.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in environmental chemistry

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in environmental chemistry

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in environmental chemistry

Audience: Graduate

CIV ENGR/G L E 612 – ECOHYDROLOGY

3 credits.

Mutual interactions between the hydrologic cycle and ecosystems, including hydrologic mechanisms that underlie ecological patterns and processes, movement of water and energy through the soil-plant-atmosphere continuum, application and development of models for simulating ecohydrologic processes, and case studies on ecohydrologic function and ecosystem services of varied environments.

Requisites: CIV ENGR 311, GEOSCI/G L E 627, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2024

Learning Outcomes: 1. Identify, describe, and quantify ecohydrologic processes

Audience: Both Grad & Undergrad

2. Build and use models for simulating hydrologic processes, ecologic structure and vegetation composition

Audience: Both Grad & Undergrad

3. Work effectively and collaborate in groups to communicate ecohydrologic concepts

Audience: Both Grad & Undergrad

4. Critically evaluate the ecohydrologic literature

Audience: Graduate

CIV ENGR 618 – SPECIAL TOPICS IN HYDRAULICS AND FLUID MECHANICS

1-3 credits.

Topics vary.

Requisites: None**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2023**Learning Outcomes:** 1. Identify and describe key theories, concepts, and methods in hydraulics and fluid mechanics

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in hydraulics and fluid mechanics

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in hydraulics and fluid mechanics

Audience: Graduate

CIV ENGR 619 – SPECIAL TOPICS IN HYDROLOGY

1-3 credits.

Topics vary.

Requisites: None**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Fall 2025**Learning Outcomes:** 1. Identify and describe key theories, concepts, and methods in hydrology

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in hydrology

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in hydrology

Audience: Graduate

CIV ENGR 621 – BIOLOGICAL TREATMENT PROCESS MODELING

1 credit.

Modeling for wastewater treatment plant evaluation and design using a commercial modeling program. Focus on biological treatment processes and the kinetics of biological growth and substrate degradation. Set up and calibrate model, configure and size plant processes, and explore the impact of configuration and kinetic parameters on treatment efficiency. Evaluate impacts and tradeoffs for advanced treatment scenarios with regards to chemical use, energy needs, sludge production, and plant footprint.

Requisites: CIV ENGR 426, 721, or 821**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Summer 2025**Learning Outcomes:** 1. Configure wastewater treatment plant processes and input data utilizing a commercial modeling program for design

Audience: Both Grad & Undergrad

2. Define the wastewater characterization requirements for calibrating a model for a given treatment scenario

Audience: Both Grad & Undergrad

3. Utilize models for planning, design, and operations problem statements

Audience: Both Grad & Undergrad

4. Utilize a model to evaluate alternatives for treatment considering carbon availability, chemical use, energy requirements, and sludge production

Audience: Graduate

5. Analyze possibilities for new and innovative control strategies

Audience: Graduate

6. Determine the most significant factors affecting plant design and use the model to do a sensitivity analysis for changes in these factors

Audience: Graduate

CIV ENGR 629 – SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING

1-3 credits.

Topics vary.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2023

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in environmental engineering

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in environmental engineering

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in environmental engineering

Audience: Graduate

CIV ENGR/M&ENVTOX/SOIL SCI 631 – TOXICANTS IN THE ENVIRONMENT: SOURCES, DISTRIBUTION, FATE, & EFFECTS

3 credits.

Nature, sources, distribution, and fate of contaminants in air, water, soil, and food and potential for harmful exposure.

Requisites: (CHEM 104, 109, or 116) and (MATH 211, 217, or 221) and (PHYSICS 104, 202, 208, or 248), or graduate/professional standing

Course Designation: Breadth - Biological Sci. Counts toward the Natural Sci req

Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe how the physicochemical properties of an organic chemical and equilibrium and kinetic principles influence the distribution of the chemical in the environment

Audience: Both Grad & Undergrad

2. Estimate the physico-chemical properties of organic compounds using linear free energy relationships

Audience: Both Grad & Undergrad

3. Predict the behavior of hazardous organic chemicals in the environment

Audience: Both Grad & Undergrad

4. Derive and use equilibrium and kinetic box models for determining the fate of organic pollutants in the environment

Audience: Graduate

CIV ENGR/G L E 635 – REMEDIATION GEOTECHNICS

3 credits.

Geotechnical practice for remediation of sites containing contaminated soil and groundwater is discussed. Topics include non-invasive and invasive subsurface exploration techniques, methods to monitor for the presence of contaminants in the saturated and unsaturated zones, and geotechnically-oriented remedial action technologies.

Requisites: CIV ENGR/G L E 330, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2023

CIV ENGR 639 – SPECIAL TOPICS IN GEOTECHNICAL ENGINEERING

1-4 credits.

Topics vary.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Summer 2024

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in geotechnical engineering

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in geotechnical engineering

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in geotechnical engineering

Audience: Graduate

CIV ENGR 643 – PRESTRESSED CONCRETE

3 credits.

Analysis and design of prestressed concrete members, including working stress and ultimate strength analysis and design for flexure; shear design; prestress losses, deflections, and composite beams. Knowledge of Concrete Structures [such as CIV ENGR 447] required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Identify, formulate, and solve engineering problems

Audience: Graduate

2. Use the techniques, skills, and modern engineering tools necessary for engineering practice

Audience: Graduate

3. Determine the required number and layout of prestressing strands in a prestressed concrete beam based on allowable stresses

Audience: Graduate

4. Analyze and design a prestressed or partially prestressed concrete beam for ultimate flexural strength

Audience: Graduate

5. Design a prestressed concrete beam for shear

Audience: Graduate

6. Estimate immediate and time-dependent prestress losses

Audience: Graduate

7. Estimate short-term and time-dependent deflections of a prestressed concrete beam

Audience: Graduate

CIV ENGR 647 – CONCRETE STRUCTURES III

3 credits.

Inelastic behavior and modeling of reinforced concrete members, with emphasis on response to earthquake-type loading. Knowledge of concrete structures [such as CIV ENGR 447] required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Learning Outcomes: 1. Identify, formulate, and solve engineering problems

Audience: Graduate

2. Use the techniques, skills, and modern engineering tools necessary for engineering practice

Audience: Graduate

3. Calculate the moment versus curvature response of reinforced concrete flexural members with or without axial force

Audience: Graduate

4. Design reinforced concrete members for combined flexure, shear and torsion under gravity-type loading

Audience: Graduate

5. Describe the influence of various design/loading parameters on the flexure and shear behavior of reinforced concrete members when subjected to monotonic and reversed cyclic loading

Audience: Graduate

6. Design reinforced concrete beams, columns, joints, and structural walls for earthquake motions

Audience: Graduate

CIV ENGR 649 – SPECIAL TOPICS IN STRUCTURAL ENGINEERING

1-3 credits.

Topics vary.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in structural engineering

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in structural engineering

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in structural engineering

Audience: Graduate

CIV ENGR 669 – SPECIAL TOPICS IN CONSTRUCTION ENGINEERING AND MANAGEMENT

1-4 credits.

Topics vary.

Requisites: Senior standing or member of Engineering Guest Students

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in construction engineering and management

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in construction engineering and management

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in construction engineering and management

Audience: Graduate

CIV ENGR 678 – ADVANCED TRAFFIC MODELING AND COMPUTER SIMULATION

3 credits.

Theoretical and practical perspectives of traffic flow modeling with a focus on micro-simulation. Simulation software, such as CORSIM, VISSIM, and PARAMICS. Develop and calibrate a set of base models of existing conditions, extend the models to include design alternatives (generally using traffic demands projected for future years), and then generate conclusions on the basis of the modeling results.

Requisites: CIV ENGR 370, graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Apply theoretical and practical perspectives of traffic flow modeling, with a focus on micro-simulation analytical methods

Audience: Both Grad & Undergrad

2. Use proficiently at least one major simulation software package for traffic flow modeling

Audience: Both Grad & Undergrad

3. Apply advanced vehicle-based microscopic traffic flow models and emerging theoretical concepts to analyze complex multi-modal conditions

Audience: Graduate

CIV ENGR 679 – SPECIAL TOPICS IN TRANSPORTATION AND CITY PLANNING

3 credits.

Topics vary.

Requisites: None

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2024

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in transportation and city planning

Audience: Both Grad & Undergrad

2. Use appropriate tools, processes, and/or software to apply key theories, concepts, and methods in transportation and city planning

Audience: Undergraduate

3. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in transportation and city planning

Audience: Graduate

CIV ENGR/PUB AFFR 694 – MANAGEMENT OF CIVIL INFRASTRUCTURE SYSTEMS

3 credits.

Comprehensive systems approach to civil infrastructure and asset management with emphasis on transportation facilities. Social, political, economic factors that influence transportation planning, design, construction, maintenance and operation. Needs assessment, information management, performance measurement, life cycle cost and benefits analysis, prioritization and optimization, budgeting and finance.

Requisites: CIV ENGR 494, or graduate/professional standing, or member of Engineering Guest Students

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2019

CIV ENGR 699 – INDEPENDENT STUDY

1-9 credits.

Under faculty supervision.

Requisites: Consent of instructor

Course Designation: Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Conduct and report on independent civil or environmental engineering research

Audience: Both Grad & Undergrad

2. Appropriately use online and library resources

Audience: Both Grad & Undergrad

3. Communicate research clearly to other researchers in their field of study

Audience: Graduate

CIV ENGR/ATM OCN 701 – THE CHEMISTRY OF AIR POLLUTION

2 credits.

Covers background and modern research methods for the application of chemical analysis tools to understanding of the origin, composition, and the chemical transformations of pollutants that occur in the atmosphere. Emphasis will be directed at the pollutants impacting human health, climate change, and ecosystem degradation. Approximately half of the course materials will be taken from the scientific literature and will provide the opportunity to advance skills in the critical reading of journal articles. The course is directed at graduate students conducting research and interested in air pollution and environmental chemistry. Gain experiences in presenting scientific research methods and results related to course materials.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

CIV ENGR 702 – GRADUATE COOPERATIVE EDUCATION PROGRAM

1-2 credits.

Work experience that combines classroom theory with practical knowledge of operations to provide a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Identify and respond appropriately to real-life engineering ethics cases relevant to co-op work

Audience: Graduate

2. Synthesize and apply appropriate technical education to real world technical work

Audience: Graduate

3. Communicate effectively in writing and speaking with a range of audiences in the workplace, including those without disciplinary expertise

Audience: Graduate

4. Develop professional and transferable habits like time management skills, collaborative problem-solving skills, and research skills for learning new information

Audience: Graduate

CIV ENGR 703 – ENVIRONMENTAL GEOCHEMISTRY

3 credits.

A quantitative treatment of chemical and biological processes controlling the speciation and partitioning of inorganic compounds in natural waters. Particular attention will be paid to heterogeneous reaction mechanisms, and kinetics controlling inorganic compounds in aqueous environments. Discuss in-situ techniques for measurement of environmental reactions. For those interested in environmental chemistry, chemistry, limnology, geology, environmental microbiology, soil science, and environmental modeling.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2026**Learning Outcomes:** 1. Describe the relationship of environmental reactions to kinetic and thermodynamic parameters

Audience: Graduate

2. Identify important biogeochemical reactions controlling nutrient and contaminant dynamics in aqueous systems

Audience: Graduate

3. Recognize factors controlling solid-phase mineralogy and reactivity with respect to engineered systems

Audience: Graduate

4. Incorporate biological reactions into a geochemical model of environmental systems

Audience: Graduate

CIV ENGR 704 – ENVIRONMENTAL CHEMICAL KINETICS

3 credits.

Fundamental molecular processes that govern the fate and transformation of organic contaminants in natural environmental systems and engineered treatment processes. Emphasizes the kinetics describing these processes and focuses on transformation mechanisms of organic contaminants in aquatic systems. Specific topics include partitioning between air, water, and solids; chemical kinetics; substitution, hydrolysis, and redox reactions; oxidation reactions encountered in ozone and chlorine-based disinfection systems; and photochemical and biological transformations. Knowledge of water chemistry [such as CIV ENGR 500] required.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Spring 2022**Learning Outcomes:** 1. Predict the environmental fate of organic compounds based on their structure

Audience: Graduate

2. Estimate partitioning between air, water, organic phases, particles, and biota

Audience: Graduate

3. Use the steady-state assumption to estimate reaction half-lives

Audience: Graduate

4. Predict the kinetics and mechanisms of nucleophilic attack and hydrolysis reactions

Audience: Graduate

5. Describe how temperature and ionic strength affect rate constants

Audience: Graduate

6. Describe direct and indirect photolysis reactions

Audience: Graduate

CIV ENGR/ENVIR ST/URB R PL 717 – WATER RESOURCES MANAGEMENT PRACTICUM PLANNING SEMINAR I

1 credit.

The first of two seminars for planning the activities of the practicum.

Requisites: Declared in Water Resources Management MS or Doctoral Minor**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** No**Last Taught:** Fall 2025

CIV ENGR/ENVIR ST/URB R PL 718 – WATER RESOURCES MANAGEMENT PRACTICUM PLANNING SEMINAR II

2 credits.

The second of two seminars for planning the field work, analysis, and reporting of the practicum.

Requisites: Declared in Water Resources Management MS or Doctoral Minor

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

CIV ENGR/ENVIR ST/URB R PL 719 – WATER RESOURCES MANAGEMENT SUMMER PRACTICUM

4 credits.

Interdisciplinary team of students and staff working with agency personnel, citizen groups, and/or private sector representatives on the analysis of a contemporary, problem-oriented water resource issue. Physical, biological, economic and social aspects of the issue analyzed. Comprehensive written report results, practicum's findings and management recommendations.

Requisites: URB R PL/CIV ENGR/ENVIR ST 718

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Summer 2025

CIV ENGR 721 – BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING

3 credits.

Biological principles important to diagnosing and controlling pollution through environmental engineering applications such as fate and transport of contaminants in the environment, eutrophication, water treatment for human consumption, biological waste treatment for pollution control and bioenergy generation.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe how microorganisms gain energy from organic and inorganic contaminants

Audience: Graduate

2. Perform calculations to determine whether a specific chemical reaction would support microbial growth

Audience: Graduate

3. Perform calculations to quantitatively estimate the rates at which microorganisms transform chemical contaminants

Audience: Graduate

4. Describe different types of waterborne pathogens

Audience: Graduate

5. Describe how microorganisms are used to produce biofuels

Audience: Graduate

CIV ENGR 722 – CHEMICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING

3 credits.

Principles of general, physical, equilibrium, colloid and biochemistry applied to environmental engineering processes such as evaluating environmental quality and treating water, air and soil to meet environmental standards.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2025

Learning Outcomes: 1. Use basic principles of general, physical, equilibrium, colloid, and biological chemistry to solve water chemistry problems related to environmental engineering

Audience: Graduate

2. Use conservation of mass and energy principles to solve water chemistry problems related to environmental engineering

Audience: Graduate

3. Describe the risks to public health and welfare associated with chemical contaminants and greenhouse gases and explain how these risks are used to develop environmental policies and regulations

Audience: Graduate

4. Describe the basic biochemical reactions important to environmental engineering (aerobic, anoxic, anaerobic, photosynthetic), and estimate the enthalpy of reactions when the formulation of reactants and products are known

Audience: Graduate

5. Explain the roles of nutrients and organic carbon in water quality, and their relative concentrations in oligotrophic waters, eutrophic waters, and typical wastes; discuss anthropogenic sources of nutrients and policies for their control

Audience: Graduate

6. Explain connections between environmental chemistry principles and processes used in environmental engineering

Audience: Graduate

7. Review viable options and complete the preliminary design of a solution to an identified environmental engineering problem using at least two areas of environmental chemistry

Audience: Graduate

CIV ENGR 723 – ENERGY PRINCIPLES OF ENVIRONMENTAL ENGINEERING

3 credits.

Principles of energy applied to environmental engineering such as energy resources, sustainability concerns, work and power, thermodynamics, system and process efficiencies, energy production from waste, heat transfer, and heating and cooling of systems.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Describe the sources and limitations of renewable and non-renewable energy

Audience: Graduate

2. Describe options to minimize the use of energy and maximize its production from renewable resources

Audience: Graduate

3. Describe important environmental consequences of energy production and consumption

Audience: Graduate

4. Prepare process flow diagrams and perform relevant energy balance calculations for an environmental engineering system or process

Audience: Graduate

5. Estimate the performance efficiency of a process or component from thermodynamic principles and size a pump, compressor, or other machine based on these principles

Audience: Graduate

6. Estimate heat transfer, heat losses, and heating demand for a system or process

Audience: Graduate

7. Using at least two energy principles, complete a preliminary design of an environmental engineering system, process, or component to meet stated needs

Audience: Graduate

CIV ENGR 729 – ENVIRONMENTAL SUSTAINABILITY TOOLS

3 credits.

Environmental impact must be quantified systematically and rigorously in order to inform decision making, process improvement, and policy. Life cycle assessment will be utilized in a project-based framework to evaluate the environmental impacts of products and process across multiple environmental impact categories.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Summer 2025

Learning Outcomes: 1. Define a question to answer using life cycle assessment

Audience: Graduate

2. Determine the relevant goal and scope, and boundaries for a life cycle assessment

Audience: Graduate

3. Determine and quantify the relevant inputs and outputs of a product system or process

Audience: Graduate

4. Determine the most relevant functional unit for a life cycle assessment

Audience: Graduate

5. Conduct a life cycle assessment on a product or process using appropriate software

Audience: Graduate

6. Interpret a life cycle assessment on a product or process in order to evaluate the environmental sustainability of the system

Audience: Graduate

7. Analyze sustainability issues and/or practices using a systems-based approach.

Audience: Graduate

8. Describe the social, economic, and environmental dimensions of selected term project topic and identify potential trade-offs and interrelationships among these dimensions at a level appropriate to the course.

Audience: Graduate

CIV ENGR/G L E 730 – ENGINEERING PROPERTIES OF SOILS

3 credits.

Determination and interpretation of soil properties for engineering purposes; physio-chemical properties of soil-water systems, permeability and capillarity, compression characteristics of soils, measurement of soil properties in the triaxial test, properties of frozen soils and permafrost.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2022

Learning Outcomes: 1. Describe the physicochemical characteristics of soils and their importance to the engineering behavior of soils

Audience: Graduate

2. Define the factors which control the hydraulic and mechanical behavior of soils

Audience: Graduate

3. Evaluate how engineering classification of soils capture fundamental responses

Audience: Graduate

4. Run and interpret laboratory tests used to characterize how physical and chemical properties of particles affect the behavior of soil masses, including hydraulic properties and the stiffness and shear strength properties

Audience: Graduate

5. Explain models that describe the behavior and properties of soils

Audience: Graduate

CIV ENGR/G L E 732 – UNSATURATED SOIL GEOENGINEERING

3 credits.

Engineering principles of unsaturated soils as they apply to geotechnical and geoenvironmental systems. Effect of soil water suction and stress on hydraulic conductivity, shear strength, and compressibility of soils in the context of geoenvironmental problems of flow and stability. Knowledge of Soil Mechanics [such as CIV ENGR/G L E 330] is required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Define properties of unsaturated soils

Audience: Graduate

2. Use principles of interfacial physics, hydrology, and soil mechanics to interpret unsaturated soil behavior

Audience: Graduate

3. Use results from measurement methods to characterize unsaturated soil properties

Audience: Graduate

CIV ENGR/G L E 733 – PHYSICOCHEMICAL BASIS OF SOIL BEHAVIOR

3 credits.

Applications of physiochemical, mineralogical and environmental considerations to the engineering behavior of soils. Soil composition, formation, fabric, pore fluid chemistry and interaction of phases. The particulate nature of soils and the fabric-engineering property (volume change, strength, deformation and conduction) relationships. Knowledge of Soil Mechanics [such as CIV ENGR/G L E 330] is required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Characterize properties of soils that consist partly or wholly of clay

Audience: Graduate

2. Define the composition and fabric of natural soils, their surface and pore-fluid chemistry, and the physical and chemical factors that govern fine-grained soil behavior

Audience: Graduate

CIV ENGR 744 – STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

4 credits.

Dynamic analysis and behavior of structures; basic principles and application of engineering seismology; determination of earthquake-induced loads for earthquake-resistant design; and analysis and design of reinforced concrete and steel buildings subjected to ground motion. Knowledge of analysis and design of reinforced concrete and structural steel buildings [such as CIV ENGR 440, 445, and 447] required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Estimate the dynamic response of single- and multi-degree of freedom systems subjected to arbitrary loads

Audience: Graduate

2. Develop closed-formed and numerical solutions to compute the time-history response of single- and multi-degree of freedom systems

Audience: Graduate

3. Estimate the earthquake-induced ground motions that can be expected to occur at a given site

Audience: Graduate

4. Estimate the response of single- and multi-story buildings subjected to earthquakes

Audience: Graduate

5. Given a site and predicted ground motions, establish the layout of the structure to resist earthquake-induced loads and displacements

Audience: Graduate

6. Determine the response of the structure to design earthquake ground motions by computing displacements, forces, stresses, deformations, and estimating damage

Audience: Graduate

CIV ENGR 749 – SPECIAL TOPICS IN STRUCTURAL ENGINEERING

1-4 credits.

Advanced topics of special interest to graduate students in structural engineering.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2022

Learning Outcomes: 1. Identify and describe key theories, concepts, and methods in structural engineering

Audience: Graduate

2. Use appropriate tools, processes, and/or software to apply, analyze, and/or evaluate advanced theories, concepts, or methods in structural engineering

Audience: Graduate

CIV ENGR 760 – RESEARCH METHODS IN CONSTRUCTION ENGINEERING MANAGEMENT

1 credit.

Present research in Construction Engineering Management, discuss ideas and results. Receive feedback on research and presentation style.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Present and discuss research in Construction Engineering Management

Audience: Graduate

2. Formulate problem statement and methodology

Audience: Graduate

3. Give and receive constructive feedback

Audience: Graduate

CIV ENGR/E M A/M E 775 – TURBULENT HEAT AND MOMENTUM TRANSFER

3 credits.

Stochastic methods in turbulent heat and momentum transfer; fully developed turbulence; numerical methods including model applications to boundary layers, reacting flows, mass transfer, and unsteady flows; linear and non-linear stability and transition; emphasis on applications of interest to Mechanical, Aerospace, and Environmental Engineers. Knowledge of fluid mechanics [such as M E 363 or CBE 320] strongly encouraged.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Describe the physics and mathematics of turbulence theory and modeling

Audience: Graduate

2. Describe general features of turbulence

Audience: Graduate

3. Use analysis tools to solve problems and process data related to turbulence

Audience: Graduate

4. Use turbulence concepts to understand and explain turbulent behavior in more complex systems

Audience: Graduate

CIV ENGR 790 – MASTER'S RESEARCH OR THESIS

1-9 credits.

Under faculty supervision.

Requisites: Declared in a Civil and Environmental Engineering or Environmental Chemistry and Technology graduate program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Integrate knowledge from multiple disciplines to address a civil or environmental engineering research question

Audience: Graduate

2. Conduct a research study using experimental, computational, and/or theoretical approaches

Audience: Graduate

3. Communicate research results in written and verbal formats

Audience: Graduate

CIV ENGR 820 – HYDRAULICS AND APPLIED FLUID MECHANICS FOR ENVIRONMENTAL ENGINEERS

3 credits.

Principles of hydraulics and fluid mechanics applied to environmental engineering systems that convey, control, and measure the flow of liquids, solid-liquid slurries, and gases.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Summer 2025

Learning Outcomes: 1. Describe flow measurement and conveyance piping, equipment, and appurtenances commonly used for fluids in environmental engineering

Audience: Graduate

2. Describe and use concepts of conservation of mass and energy for fluid flow

Audience: Graduate

3. Estimate energy losses in a given flow system for water, sludge/biosolids mixtures, other liquids, and gases under steady flow conditions

Audience: Graduate

4. Describe problems of unsteady flow and transient flow conditions that may be encountered in environmental engineering and how such problems may be addressed by design

Audience: Graduate

5. Examine and design full pipe flow and open channel flow systems, including pumping and blower/compressor systems, hydraulic control structures, piping and channels for fluids normally encountered in environmental engineering problems

Audience: Graduate

6. Use modern engineering tools to solve hydraulics and applied fluid mechanics problems in environmental engineering

Audience: Graduate

CIV ENGR 821 – ENVIRONMENTAL ENGINEERING: BIOLOGICAL TREATMENT PROCESSES

3-4 credits.

Advanced theory and applications of biological systems for the treatment of wastes; lab techniques to assess treatability and to provide design parameters. Introductory knowledge of Environmental Engineering [such as CIV ENGR 320] is required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2025

Learning Outcomes: 1. Describe how microbial communities work in synergistic ways to remove organic and inorganic contaminants from wastewater

Audience: Graduate

2. Describe the specific microbial metabolism associated with nitrogen and phosphorus removal in wastewater treatment plants

Audience: Graduate

3. Perform calculations to estimate the efficiency of different wastewater treatment processes

Audience: Graduate

4. Use computer simulation tools for analysis of wastewater treatment processes

Audience: Graduate

5. Examine data from biological treatment processes to identify causes of poor performance

Audience: Graduate

**CIV ENGR 822 – ENVIRONMENTAL ENGINEERING: PHYSICAL/
CHEMICAL TREATMENT PROCESS**

3-4 credits.

Advanced theory and applications of chemical and physical-chemical processes for the treatment of water and wastewater; lab techniques to assess design requirements and treatability. Introductory knowledge of Environmental Engineering [such as CIV ENGR 320] is required.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2024

Learning Outcomes: 1. Describe the fundamental physical and chemical mechanisms that drive the performance of phase transfer processes, chemical transformation processes, and physical separation processes

Audience: Graduate

2. Describe the influence of physical and chemical mechanisms on performance of the above processes

Audience: Graduate

3. Describe the fundamental hydraulic mechanisms of batch and flow-through reactors and the influence of these mechanisms on performance of the above processes

Audience: Graduate

4. Draw process flow diagrams and use them in deriving mathematical models that predict reactor performance

Audience: Graduate

5. List assumptions used in the derivation of mathematical models and list the limitations of the resulting models

Audience: Graduate

6. Conduct experiments and interpret results using derived mathematical models combined with statistical analysis methods such as nonlinear regression

Audience: Graduate

7. Describe limitations in experimental design and their effect on interpretation of data

Audience: Graduate

**CIV ENGR 823 – ENVIRONMENTAL ENGINEERING DESIGN
PROJECT**

3 credits.

Engineering design project applied to environmental engineering solutions involving environmental chemistry, environmental quality, physical-chemical treatment processes, biological treatment processes, solid and hazardous waste engineering, energy, resource recovery, economic analysis, hydrology, and/or hydraulics and applied fluid mechanics.

Requisites: Declared in Civil and Environmental Engineering MS, Environmental Chemistry and Technology MS, or Civil and Environmental Engineering: Environmental Engineering ME

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2026

Learning Outcomes: 1. Use teamwork and leadership skills needed to plan and design solutions to open ended problems in environmental engineering

Audience: Graduate

2. Perform problem formulation and analysis of an environmental engineering problem

Audience: Graduate

3. Use modern engineering tools to analyze and solve an environmental engineering problem

Audience: Graduate

4. Use knowledge and experience gained during the course and in prior coursework to analyze and solve an environmental engineering problem

Audience: Graduate

5. Use written and verbal communication skills necessary to gain technical and public input to the analysis and understanding of the recommended solution

Audience: Graduate

CIV ENGR 890 – PRE-DISSERTATOR'S RESEARCH

1-9 credits.

Under faculty supervision.

Requisites: Declared in Civil and Environmental Engineering PHD or Environmental Chemistry and Technology PHD**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Demonstrate broad knowledge of civil or environmental engineering

Audience: Graduate

2. Integrate knowledge from multiple disciplines to independently develop civil or environmental engineering research hypotheses

Audience: Graduate

3. Design and conduct preliminary research to iteratively test and finalize hypotheses

Audience: Graduate

4. Communicate research results in written and verbal formats

Audience: Graduate

CIV ENGR 909 – GRADUATE SEMINAR - ENVIRONMENTAL CHEMISTRY & TECHNOLOGY

1 credit.

Current research in environmental chemistry and technology.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Demonstrate awareness of historic and/or current advances in environmental chemistry and technology research, practice, policy and/or professional conduct

Audience: Graduate

CIV ENGR/ATM OCN/BOTANY/ENVIR ST/GEOSCI/ZOOLOGY 911 – LIMNOLOGY AND MARINE SCIENCE SEMINAR

1 credit.

Sections in various fields of zoological research.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Explain important research in current limnology.

Audience: Graduate

2. Utilize different research presentation methods.

Audience: Graduate

3. Assess scientific information and ask thoughtful questions.

Audience: Graduate

CIV ENGR 919 – SEMINAR-HYDRAULIC ENGINEERING AND FLUID MECHANICS

1 credit.

Current research and review of literature in theoretical and applied fluid mechanics and hydraulic engineering.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Demonstrate awareness of historic and/or current advances in hydraulic engineering and fluid mechanics research, practice, policy and/or professional conduct

Audience: Graduate

CIV ENGR 929 – SEMINAR-ENVIRONMENTAL ENGINEERING

1 credit.

Current research and literature on water, wastewater, water pollution control, solid wastes engineering and management.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Demonstrate awareness of historic and/or current advances in environmental engineering research, practice, policy and/or professional conduct

Audience: Graduate

CIV ENGR 939 – GEOTECHNICAL ENGINEERING SEMINAR

1 credit.

Geotechnical analysis, design, and construction.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2026**Learning Outcomes:** 1. Demonstrate awareness of historic and/or current advances in geotechnical engineering research, practice, policy and/or professional conduct

Audience: Graduate

CIV ENGR 949 – SEMINAR-STRUCTURAL ENGINEERING

1 credit.

Structural analysis, design, and construction.

Requisites: Graduate/professional standing**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement**Repeatable for Credit:** Yes, unlimited number of completions**Last Taught:** Spring 2023**Learning Outcomes:** 1. Demonstrate awareness of historic and/or current advances in structural engineering research, practice, policy and/or professional conduct

Audience: Graduate

CIV ENGR 990 – THESIS

1-12 credits.

Under faculty supervision.

Requisites: Declared in Civil and Environmental Engineering PHD or Environmental Chemistry and Technology PHD

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2026

Learning Outcomes: 1. Integrate knowledge from multiple disciplines to independently develop civil or environmental engineering research hypotheses

Audience: Graduate

2. Design and conduct fundamental research tasks to test hypotheses

Audience: Graduate

3. Interpret the results of the research, then communicate the interpretation in both written and verbal formats

Audience: Graduate

CIV ENGR 999 – ADVANCED INDEPENDENT STUDY

1-9 credits.

Under faculty supervision.

Requisites: Consent of instructor

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Fall 2025

Learning Outcomes: 1. Conduct and report on independent civil or environmental engineering research

Audience: Graduate

2. Independently develop civil or environmental engineering research questions

Audience: Graduate

3. Appropriately use online and library resources

Audience: Graduate