

# CIVIL ENGINEERING

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## Overview

### Mission Statement

The mission of the Department of Civil Engineering:

- deliver high-quality comprehensive degree programs (BS, MS, MEng, PhD, EAS PhD) to all of our students at both the undergraduate and graduate levels
- matriculate students who excel in professional practice and leadership and who possess compassion and respect for people of all cultural backgrounds
- teach our classes with excellence, whether in a traditional classroom setting or online
- offer our students state-of-the-art laboratories, equipment and classrooms with the latest technology needed for a complete learning experience
- develop ambitious and innovative research programs involving both faculty and students through funding from federal, state and local sources
- provide supportive mentoring and guidance to our students through teaching, research and advising
- produce students who can work as leading professionals in civil engineering and in many other fields for which civil engineering knowledge can be a foundation

## Civil Engineering Graduate Admissions Information

### Requirements for Admission

All engineering graduate applicants must submit the following materials.

- **Application**
- **Application fee** – \$50 domestic; \$75 international
- **Statement of purpose** – must be an original essay submitted with application. Scanned copies will not be accepted for submission.
- **Resume** – must be submitted with application
- **Official transcripts** – we require one official copy of each previous transcript. Send e-transcripts to the Graduate School at [graduateadmissions@ucdenver.edu](mailto:graduateadmissions@ucdenver.edu)
- **Letters of recommendation** – two are required; a 3rd is optional
- **Official GRE scores** – Not required. If choosing to submit, send scores officially through ETS using code #4875.

#### NOTES:

1. Written application materials submitted are scanned for plagiarism and are added to a local database used for plagiarism detection.
2. Funding is **not** guaranteed. All students should seek additional, external resources to fund their studies.

## English Language Proficiency (ELP) requirements

In addition to the above requirements, applicants earning from non-English speaking countries need to demonstrate English language proficiency. Please visit International Admissions Graduate Admissions Process page (<https://www.ucdenver.edu/international-admissions/apply-for-admission/graduate/>) for ELP delivery instructions and additional information.

## Application deadlines

Applicants must make arrangements to ensure all their materials (including transcripts, references, and any required test scores) are received by the relevant deadlines below. Applications with outstanding materials are considered incomplete and will be canceled unless a request for deferment to a later term is requested.

### Domestic MS/MEng

Semester	Date
Fall	April 15
Spring	October 15

### Domestic PhD

Semester	Date
Fall	March 15
Spring	September 15

### International MS/MEng/PhD

Semester	Date
Fall	March 15
Spring	September 15

## Programs

- Civil Engineering, MEng (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil-engineering/civil-engineering-meng/>)
- Civil Engineering, MS (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil-engineering/civil-engineering-ms/>)
- Civil Engineering, PhD (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil-engineering/civil-engineering-phd/>)
- Construction Project Management Graduate Certificate (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil-engineering/construction-project-management-graduate-certificate/>)
- Engineering and Applied Science, PhD (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil-engineering/engineering-applied-science-phd/>)
- Geographic Information Systems and Geomatics Graduate Certificate (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil-engineering/geographic-information-systems-geomatics-graduate-certificate/>)
- Integrated Construction, Management + Leadership Graduate Certificate (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-engineering-design-computing/civil->

engineering/integrated-construction-management-leadership-graduate-certificate/)

## Faculty

### Professors:

**Caroline Clevenger**, PhD, Stanford University, PE, RA-Colorado  
**Yail Jimmy Kim**, PhD, Queen's University, PE-Canada  
**Wesley Marshall**, PhD, University of Connecticut, PE-Connecticut  
**David C. Mays**, PhD, University of California at Berkeley, PE-Colorado, California  
**Kevin L. Rens**, PhD, Iowa State University, PE-Colorado

### Associate Professors:

**Arunprakash Karunanithi**, PhD, University of Connecticut  
**Chengyu Li**, PhD, Arizona State University; PE-Colorado, North Carolina, New Mexico, Washington; SE-Utah, Arizona, Washington

### Assistant Professors:

**Moatassem Abdallah**, PhD, University of Illinois at Urbana-Champaign  
**Heidi Brothers**, PhD, University of Cincinnati  
**Allison Goodwell**, PhD, University of Illinois at Urbana-Champaign  
**Frederick R. Rutz**, PhD, University of Colorado, PE-Colorado

### Professors Emeriti:

**Paul E. Bartlett**, MS, University of Colorado, PE-Colorado  
**Nien-Yin Chang**, PhD, Ohio State University, PE-Ohio and Colorado  
**James C.Y. Guo**, PhD, University of Illinois at Urbana-Champaign, PE-Colorado  
**David W. Hubly**, PhD, Iowa State University, PE-Colorado  
**Bruce N. Janson**, PhD, University of Illinois at Urbana-Champaign  
**Lynn E. Johnson**, PhD, Cornell University, PE-Connecticut  
**Oren G. Strom**, PhD, University of Texas at Austin

## Civil Engineering (CVEN)

**CVEN 5025 - Autocad Civil 3d & Advanced Civil Engineering Graphics (3 Credits)**

Lectures target civil engineering industry specific site information modeling software and geospatial industry specific geographical information systems software to elevate students' knowledge of each software to an in-depth understanding. Laboratory exercises will focus on civil drafting and design, producing documentation, and general project workflows. Additional laboratory exercises will focus on geospatial data creation, data management, and cartographic display. Prereq: CVEN 1025. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 1025

**CVEN 5087 - Engineering Contracts (3 Credits)**

Laws met by the practicing engineer, types of contracts, specification writing, laws on contracts, agency, partnership, sales and property, with primary emphasis on rights and duties of the engineer. Cross-listed with CVEN 4087. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**CVEN 5110 - Advanced Structural Classical Analysis (3 Credits)**

Understanding classical hand-solved analysis techniques in civil and structural engineering. Methods to be studied include: Moment Area, Conjugate Beam, Virtual Work, Stiffness Method, Force Method, Slope Deflection, and Moment Distribution. Prerequisite: CVEN 3505 with B- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prerequisite: CVEN 3505 with B- or better or graduate standing.

**CVEN 5111 - Structural Dynamics (3 Credits)**

Vibration and dynamic response of simple linear and nonlinear structures to periodic and general disturbing forces. Frequency domain analysis, response analysis of multi-degree-of-freedom systems. Wind and earthquake effects. Prereq: CVEN 3505 with a B- or higher or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3505 with a B- or higher or graduate standing.

**CVEN 5112 - Structural Design Loads (3 Credits)**

The course will review the probabilistic approach for load determination used in modern building codes from theoretical and applied perspectives. The course is intended to study design dead loads, live loads, snow loads, earthquake loads, wind loads, construction loads, and load combinations for buildings. There will be off-campus events at times other than regular class hours. Other topics may be treated as time permits. Prereq: CVEN 3505 with a C- or higher or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3505 with a C- or higher or graduate standing (GRAD or NDGR).

**CVEN 5121 - Intermediate Mechanics of Materials (3 Credits)**

Intermediate-level course in the mechanics of deformable bodies. Plane stress and strain; stress-strain relation with emphasis on elastic and inelastic behavior of members, and theories of failure. Discussion of basic methods of structural mechanics, with applications to asymmetric and curved beams, thick walled pressure vessels, torsion of members of noncircular section, and other selected problems in stress analysis.

Prereq: CVEN 3121 or MECH 3043 and MATH 3191 and 3200 or MATH 3195 with a C- or higher, or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

(CVEN 3121 or MECH 3043) AND ((MATH 3191 and MATH 3200) or MATH 3195) OR GRAD/NDGR

**CVEN 5333 - Surface Water Hydrology (3 Credits)**

Fundamentals of hydrology emphasizing surface water processes. Topics include the hydrologic cycle, frequency analysis, drought management, flood routing, rainfall-runoff relationships (rational method, unit hydrograph, and hydrologic software) and hydrologic design. Prereq: B- or better in CVEN 3313 or graduate standing or instructor permission. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: B- or better in CVEN 3313 or graduate standing or instructor permission.

**CVEN 5334 - Groundwater Hydrology (3 Credits)**

Topics include groundwater occurrence, hydrologic cycle and budget, interactions with surface waters, principles of groundwater flow, well hydraulics, well field design, regional flow systems, water and pollutant chemistry, computer modeling and groundwater management. Emphasis is on quantitative analysis methods for groundwater resource inventory, design and management. Prereq: B- or better in CVEN 3313 or graduate standing or instructor permission. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: B- or better in CVEN 3313 or graduate standing or instructor permission.

**CVEN 5335 - Vadose Zone Hydrology (3 Credits)**

Engineering analysis of the vadose zone, the unsaturated porous media linking the earth surface to groundwater. Darcy's law for flow. Richards equation for moisture content. The advection-dispersion equation for solutes. Analytical solutions and numerical modeling applied to infiltration, evaporation, drainage, and subsurface remediation. Prereq: B- or better in CVEN 3313 or graduate standing or instructor permission. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: B- or better in CVEN 3313 or graduate standing or instructor permission.

**CVEN 5343 - Open Channel Hydraulics (3 Credits)**

Engineering analysis and design of natural and artificial open channels. Application of uniform flow concept to design of erodible and non-erodible channels. Application of energy and momentum principles to conditions of gradually varied flow, spatially varied flow and rapidly varied flow. Prereq: CVEN 3323 with a C- or better or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3323 with a C- or better or graduate standing (GRAD or NDGR).

**CVEN 5381 - Introduction to Geographic Information Systems (3 Credits)**

Provides an overview exposure and experience with various aspects of GIS technology and its uses for natural resource and infrastructure, planning, design and management. This course involves a survey of GIS software and hardware, review of cartographic mapping principles, hands-on applications to environmental impact assessment, municipal facilities management, transportation, water resources and demographics. GIS project management factors are addressed. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**CVEN 5382 - Geospatial Data Development (3 Credits)**

This second GIS course builds on the introductory course and addresses principles and technologies for development and conversion of spatial databases, including photogrammetry, surveying and geodesy, coordinate systems and transformations, and remote sensing. Prereq: CVEN 5381 with a B- or better OR graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5381 with a B- or better OR graduate standing.

**CVEN 5383 - GIS Analysis – Theory and Practice (3 Credits)**

This third course reviews GIS software functions and terminology, including data entry (input, editing), manipulation (projection, merge, window, aggregate), analysis (map algebra, overlay, Boolean, interpolation network, measurements, distance, terrain modeling, statistical analysis), query (spatial, attribute), and display/reporting. Integration of various domain-specific systems analysis models with GIS databases is also addressed. Laboratory activities involve programming applications using available GIS. Prereq: CVEN 5381. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5381

**CVEN 5384 - GIS Project Management (3 Credits)**

This course explains how to build a foundation for GIS project success and deliver results. Topics include data governance, administration of technical infrastructure, managing roles and skills, key leadership concepts, and project management methodologies like Agile/Scrum. Best practices and real world applications are discussed. Also addressed are issues of GIS institutional acceptance, the role of computerized spatial data systems in decision-making, application of planning techniques for accomplishing resource goals, and administrative structures that enhance efficiency of use. Prereq: CVEN 5381 with a B- or better or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5381 with a B- or better OR graduate standing.

**CVEN 5385 - GIS Relational Database Systems (3 Credits)**

Introduces relational database management system concepts with emphasis on GIS. Includes examination of relational database systems from conceptual design through relational schema design and physical implementation. Topics include SQL, database design and implementation for large database systems, transaction management, concurrency control, distributed database management systems and the interaction and progressive integration of GIS technologies and RDBMS technologies. Prereq or Coreq: CVEN 5381 or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq or Coreq: CVEN 5381 or graduate standing.

**CVEN 5386 - GIS Laboratory (3 Credits)**

Provides in-depth experience with use and programming of a particular GIS software, including ArcGIS and related object-oriented programming languages. Advanced functionality for user authoring of software interface, data management and analysis functions and output generation. Exact content will vary by semester. Prereq: CVEN 5381. Repeatable. Max Hours: 18 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 18.

Prereq: CVEN 5381

**CVEN 5387 - Advanced Remote Sensing (3 Credits)**

Addresses remote sensing concepts including 1) imaging sensors and geo-referencing; 2) image processing for radiometric, multi-spectral image enhancement, and multi-sensor image fusion; and 3) multi-spectral image classification, including feature extraction, supervised and unsupervised classification, and extensions to hyper-spectral data. Prereq: CVEN 5382 with a B- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5382 with a B- or better OR graduate standing.

**CVEN 5388 - Site Engineering (3 Credits)**

Course introduces the fundamentals of site engineering which require understanding and interpreting landforms, slopes, contour lines, grading, drainage, and earthwork to storm water management, hydrology reports, designing roadways, and street networks. Other topics include designing for ADA and concepts of sustainability in site design. Note: CAD experience is recommended. Cross-listed with CVEN 4388. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 1025

**CVEN 5389 - Open Source Desktop Mapping, Modeling & Data Processing (3 Credits)**

This graduate-level course covers the open source tools and procedures that students can use for desktop GIS mapping, modelling, and data analysis and preparation that are unique in comparison to other GIS software used in the industry. Prereq: CVEN 5381 Intro to GIS or equivalent permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5381

**CVEN 5390 - Interactive Web Mapping GIS (3 Credits)**

This course introduces students to designing, creating, delivering, and using interactive web maps. Many people rely daily on web maps to direct us from point A to point B and more. After starting with a broad introductory background, this is a technical hands-on course in which students use several open source (FOSS) technologies. Prereq: CVEN 5381 or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5381 or graduate standing (GRAD or NDGR).

**CVEN 5391 - Introduction to Geomatics (3 Credits)**

This course presents the concepts of Geomatics along with spatial data, tools, and their connection. This course covers spatial data collection methods, data assessment, and processing. The course also covers projections, methods of coordinate conversion and transformation, and data transfer across different spatial analysis platforms. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**CVEN 5392 - Unmanned Aerial Systems (3 Credits)**

This course presents concepts and practical methods of using Unmanned Aerial Vehicles for engineering projects. The course covers mission planning, operations, field data collection and processing, and data analysis. Legal and ethical considerations are also covered, as well as the relative costs and benefits of using UAV. Prereq: CVEN 5391. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5391

**CVEN 5395 - GPS/GNSS (3 Credits)**

This course presents the practical concepts and implications of using GPS/GNSS for engineering projects. The course covers a variety of techniques for field data collection, processing, and data analysis. The course emphasis is on changes that are occurring because of using GPS/GNSS in the field. Prereq: CVEN 5391. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5391

**CVEN 5396 - HDS/LiDAR Tools & Data Analyses (3 Credits)**

High Definition Surveying (HDS) scanners are extremely reliable and accurate geospatial data collection devices for surveyors, GIS analysts, engineers, and planners. The goal of this unique course is to present the instrumentation and technological principals used in data collection, project phases, data processing and analyses. This course is designed to provide information and practical skills for students wanting to learn how to plan and execute terrestrial LIDAR data collection projects with HDS scanners and HDS data processing software. Prereq: CVEN 5381 and CVEN 5395 or equivalent. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5381 and CVEN 5395

**CVEN 5397 - Unmanned Aerial Systems Data processing (3 Credits)**

This course will provide information and practical skills for unmanned aerial systems data processing and analyses. The course focuses on sensor selection, ground control, data processing, and data analyses. Prereq: CVEN 5391 and CVEN 5392. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5391 and CVEN 5392

**CVEN 5401 - Introduction to Environmental Engineering (3 Credits)**

Introduces students to the broad field of environmental engineering. Topics include essential chemical, biological, and risk assessment concepts needed for addressing environmental problems. Major unit operations and processes used for treating wastewater and potable drinking water. An overview of technologies used for treating particulate and gaseous air pollutants, managing solid wastes, and remediating hazardous wastes. The course also introduces environmental sustainability, green engineering, life cycle assessment and other systems oriented concepts. Includes graduate-level analysis, modeling, or reflection on the refereed literature. Prereq: CHEM 1130, CHEM 2031, or ENGR 1130, and Graduate standing or permission of instructor. Cross-listed with CVEN 3401. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 1130, CHEM 2031, or ENGR 1130 or Graduate standing or instructor permission.

**CVEN 5402 - Contaminant Fate and Transport (3 Credits)**

Provides unified understanding of fundamental physical, chemical and biological processes that govern the transport and fate of pollutants in environmental systems - water, air and subsurface. The course focuses on multimedia modeling and model solution methods. The course also introduces exposure and risk assessment techniques. Prereq: CHEM 1130, CHEM 2031, or ENGR 1130 or graduate standing or instructor permission. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 1130, CHEM 2031, or ENGR 1130 or Graduate standing or instructor permission.

**CVEN 5403 - Environmental Regulations and Management Systems (3 Credits)**

Students will receive an overview and understanding of major environmental laws and will be introduced to legal concepts used to develop environmental laws. In addition, students will learn about environmental management systems and their applications to environmental problems. Prereq: Graduate standing or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

**CVEN 5404 - Water and Wastewater Treatment (3 Credits)**

Water and wastewater treatment, including aqueous chemistry (equilibrium, reaction kinetics, redox reactions, and acid-base equilibria), physicochemical processes (sedimentation, filtration, adsorption, membrane separation), and biological processes (applied microbiology, reactor configuration, waste-to-energy technology). Prereq: CHEM 1130, CHEM 2031, ENGR 1130, graduate standing or instructor permission. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CHEM 1130, CHEM 2031, or ENGR 1130 or Graduate standing or instructor permission.

**CVEN 5405 - Environmental Life Cycle Assessment (3 Credits)**

This course covers cradle-to-grave systems thinking and focuses on quantitative methods for environmental systems modeling, analysis and assessment. The primary method covered is life cycle assessment (LCA). The students will learn the various steps for conducting a process-based LCA including goal and scope definition, life cycle inventory (LCI), life cycle impact assessment (LCIA) and interpretation. For a broader life cycle perspective Economic Input-Output LCA (EIO-LCA) will be introduced. Emphasis will also be placed on framing the LCA analysis around attributional (technology/process) versus consequential (policy/decision) focus. Mathematical techniques for uncertainty & sensitivity analysis, such as Monte Carlo simulations will be covered. Students will be exposed to several LCA case studies. Prereq: Graduate standing or permission of instructor. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Graduate level students

**CVEN 5406 - Engineering and Science Informatics (3 Credits)**

Students will learn applied, basic statistics & probability concepts and provide experience in the correct use and interpretation of those techniques. The course is designed in such a way that any graduate or undergraduate level student wanting to learn data analysis will benefit. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 3.

**CVEN 5407 - Complex Systems Methods (3 Credits)**

This graduate course introduces nonlinear dynamics, information theory, and network analysis in an environmental engineering, earth sciences, and sustainability context. Techniques will be applied to analyze environmental and weather data in addition to other examples relevant to engineering and critical zone science. Restriction: Restricted to graduate standing or with instructor's permission. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Graduate level students

**CVEN 5426 - Pipe Network and Sewer Design (3 Credits)**

Design of pressurized pipe networks for water supply and sanitary sewers for wastewater collection. Topics include the civil engineering design process, estimation of water and wastewater design loads, and design of pressurized pipe networks and sanitary sewers including pump selection, service reservoirs, lift stations, and relevant software. Design project and field trip required. Includes graduate-level analysis, modeling, or reflection on the refereed literature. Cross-listed with CVEN 4426. Prereq: CVEN 3323. Restriction: Restricted to students with graduate standing or with instructor permission. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3323. Restriction: Restricted to students with graduate standing or with instructor's permission.

**CVEN 5427 - Storm Water System Design (3 Credits)**

This course covers urban watershed analysis, design rainfall and hydrologic losses, flood frequency and design event, rational method for peak runoff prediction, street hydraulic capacity and safety, culvert hydraulics, street inlet collection system, and storm sewer system design and flow analysis. Includes graduate-level analysis, modeling, or reflection on the refereed literature. Prereq: CVEN 3323 with a C- or better or graduate standing. Cross-listed with CVEN 4427. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3323 with a C- or better or graduate standing (GRAD or NDGR).

**CVEN 5434 - Sustainable Water Systems: Biological Processes (3 Credits)**

A comprehensive course that covers the theory and application of biological processes used in water quality engineering, with an emphasis on state-of-the-art water pollution control and waste-to-energy technologies. The initial lectures will introduce material on microbial energetics, diversity, and kinetics. The remainder of the course will involve the application of fundamental principles to treatment and energy recovery processes, including bioreactor configurations and design considerations. Prereq: Graduate standing or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

**CVEN 5460 - Introduction to Sustainable Urban Infrastructure (3 Credits)**

This course takes a systems approach to urban infrastructures that deliver critical materials to cities; primarily water, energy, transportation, buildings, and food systems. The focus is on the current state of sustainable development, cities, and infrastructure systems, exploring sustainability strategies and measuring their effectiveness, and analyzing implementation and diffusion of sustainability strategies. Cross-listed with URPL 6399. Prereq: Graduate standing or instructor permission. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to students with graduate standing.

**CVEN 5464 - Sustainability and Climate Change (3 Credits)**

This course explores environmental sustainability in the context of climate change, emphasizing feedbacks and interactions within the climate-ecosystem-water-energy-food system. Course topics include climate and ecosystem modeling, climate data analysis, and testing students' assumptions and inferences regarding various sustainability topics. Prereq: Graduate standing or instructor permission. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to students with graduate standing.

**CVEN 5514 - Matrix Analysis of Structures (3 Credits)**

Matrix analysis of skeletal structures. Systematic formulation of stiffness and flexibility methods of analysis of skeletal structures. Application of modern computational tools to structural analysis, including introduction to the finite element method. Prereq: CVEN 3505. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3505 with a C- or higher

**CVEN 5515 - Introduction to Finite Element Analysis (3 Credits)**

Systematic formulation and application of the finite element approximation to the solution of engineering problems. Topics include one- and two-dimensional elasticity problems, two-dimensional heat flow and irrotational fluid flow. Elements considered include triangular and quadrilateral elements formulated by elementary and isoparametric techniques. Prereq: Graduate standing or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: Graduate standing (Grad or Non-Degree Grad)

**CVEN 5540 - Masonry Design (3 Credits)**

The course will review the probabilistic approach for load determination used in modern building codes from theoretical and applied perspectives. The course is intended to study design dead loads, live loads, snow loads, earthquake loads, wind loads, construction loads, and load combinations for buildings. There will be off-campus events at times other than regular class hours. Other topics may be treated as time permits. Prereq or Coreq: CVEN 4585 or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq/Coreq: CVEN 4585 or graduate standing.

**CVEN 5550 - Highway Bridge Design (3 Credits)**

Design of highway bridges in accordance with the ASSHTO LRFD Bridge Design Specification. Topic coverage includes bridge planning, construction materials in bridges, bridge systems, design loads, structural modeling and analysis, design of concrete deck system, and design of concrete and steel superstructures. Prereq: CVEN 4575 and CVEN 4585 with a C- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 4575 and CVEN 4585 with a C- or better or graduate standing.

**CVEN 5565 - Advanced Timber Structure Design (3 Credits)**

Design of wood framing systems including beams, columns, trusses, and diaphragms. Wood as a material, framing terminology, connection design, structural composite lumber, glued-laminated members, and plywood are covered. The course will emphasize on preparing students for a career in structural engineering. Prereq: Graduate Standing or (CVEN 3505 and 3141 with a C- or higher and Civil Engineering major). Cross-listed with CVEN 4565. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prerequisite: Graduate Standing or (CVEN 3505 and 3141 with a C- or higher and Civil Engineering Majors.)

**CVEN 5575 - Advanced Topics in Structural Steel Design (3 Credits)**

Plate buckling, plate girder design and other topics determined by class interest. Prereq: CVEN 4575 with a C- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 4575 with a C- or better or graduate standing.

**CVEN 5580 - Design of prestressed concrete structures (3 Credits)**

To learn the basic concepts of analysis and design of prestressed concrete, which is essentially reinforced concrete in which steel reinforcement is tensioned against the concrete, thereby introducing compression in concrete and hence overcoming the tensile weakness of concrete relative to its compressive strength. Prereq: CVEN 4585. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 4585

**CVEN 5585 - Advanced Topics in Reinforced Concrete (3 Credits)**

Advanced topics relating to design and analysis of reinforced concrete structures. Prereq: CVEN 4585. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 4585

**CVEN 5590 - Design of Prestressed Concrete (3 Credits)**

To learn the basic concepts of analysis and design of prestressed concrete, which is reinforced concrete in which steel is tensioned against the concrete, thereby introducing compression in concrete and hence overcoming the tensile weakness of concrete relative to its compressive strength. Cross-listed with CVEN 4590. Prereq: CVEN 4585 with a C- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 4585 with a C- or better or graduate standing.

**CVEN 5591 - Design of Composite Structures (3 Credits)**

The objective of this course is to provide engineering students with an overall awareness of the application and design of composite structures. Practical examples are discussed based on theory. Prereq: CVEN 4585 with a C- or better or graduate standing. Cross-listed with CVEN 4591. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 4585 with a C- or better or graduate standing.

**CVEN 5592 - Computer-Aided Structural Analysis and Design (3 Credits)**

The objective of this course is to introduce students to the fundamentals of computer-aided structural analysis and design. The course emphasizes different theoretical formulations of computational mechanics and the practical use of computer programs used worldwide in the structural engineering profession. Emphasis is also placed on techniques to check the reliability and quality of solutions. Prereq: CVEN 3505 with a C- or better or graduate standing. Cross-listed with CVEN 4592. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3505 with a C- or higher or graduate standing (GRAD or NDGR).

**CVEN 5602 - Advanced Highway Design (3 Credits)**

This course delves into the art and science of designing sustainable and context sensitive street and highway facilities. Topics include road classification, transportation planning, road alignments, cross-section design, bicycle and pedestrian facilities, intersections, and street network design. Such details are a focus of the course; however, the overarching theme reflects upon the social, economic, and environmental implications of highways and as well as proper integration into the overall transportation system. Cross-listed with CVEN 4602. Prereq: Permission of Instructor. Prereq: CVEN 3602 with a B- or better or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3602 with a B- or better or graduate standing.

Typically Offered: Fall.

**CVEN 5611 - Transportation Engineering Statistics (3 Credits)**

Covers statistical analysis methods for engineering studies in general, and for highway accident and traffic flow data in particular. Topics include data needs, sampling designs, survey methods, hypothesis testing, tests of proportions, non-parametric tests, analysis of variance, multivariate regression, and other tests of fit. Introductory overview of state and federal accident databases. Comparisons of accident rates by highway type, vehicle speeds, vehicle types, weather conditions and other factors also presented. Restriction: Graduate standing majors in the College of Engineering, Design and Computing or instructor permission. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate standing majors in the College of Engineering, Design and Computing

**CVEN 5612 - Traffic Impact Assessment (3 Credits)**

Covers (1) procedures to satisfy state and local requirements for transportation impact studies, (2) methods to perform trip generation, distribution, and traffic assignment for impact analyses, and (3) analysis of transportation impacts on residential communities, mode choice, regional business (downtown or suburban), peak and off-peak travel times, noise, safety, parking and pedestrians. A course project requires students to develop an application of analysis software to a case study area. Prereq: CVEN 3602 with a B- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3602 with a B- or better or graduate standing.

**CVEN 5613 - Traffic Simulation Modeling (3 Credits)**

This graduate-level course introduces students to the principles, methods, and software needed to perform traffic simulations of alternative transportation modes in urban areas. Students will develop a case study simulation of their choosing. Pre-req: CVEN 5621 Highway Capacity Analysis or equivalent permission of the instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5621

**CVEN 5621 - Highway Capacity Analysis (3 Credits)**

Covers the principles and applications of highway capacity analysis for freeways and arterials, ramps and interchanges, weave and merge sections, signalized and unsignalized intersections, roundabouts, pedestrian areas and transit. Emphasis is on level-of-service analysis procedures in the Highway Capacity Manual, although other approaches are also discussed. Additional topics include roadway characteristics, vehicle dynamics, human factors, speed and volume studies, travel time surveys and traffic flow characteristics. Prereq: CVEN 3602 with a B- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3602 with a B- or better or graduate standing.

**CVEN 5622 - Traffic Operations and Control (3 Credits)**

Covers principles of traffic flow and analysis methods for surface street traffic systems. Emphasis is on network modeling and simulation of coordinated signal systems, together with unsignalized intersections and freeway junctions using modern software tools. Additional topics include alternative signal timing plans, signal controllers, vehicle detection systems for volume, speed, occupancy and ramp metering. A course project requires students to develop and apply modeling software to a case study area. Prereq: CVEN 5621 with a B- or better or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5621 with a B- or better or graduate standing.

**CVEN 5631 - Transport Modeling & Big Data (3 Credits)**

This graduate-level course introduces students to travel demand modeling as developed over the last 60 years. It covers the fundamentals of conventional models and data needs but also delves into newer "big" data sources and methods that will allow us to observe and analyze transportation in completely new ways. Restriction: Graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: Graduate standing (Grad or Non-Degree Grad)

**CVEN 5632 - Urban Transportation Modeling (3 Credits)**

An advanced coverage of urban and regional transportation planning models, procedures and software. Mathematical formulations, properties, and solution algorithms are presented. Additional topics include methods of data acquisition from public domain databases for use in modeling software. A course project requires students to develop an application of modeling software to a case study area. Prereq: CVEN 5631 or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5631

**CVEN 5633 - Sustainable Transportation Systems (3 Credits)**

This course examines notable topics in sustainable transportation: demystifies conventional transportation engineering methods; and explores empirical examples of why such methods are often misguided. The intent is to enlighten engineering students and help support planning/policy students interested in transportation sustainability. Restriction: Graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: Graduate standing (Grad or Non-Degree Grad)

**CVEN 5641 - Transit System Design (3 Credits)**

This course introduces students to the components of transit system planning and design including station design and accessibility. The course focuses primarily on light rail design, but provides an overview of different transit modes. The instructors of this course have hands-on experience in transit planning, design, and construction. Prereq: graduate standing or permission of instructor.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

**CVEN 5642 - Transit Construction (3 Credits)**

This course introduces students to the fundamentals of transit construction necessary for successful project completion. It also covers how many different types of transit projects are managed and sustained. The instructors of this course have hands-on experience in transit construction, scheduling, and project control. Prereq: graduate standing or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to graduate students

**CVEN 5650 - Urban Street Design (3 Credits)**

This course delves into the art and science of designing sustainable and context sensitive street and highway facilities. This course is intended to intersect with CVEN 4602/5602 – Advanced Highway Design, which covers rural highway design. Topics for this course will focus on urban street design principles, including transportation planning, bicycle and pedestrian facilities, intersections, and street network design, as well as techniques and software for coordinated signal timing. Such details are a focus of the course; however, the overarching theme reflects upon the social, economic, and environmental implications of highways and as well as proper integration into the overall transportation system. Prereq: CVEN 3602 with a C- or higher, recommend B- or higher. Prereq or coreq: CVEN 4602 or CVEN 5602. Cross-listed with CVEN 4650. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3602 with C- or higher and Prereq or Coreq: CVEN 4602 or CVEN 5602; OR Graduate standing(GRAD/NDGR).

**CVEN 5662 - Transportation System Safety (3 Credits)**

This is a graduate-level course on road safety that will: investigate contemporary safety analysis techniques; highlight the disconnect between the current safety paradigm and actual safety outcomes; cover drive, bicyclist and pedestrian safety concerns; and discuss notable efforts such as Vision Zero. Restriction: Graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: Graduate standing (Grad or Non-Degree Grad)

**CVEN 5682 - Pavement Design (3 Credits)**

This course addresses both the structural analysis and design methods for pavements. Emphasis will be on mechanistic analysis. It covers very broad areas of properties of pavement materials such as concrete and hot-mix asphalt, base course, and subgrade; traffic loads, the design and performance of flexible pavements and rigid pavements; and drainage. Computer codes included in the textbook package will be used in the course, mainly because of its availability without additional cost. Other topics may be treated as time permits. Prereq: CVEN 3141, 3505, and 3708/3718 with a C- or higher, OR graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3141, CVEN 3505, and CVEN 3718 with a C- or higher OR Graduate standing.

**CVEN 5708 - Advanced Soils Engineering (3 Credits)**

A unified treatment of the foundation of soil engineering analysis. Topics include stress-strain-strength of soils; generalized limiting equilibrium analysis; stability analyses of earth-retaining structures, slopes, and shallow foundations; probabilistic approach of stability assessment; computation of settlement of foundations in sand and clay and time-rate of consolidation and critical state concept. Special attention is directed toward the illustration of theory through practical examples. Prereq: CVEN 3708 or 3718, and CVEN 4718 or 4728, or Graduate Standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3708 or 3718, and CVEN 4718 or 4728, or Graduate Standing.

**CVEN 5709 - Settlement Analysis (3 Credits)**

A unified treatment of settlement analysis on sand and clay. Topics include settlement of shallow foundation, settlement of deep foundation, and settlement of embankments, walls and excavations. Conventional methods of analysis and the finite element method of analysis are covered. Critical design implications are emphasized. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**CVEN 5718 - Engineering Properties of Soils (3 Credits)**

Engineering properties of soils, including index properties, permeability, stress-strain behaviors, shear strength, compressibility, critical state soil models and their application in interpreting soil behaviors. Attention also is directed to laboratory and in situ tests to examine the validity of shear strength and compressibility theories and their application to stability and settlement analysis. Prereq: CVEN 3708 or 3718, and CVEN 4718 or 4728, or Graduate Standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3708 or 3718, and CVEN 4718 or 4728, or Graduate Standing.

**CVEN 5719 - Design and Construction of Geosynthetic-Reinforced Soil Structures (3 Credits)**

Theory of reinforced soil; mechanical and hydraulic properties of geosynthetics; soil-geosynthetic interaction behavior; design concepts of GRS structures; design and construction of GRS retaining walls; design and construction of GRS embankments and slopes; design and construction of GRS foundations. Prereq: CVEN 5708. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 5708

**CVEN 5738 - Foundation Engineering (3 Credits)**

Methods of subsurface exploration and sampling of soils, lateral support in open cuts, control of groundwater, analysis and design of shallow foundations, analysis and design of deep foundations, bridge abutments and cofferdams, underpinning, and application of modern computational techniques to analysis and design of foundations. Cross-listed with CVEN 4738. Prereq: CVEN 3141 and 3718 with a C- or higher. Restriction: Restricted to Civil or Construction Engineering majors or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3141 and 3718 with a C- or higher. Restriction: Restricted to Civil or Construction Engineering majors. OR Graduate standing.

**CVEN 5758 - Foundations on Expansive Soils (3 Credits)**

Expansive soils swell upon wetting because of the swelling nature of constituent clay minerals, particularly montmorillonite. This course studies swelling nature of different clay minerals, effects of wetting, swelling potential, swelling pressures, and design of different foundation systems. Prereq: CVEN 4738, B.S.C.E. or permission of instructor. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**CVEN 5768 - Introduction to Rock Engineering (3 Credits)**

Nature of rock masses, geological exploration, deformability and strength, in situ stresses and deformation, rock hydraulics. Prereq: CVEN 3708 or 3718, and CVEN 4718 or 4728, or Graduate Standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CVEN 3708 or 3718, and CVEN 4718 or 4728, or Graduate Standing.



**CVEN 5780 - Engineering Geology (3 Credits)**

Studies geology as utilized in engineering and environmental practice. Emphasizes a conceptual integration of geologic materials, processes, and rates of change as a basis for successful application of geologic knowledge to environmental planning and engineering design projects. Prereq: MATH 2411 and CVEN 2121. Cross-listed with CVEN 4780 and GEOL 4780/5780. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: CVEN 2121 and MATH 2411

**CVEN 5798 - Dynamics of Soils and Foundations (3 Credits)**

Principles of vibrations of, and wave propagation in, elastic, homogeneous, isotropic media; laboratory and in situ measurements of soil properties; applications of these principles and properties to the design of foundations subject to dynamic loading generated by machinery, earthquakes, or blasts. Prereq: CVEN 5708, 5718, and graduate standing or permission of instructor. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: CVEN 5708, 5718, and Graduate Standing

**CVEN 5800 - Special Topics (3 Credits)**

Topical courses offered once or on irregular intervals. Typical topics include: computer-aided structural engineering, pre-stressed concrete, non-matrix structural analysis, geotechnical aspects of hazardous waste management, geographic information systems and facility management, groundwater hydrology, engineering project management, structural planning, engineering practice, spreadsheet application, field instrumentation, hazardous wastes engineering, bridge super and substructure design, advanced steel design, hydraulic transients, foundations – expansive soils, sludge process design. Prereq: Variable. Repeatable. Max Hours: 9 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 9.

**CVEN 5840 - Independent Study (1-6 Credits)**

Available only through approval of the graduate advisor. Subjects arranged to fit needs of particular student. Repeatable. Max Hours: 6 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 6.

**CVEN 5939 - Internship (1-3 Credits)**

Repeatable. Max hours: 3 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 3.

**CVEN 5950 - Master's Thesis (1-8 Credits)**

Repeatable. Max hours: 8 Credits.  
Grading Basis: Letter Grade with IP  
Repeatable. Max Credits: 8.  
Additional Information: Report as Full Time.

**CVEN 5960 - Master's Report (1-8 Credits)**

Repeatable. Max hours: 8 Credits.  
Grading Basis: Letter Grade with IP  
Repeatable. Max Credits: 8.  
Additional Information: Report as Full Time.

**CVEN 6111 - Dynamics of Structures (3 Credits)**

Linear and nonlinear dynamic matrix analysis of multi-degree-of-freedom structural systems. Analysis and design for wind and earthquake loads including modal analysis and sub structuring techniques. Computer programming. Prereq: CVEN 5111. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: CVEN 5111

**CVEN 6131 - Theory of Elasticity (3 Credits)**

Mathematical theory of elasticity and its applications to engineering problems. Discussion of the basic analytical and numerical methods of solutions. Prereq: CVEN 5121. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: CVEN 5121

**CVEN 6165 - Buckling in Structures (3 Credits)**

Buckling of columns, beams, frames, plates, and shells in the elastic and plastic range. Post-buckling strength of plates. Beam-columns. Analysis by exact and approximate methods with special emphasis on practical implications and application of solutions. Prereq: CVEN 3121. Max Hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: CVEN 3121

**CVEN 6738 - Finite Element Method in Geotechnical Engineering (3 Credits)**

Topics covered include: review of finite element methods, advantages and limitation of FEM for analysis of geotechnical engineering problems, one- and two-dimensional seepage analysis, consolidation analysis, incremental and iterative procedures in nonlinear analysis, no-tension analysis, simulation of construction sequence, simulation of soil behavior, simulation of interface behavior, and load-displacement analysis of earth structures. Prereq: CVEN 5708 and 5515 or consent of instructor. Max Hours: 3 Credits.  
Grading Basis: Letter Grade

**CVEN 7840 - Independent Study (1-3 Credits)**

Available only through approval of the graduate advisor. Subjects arranged to fit needs of particular student. Repeatable. Max Hours: 6 Credits.  
Grading Basis: Letter Grade  
Repeatable. Max Credits: 6.

**CVEN 8990 - Doctoral Dissertation (1-15 Credits)**

Repeatable. Max hours: 15 Credits.  
Grading Basis: Letter Grade with IP  
Repeatable. Max Credits: 15.  
Additional Information: Report as Full Time.

## Construction Engineering and Management (CEMT)

**CEMT 5231 - Construction Materials and Methods (3 Credits)**

This course serves as an introduction to the primary materials and methods used to construct buildings and infrastructure across the United States, including concrete, wood and steel. Students explore processes related to specifying and installing materials, as well as analyze various material performance characteristics. Students are required to complete lectures, videos and class activities. Students also research and present information on a wide range of materials and construction processes. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max hours: 3 Credits.  
Grading Basis: Letter Grade  
Prereq: CEMT 2100 or CVEN 4230 or graduate standing.

**CEMT 5232 - Construction Planning and Control (3 Credits)**

This course presents knowledge on planning and controlling of construction projects. Students will learn the basics of construction planning to develop work breakdown structure and activity list, estimate activity cost and duration, and identify job logic and precedence relationships. Several scheduling techniques will be presented in this class, including bar chart, network scheduling, uncertainty in scheduling (PERT), limited resources scheduling, resource leveling, line of balance, and time-cost tradeoff analysis. Furthermore, this class will provide knowledge on cash flow analysis and construction control techniques such as Earned Value method. Students will acquire skills on the use of currently available computer scheduling and planning software such as Primavera 6 and Navisworks Manage to create 5D models to visualize sequence of the construction activities. In addition, students will form teams and work on a project throughout the semester to apply the skills that they learn in class. Cross-listed with CVEN 4232. Prereq: CEMT 2100 or CVEN 4230 and a statistics course (MATH 2830, 3800, CVEN 3611, ELEC 3817, or BANA 2010) or graduate standing. Max Hours: 3 Credits. Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 and a statistics course (MATH 2830, 3800, CVEN 3611, ELEC 3817, or BANA 2010) or graduate standing.

**CEMT 5233 - Construction Cost Estimating (3 Credits)**

This course presents the application of scientific principles to rough and detailed cost estimating for construction. The course starts with an introduction to estimating and how it fits in bid/proposal process and construction management. Quantity take offs, putting costs to those quantities, overhead costs, cost markups and profits; and computerized estimating will be explored. The project includes quantity take and cost estimate for the concrete and metals portion of an actual project. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max hours: 3 Credits. Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 or Graduate standing.

**CEMT 5234 - Sustainable Construction (3 Credits)**

This course will serve as an introduction to major components and technologies used in sustainable design and construction to create healthy, environmentally-sensitive built environments. Content focuses on construction processes, renewable energy systems, healthy buildings, natural and cultural resources, and traditional as well as cutting-edge building techniques. Course participants will gain knowledge about effective sustainable practices through active learning by engaging in case studies, class presentations, and group activities. Numerous guest speakers will share first-hand experience regarding implementation and professional practice of sustainable principles in the real-world. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max Hours: 3 Credits. Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 or graduate standing.

**CEMT 5235 - Advanced Construction Engineering (3 Credits)**

This course starts with a high-level overview of Construction Engineering Management including organizations involved, current approaches and industry challenges. The course delves into contracts, estimating and managing earthwork, temporary construction, scheduling, quality and others. The course is delivered in an accelerated 8-week format. Cross-listed with CVEN 4235. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 or graduate standing.

**CEMT 5236 - Project Management Systems (3 Credits)**

Address the basic nature of managing projects and the advantages and disadvantages to this approach. Introduce the characteristics, techniques, and problems associated with initiating, planning, executing, controlling, and closeout of projects. Learn about the International Standards of PM and how to use them. Develop a management perspective about projects to help develop future project managers. Max hours: 3 Credits.

Grading Basis: Letter Grade

**CEMT 5237 - Advanced Project Management (3 Credits)**

A survey of advanced topics in project management building on the Project Management Systems course and utilizing the Project Management of Knowledge. Case studies, complex problems, and a class project will be utilized in the course to bring a practical perspective to the conceptual lessons. Cross-listed with CVEN 6237. Max hours: 3 Credits. Grading Basis: Letter Grade

**CEMT 5238 - Integrated Construction Leadership (3 Credits)**

This interdisciplinary course focuses on leadership. It is structured to feature top level executives in architecture, engineering and construction (AEC) industries to discuss current industry practice. It provides students opportunities to apply management and leadership principles in construction related projects and activities. The course is delivered in an accelerated 8-week format. Cross-listed with CVEN 6238. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max Hours: 3 Credits. Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 or graduate standing.

**CEMT 5239 - Introduction to Temporary Structures and Construction Engineering (3 Credits)**

This course will introduce the many types of temporary structures that are integral in the completion of construction projects. The temporary structures to be discussed include but are not limited to formwork, falsework, scaffolding, Support of Excavation (SOE), and equipment bridges. Construction Engineering will also be introduced including the application of structural engineering to crane picks and demolitions. The course includes planning, management and design aspects. The project includes the delivery of a formwork design that stresses the importance of constructability, cost, while providing updates throughout the project to the instructor. Cross-listed with CEMT 4239. Prereq: CEMT 2100 with a C- or better and junior or graduate standing. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CEMT 2100 with a C- or better and junior or graduate standing.

**CEMT 5240 - Building Information Modeling (BIM) (3 Credits)**

Building Information Modeling is an advanced approach to facility design and construction using object-oriented 3-D models. It can be integrated in the design and construction for analytical purposes, including design, visualization, quantity takeoff, cost estimating, planning, and facility management. Prereq: CEMT 2100 or CVEN 4230. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230.

**CEMT 5242 - Construction Safety (3 Credits)**

This course is a study of safety practices in the construction industry and the specific safety procedures used in safety management of a construction project. Topics include safety risks inherent in construction projects, the roles of government, the judicial system, the insurance industry, designers and project owners in safety management and the economic impact of injuries. Advanced topics include safety risk quantification and analysis, design for safety and emerging technologies. Prereq: CEMT 2100 or CVEN 4230. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230.

**CEMT 5246 - Construction, Business and Innovation (3 Credits)**

AEC professionals rely on technical and soft (social) skills to solve complex challenges. The interdisciplinary nature of project delivery, to an increasing extent, requires professionals to collaborate across disciplines. This course explores innovation and collaboration at the interface of construction and business. Max hours: 3 Credits.

Grading Basis: Letter Grade

**CEMT 6235 - Advanced Construction Engineering (3 Credits)**

This course starts with a high-level overview of Construction Engineering Management including organizations involved, current approaches and industry challenges. The course delves into contracts, estimating and managing earthwork, temporary construction, scheduling, quality and others. The course is delivered in an accelerated 8-week format. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 or graduate standing.

**CEMT 6237 - Advanced Project Management (3 Credits)**

A survey of advanced topics in project management building on the Project Management Systems course and utilizing the Project Management of Knowledge. Case studies, complex problems, and a class project will be utilized in the course to bring a practical perspective to the conceptual lessons. Cross-listed with CVEN 5237. Max Hours: 3 Credits.

Grading Basis: Letter Grade

**CEMT 6238 - Integrated Construction Leadership (3 Credits)**

This interdisciplinary course focuses on leadership. It is structured to feature top level executives in architecture, engineering and construction (AEC) industries to discuss current industry practice. It provides students opportunities to apply management and leadership principles in construction related projects and activities. The course is delivered in an accelerated 8-week format. Cross-listed with CVEN 5238. Prereq: CEMT 2100 or CVEN 4230 or graduate standing. Max Hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: CEMT 2100 or CVEN 4230 or graduate standing.