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 Graduate Admissions at 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/)
- Human-Centered Transportation Graduate Certificate (http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-

departments/college-engineering-design-computing/civil-engineering/human-centered-transportation-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 Solid Mechanics and Stress Analysis (3 Credits)
This course expands upon the content presented in Mechanics of Materials offered at the undergraduate level. Topics covered include analytical and graphical methods for the investigation of stress and stability within diverse structural systems including cables, trusses, arches, and masonry structures; stress and deformation within solid bodies subject to arbitrary loading and their treatment via energy methods; analysis of historical/heritage structures; introduction to finite element methods. Prereq: Requires prerequisite course of CVEN 3121 or MECH 3042 (all minimum grade B-) OR Graduate Standing in any program including non-degree. Max hours: 3 Credits.
Grading Basis: Letter Grade
Requires prerequisite course of CVEN 3121 or MECH 3042 (all minimum grade B-) OR Graduate Standing in any program including non-degree.

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. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: B- or better in CVEN 3313 or graduate standing.

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. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: B- or better in CVEN 3313 or graduate standing.

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. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: B- or better in CVEN 3313 or graduate standing.

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. Cross-listed with CVEN 4381. 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. Cross-listed with CVEN 4382. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 5381 with a B- or better OR graduate standing.

CVEN 5383 - GIS Analysis (3 Credits)
Embark on a journey into the dynamic world of Geographic Information Systems (GIS) Analysis tailored for engineering students. In this course, you will acquire the essential knowledge and practical skills needed to harness the power of GIS technology for data analysis, visualization, and decision-making. From fundamental concepts to advanced techniques, you will explore the diverse applications of GIS across various engineering disciplines. Through hands-on exercises and real-world case studies, you will delve into advanced geospatial techniques, emphasizing their engineering applications in spatial, network, and 3D GIS analyses. We will dive deep into spatial analysis methods, such as proximity analysis, spatial statistics, and network analysis, to uncover hidden patterns and insights within geographic data and their significance on engineering problem-solving. This course will equip you with the tools and expertise to excel in spatial data analysis and make informed decisions in our increasingly spatially connected world. Prereq: CVEN 5381 with a B- or better or graduate standing. Cross-listed with CVEN 4383. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 5381 with a B- or better or graduate standing.

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. Cross-listed with CVEN 4384. 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 RBDMS technologies. Prereq or Coreq: CVEN 5381 or graduate standing. Cross-listed with CVEN 4385. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq or Coreq: CVEN 5381 or graduate standing.

CVEN 5386 - GIS Laboratory - Advanced Topics in Geospatial Fieldwork (3 Credits)
This geospatial course delves into the advanced principles and practices of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) fieldwork. Building upon prior introductory GIS coursework, you will explore the methodologies, techniques, and tools that are essential for conducting effective fieldwork in various engineering disciplines and beyond. Through hands-on exercises and real-world case studies, you will deepen their understanding of how to plan and execute an effective geospatial data collection field effort. You will also learn how to leverage ArcGIS Online web maps and mobile applications – including Survey123 and Field Maps – as well as understand emerging trends and technologies in GPS/GNSS that make data collection possible. This course will equip you with the tools and expertise to understand geospatial data collection in the field and make informed decisions in our increasingly spatially connected world. Prereq:CVEN 5381 (minimum grade C-) and graduate student standing only. Cross-listed with CVEN 4386. Max hours: 3 Credits.
Grading Basis: Letter Grade
Requires prerequisite course of CVEN 5381 (minimum grade C-) and graduate student standing only.

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. Cross-listed with CVEN 4387. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 5382 with a B- or better OR graduate standing.

CVEN 5388 - Geographic Information Systems for Transportation Infrastructure (GIS-T) (3 Credits)
This course provides an overview of geospatial transportation infrastructure data and its uses for design, policy, planning, and asset management. This course will identify traditional and innovative transportation infrastructure data sources, including new mobile data collection methods. It will also cover geospatial data management, spatial analysis approaches, as well as GIS methods to analyze demographics and relevant federal standards with respect to municipal policies. Prereq: CVEN 4381, CVEN 5381, CVEN 4391, or CVEN 5391 with a B- or better or graduate standing. Cross-listed with CVEN 4388. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 4381, CVEN 5381, CVEN 4391, or CVEN 5391 with a B- or better or graduate standing.

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. Cross-listed with CVEN 4390. 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. Cross-listed with CVEN 4391. 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. Cross-listed with CVEN 4392. 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. Cross-listed with CVEN 4395. 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. Cross-listed with CVEN 4396. Max hours: 3 Credits.
Grading Basis: Letter Grade

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 or graduate standing. Cross-listed with CVEN 4397. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 5391 and CVEN 5392 or graduate standing.

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, or 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.

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. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CHEM 1130, CHEM 2031, or ENGR 1130 or graduate standing.

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, 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.

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 3313 and Prereq or Coreq: ENGR 1100 OR graduate standing. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 3313 and Prereq or Coreq: ENGR 1100 OR graduate standing.

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 - Biological Treatment 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 reminder 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 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 5520 - Structural Engineering and the Ocean Environment (3 Credits)
This course explores the design of structures for coastal and ocean resilience within the broader context of climate change adaptation. The following subjects will be introduced: coastal and oceanic wave dynamics; hydrodynamic forces on coastal structures and methods for attenuation; analysis and design of floating structures. Prereq: MATH 2421 with a C- or better and CVEN 3121 or MECH 3043 with a C- or better OR graduate standing (any program, including non-degree). Cross-listed with CVEN 4520. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: MATH 2421 with a C- or better and CVEN 3121 or MECH 3043 with a C- or better OR graduate standing (any program, including non-degree).

CVEN 5530 - Structural Rehabilitation (3 Credits)
This course teaches the fundamental concepts of structural rehabilitation for flexural, shear, and axial members using carbon fiber reinforced polymer composites. Students will learn to conduct a rehabilitation design, to carry out experimental work in the laboratory and to interpret test data for engineering applications. After completing this course, students are expected to understand the concept of structural rehabilitation and to implement it in practice. Prereq or Coreq: Requires prerequisite or corequisite course of CVEN 4585 (if prereq, minimum grade C-) or graduate standing. Cross-listed with CVEN 4530. Max hours: 3 Credits.
Grading Basis: Letter Grade
Requires prerequisite or corequisite course of CVEN 4585 (minimum grade C-) or graduate standing.

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 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 focuses on advanced techniques and practices for roadway design. Students will learn about the latest design standards, guidelines, and best practices, including the use of geometrics, alignment, cross-section design, and the integration of Intelligent Transportation Systems (ITS) into roadway design. The course will cover topics such as road safety, design for alternative modes, and the incorporation of sustainability principles into roadway design. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world roadway design projects. The course will also explore the latest technologies and tools for roadway design, including computer-aided design (CAD). By the end of the course, students will have a comprehensive understanding of advanced roadway design and the skills necessary to design roads that meet the needs of communities and support sustainable mobility. Prereq: Requires prerequisite course of CVEN 3602 (minimum grade C-) AND Junior Standing OR Graduate Standing. Cross-listed with CVEN 4602. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 3602 with a C- or better or graduate standing.
Typically Offered: Spring.

CVEN 5611 - Transportation Engineering Statistics (3 Credits)
This course provides an overview of statistical methods and techniques used in transportation engineering. Students will learn how to collect, analyze, and interpret transportation data to support decision-making in transportation planning and engineering. Topics covered in the course include descriptive statistics, probability distributions, hypothesis testing, regression analysis, and time series analysis. The course will also cover the use of statistical software for transportation data analysis and the application of statistical methods to real-world transportation problems. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world transportation data sets. By the end of the course, students will have a comprehensive understanding of transportation engineering statistics and the skills necessary to use statistical methods to support transportation planning and engineering decision-making. Restriction: Graduate Standing or Permission of Instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Graduate level students.

CVEN 5612 - Traffic Impact Assessment (3 Credits)
This course provides a comprehensive overview of the Traffic Impact Assessment (TIA) process. Students will learn the principles and techniques for conducting TIAs, including the collection and analysis of traffic data, the use of traffic modeling software, and the assessment of potential impacts on the transportation system and the surrounding community. Students will also learn to evaluate the effectiveness of mitigation measures and recommend strategies for reducing the impacts of transportation projects. The course will cover relevant regulations, guidelines, and best practices in TIA, and will include case studies and hands-on exercises to apply the concepts learned. Upon completion of the course, students will have a solid understanding of the TIA process and the skills necessary to conduct effective TIAs for transportation projects. Prereq: CVEN 3602 with a B- or better or graduate standing. Cross-listed with CVEN 4612. 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 course provides an overview of statistical methods and techniques used in transportation engineering. Students will learn how to collect, analyze, and interpret transportation data to support decision-making in transportation planning and engineering. Topics covered in the course include descriptive statistics, probability distributions, hypothesis testing, regression analysis, and time series analysis. The course will also cover the use of statistical software for transportation data analysis and the application of statistical methods to real-world transportation problems. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world transportation data sets. By the end of the course, students will have a comprehensive understanding of transportation engineering statistics and the skills necessary to use statistical methods to support transportation planning and engineering decision-making. Prereq: CVEN 4621/5621 Highway Capacity Analysis with C- or better, graduate standing, or permission of the instructor. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 4621 or CVEN 5621 with C- or better and graduate standing.

CVEN 5621 - Highway Capacity Analysis (3 Credits)
This course provides an in-depth examination of highway capacity analysis and its applications in transportation planning and engineering. Students will learn the fundamental concepts and methodologies for analyzing highway capacity, including the use of the Highway Capacity Manual (HCM) and other relevant guidelines. The course will cover a range of topics including level of service (LOS) analysis, intersection capacity analysis, freeway capacity analysis, and analysis of alternative transportation modes. Students will also learn to apply various techniques for estimating traffic demand, including forecasting methods, and to evaluate the impacts of congestion, incidents, and other factors. The course will include case studies and hands-on exercises to provide students with practical experience in conducting highway capacity analysis. Upon completion of the course, students will have a solid understanding of capacity analysis and the skills necessary to apply these concepts to real-world transportation problems. Prereq: CVEN 3602 with a B- or better or graduate standing. Cross-listed with CVEN 4621. 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)
This course provides an overview of traffic operations and control principles and practices in transportation engineering. Students will learn about the various strategies and technologies used to manage and control traffic flow, including traffic signals, ramp metering, dynamic lane assignment, and real-time incident management. The course will cover topics such as traffic flow theory, capacity analysis, traffic simulation, and the design and implementation of advanced transportation management systems. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world traffic operations and control problems. The course will also cover the use of data and information systems to support traffic operations and control, including the integration of real-time data from various sources and the use of data analytics to improve traffic management decision-making. By the end of the course, students will have a comprehensive understanding of traffic operations and control and the skills necessary to design and implement effective traffic management strategies. Prereq: CVEN 4621 or CVEN 5621 wtih a B- or better or graduate standing. Cross-listed with CVEN 4622. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 4621 or 5621 wtih a B- or better or graduate standing.

CVEN 5631 - Transport Modeling and Big Data (3 Credits)
This course focuses on the use of transport modeling and big data techniques in transportation planning and engineering. Students will learn industry-relevant skills about the various types of transport models – including travel demand models, traffic simulation models, and transportation network models – and how they are used to support transportation decision-making. The course will cover the basic principles and methods for collecting, processing, and analyzing big data in transportation, including the use of data sources such as GPS, cell phone data, and social media. Students will also learn the statistical programming software R/RStudio as the primary tool to engage in hands-on exercises and real-world case studies. The course will also explore the use of advanced analytical tools and techniques, including machine learning and data mining, to support transportation modeling and decision-making. By the end of the course, students will have a comprehensive understanding of transport modeling and big data as well as the skills necessary to use these tools and techniques to support transportation planning and engineering. Prereq: Senior or graduate standing. Cross-listed with CVEN 4631. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: Senior or graduate standing.

CVEN 5632 - Transportation Data Analytics (3 Credits)
This course focuses on providing students with industry and research ready skills on transportation data and data analysis. Students will learn statistical and machine learning techniques suitable for modeling transportation data and work with real life different types of transportation data (e.g., safety data, GPS data, ridership data etc.) available in the public domain. Additionally, students will learn ways to present the analysis results to non-technical audience like policy and decision makers through compelling visualization and story telling through data. By the end of the course, students will have a comprehensive understanding of how to use advanced transport models and big data to support evidence-based decision-making in the transportation sector. Prereq: CVEN 4631/5631 with a C- or better, graduate standing, or permission of instructor. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 4631 or CVEN 5631 with a C- or better and graduate standing.

CVEN 5633 - Sustainable Transportation Systems (3 Credits)
This course was built to bring together engineers and planners but is open to students of diverse disciplines who might have interest in transportation and/or sustainability. Each week, we demystify a different topic in transportation engineering to help students understand what transportation engineers do and why. We then delve into why our transportation engineering fundamentals often lead to unstainable outcomes and how we can do better. This course provides an overview of the principles and practices of sustainable transportation in transportation engineering. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world sustainable transportation projects. By the end of the course, students will have a comprehensive understanding of sustainable transportation. This course will also will enlighten engineering students to look beyond the guidebooks while providing planners and other students with the ability to effectively argue with a traffic engineer. Restriction: Graduate standing. Cross-listed with CVEN 4633. Max Hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: Graduate standing (Grad or Non-Degree Grad)

CVEN 5641 - Transit System Planning and Design (3 Credits)
Great cities don't work without great transit. This course provides an overview of the principles and practices of transit system planning and design in transportation engineering. Students will learn about the various types of transit systems – including bus rapid transit, light rail transit, and commuter rail, paratransit, and micromobility – while critically assessing such systems from around the world. The course will cover topics such as ridership forecasting, network design, station planning, and the integration of transit into the overall transportation network. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world transit system planning and design projects. The course will also cover the use of data and information systems to support transit planning and design, including the collection and analysis of passenger data and the use of geospatial information systems. By the end of the course, students will have a comprehensive understanding of transit system planning and design and the skills necessary to plan and design effective transit systems that meet the needs of communities and support sustainable mobility. Restriction: Restricted to students with graduate or NDGR standing. Cross-listed with CVEN 4641. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to graduate students and graduate non-degree seeking students.

CVEN 5642 - Transit Operations (3 Credits)
This course provides an in-depth examination of advanced transit operations principles and practices in transportation engineering. Students will learn about the various strategies and technologies used to manage and control transit operations, including real-time passenger information systems, vehicle tracking systems, and integrated scheduling and dispatch systems. The course will cover topics such as service planning, network design, route optimization, and the use of data analytics to improve transit operations. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world transit operations problems. We often use Denver's RTD system as an example but also compare its operations to transit systems from around the world. The course will also cover the use of information and communication technologies to support transit operations, including the integration of real-time data from various sources and the use of data analytics to support decision-making. By the end of the course, students will have a comprehensive understanding of advanced transit operations and the skills necessary to design and implement effective transit operations strategies that meet the needs of communities and support sustainable mobility. 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 explores the principles and practices of urban street design, with a focus on creating safe, efficient, and livable streets for all users. Students will learn about the key elements of street design, including lane widths, intersection geometry, sidewalk design, and bicycle facilities, and how these elements impact street safety and accessibility for pedestrians, bicycles, and vehicles. The course will also cover design guidelines and best practices, such as the Complete Streets concept, and will provide an overview of relevant policies and laws. Students will engage in hands-on exercises to apply design concepts to real-world urban street design problems, and will have the opportunity to analyze and critique real-world street design projects. By the end of the course, students will have a comprehensive understanding of urban street design and the skills necessary to create streets that are safe, accessible, and supportive of a range of transportation modes. 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 a C- or higher. Coreq or prereq: CVEN 4602 or CVEN 5602.

CVEN 5662 - Transportation System Safety (3 Credits)
More than a million people die on our streets every year, but we treat these fatalities as the cost of doing business rather than the preventable public health crisis they should represent. Conventional traffic engineering blames upwards of 94% of road fatalities on human error, but rather than relying on Education or Enforcement, this course looks to what Engineering can do to proactively design safety streets and communities. To do so, this course focuses on the principles and practices of Safe Systems in transportation engineering. Students will learn about the various factors that contribute to transportation safety, including road design, vehicle design, and human behavior. The course will also cover topics such as crash data, crash analysis, risk assessment, and the development of safety plans and programs. Students will engage in hands-on exercises and case studies to apply the concepts learned and will have the opportunity to analyze real-world transportation safety problems. By the end of the course, students will have a comprehensive understanding of transportation system safety and the skills necessary to plan and design safe transportation systems that meet the needs of communities and support safe transportation. Restriction: Graduate standing. Cross-listed with CVEN 4662. 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. Cross-listed with CVEN 4682. 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 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 Design (3 Credits)
Applies principles of soil mechanics to the analysis and design of foundations and earth retaining structures. Theories of consolidation, lateral earth pressure, and bearing capacity. Analysis of foundation settlement and design of shallow and deep foundations and retaining walls. Prereq: CVEN 3141 and 3718 with a C- or higher. Restriction: Restricted to Civil or Construction Engineering majors or graduate standing. Cross-listed with CVEN 4738. 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 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 - Structural Dynamics II (3 Credits)
Analyzes and designs structures for earthquake load including: earthquake ground motions, response of linear and nonlinear structures, response and design spectra, seismic design load, seismic analysis, building code requirements and design of steel and concrete structures for seismic load. Prereq: CVEN 5111. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CVEN 5111
Typically Offered: Spring.

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: Requires prerequisite course of CEMT 2100 (minimum grade C-) or graduate standing. Cross-listed with CEMT 3231. Max hours: 3 Credits.
Grading Basis: Letter Grade
Requires prerequisite course of CEMT 2100 (minimum grade C-) 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 forms teams and work on a project throughout the semester to apply the skills that they learn in class. Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing. Cross-listed with CVEN 4232. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better 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, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing. Cross-listed with CEMT 4233. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better 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, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing. Cross-listed with CEMT 4234. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better 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. Prereq: CEMT 2100 or CVEN 4230 with a C- or better or graduate standing. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100 or CVEN 4230 with a C- or better 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. Restriction: Graduate standing. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: Graduate standing (Grad or Non-Degree Grad)

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. Restriction: Graduate standing. Cross-listed with CVEN 6237. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: Graduate standing (Grad or Non-Degree Grad)

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. Prereq: CEMT 2100 or CVEN 4230 with a C- or better or graduate standing. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100 or CVEN 4230 with a C- or better 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, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing. Cross-listed with CEMT 4240. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing.

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 injures. Advanced topics include safety risk quantification and analysis, design for safety and emerging technologies. Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing. Cross-listed with CEMT 4242. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: CEMT 2100, CEMT 2300, CEMT 3100, and CEMT 3231 all with a C- or better or graduate standing.

CEMT 5245 - Construction Dispute Resolution (3 Credits)
Construction disputes are an inevitable component of construction projects, and the navigation and analysis of the disputes is an important consideration for project stakeholders in successfully completing construction projects. This class introduces the basic concepts of dispute-resolution techniques in the construction industry. It discusses the selection and navigation of different techniques in the dispute resolution process, from prevention through negotiation, non-binding, binding, and litigation. It explores how to perform a forensic analysis of construction disputes, discussing entitlement, causation, and quantification of delay and cost disputes. Restriction: Restricted to students with senior standing or graduate standing. Prereq: CEMT 4232 or CEMT 5232 with a B- or better. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to students with senior standing or graduate standing. Prereq: CEMT 4232 or CEMT 5232 with a B- or better.

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. Restriction: Graduate standing. Max hours: 3 Credits.
Grading Basis: Letter Grade
Prereq: Graduate standing (Grad or Non-Degree Grad)

CEMT 5701 - Surveying Basics (1 Credit)
Presents basic techniques of land and construction surveying, including measurement of position, elevation, orientation and length of lines, area, volume and layout calculations with total station surveying. A mini project is part of the course. Restriction: Restricted to students with graduate standing, including non-degree. Cross-listed with CVEN 2214. Max hours: 1 Credits.
Grading Basis: Letter Grade
Prereq: Graduate standing (Grad or Non-Degree Grad)

CEMT 5702 - Surveying Data Collection/Surveying Lab (1 Credit)
Presents basic techniques and technologies for collection of elevation, orientation, and locations of objects. Optical, laser, total station, and GIS Equipment are included. A mini project is part of the course. Prereq: Requires prerequisite course of CEMT 5701(minimum grade D-) or graduate standing, including non-degree graduate students. Cross-listed with CVEN 2215. Max hours: 1 Credits.
Grading Basis: Letter Grade
Requires prerequisite course of CEMT 5701 (minimum grade D-) or graduate standing, including non-degree graduate students.

CEMT 5703 - Surveying Data Processing and Analytics (1 Credit)
Presents basic techniques, technologies, and software for processing of field and survey data including feature extraction and basemap development, integrating data from multiple sources, accuracy, calibration, and case studies. Prereq: Requires prerequisite courses of CEMT 5701 and CEMT 5702 (all minimum grade D-) or graduate standing, including non-degree seeking graduate students. Cross-listed with CEMT 3703
Grading Basis: Letter Grade
Requires prerequisite courses of CEMT 5701 and CEMT 5702 (all minimum grade D-) or graduate standing, including non-degree seeking graduate students.

CEMT 5724 - Construction Technology 1 (Drones, construction coordination and VR/AR) (3 Credits)
This course is divided into three modules, each focusing on key technologies in the construction industry. The Drone Operation and Data Processing module teaches students drone operation, safety, and data collection, along with hands-on experience in 3D modeling and aerial imagery analysis. In the Construction Coordination Methods and Tools module, students learn to use laser scanning equipment and cloud-based software for real-time data sharing and project coordination. The Virtual and Augmented Reality module introduces students to VR/AR technologies, focusing on improving communication, design, and planning, with practical applications in construction. Restriction: Restricted to students with senior or graduate standing. Cross-listed with CEMT 4724. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to graduate level or senior level or higher students

CEMT 5734 - Construction Technology 2 (Robotics, AI and data analytics) (3 Credits)
This course covers three key modules: robotics, AI, and data analytics, focusing on their applications in the construction industry. The Robotics in Construction module introduces students to cutting-edge autonomous systems like SPOT by Boston Dynamics and various robotic equipment, teaching them programming, navigation, and human-robot interaction. The AI in Construction module focuses on AI-driven solutions for project optimization, risk management, and predictive maintenance, offering hands-on experience with machine learning models. The Data Analytics for Construction module trains students to process and analyze construction data, leveraging big data to improve project performance, safety, and efficiency. Restriction: Restricted to students with senior or graduate standing. Cross-listed with CEMT 4734. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to graduate level or senior level or higher students

CEMT 5800 - Special Topics in Construction (3 Credits)
These special topics courses cover a variety of topics in construction engineering and management. Restriction: Restricted to students with graduate standing. Repeatable. Max hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.
Prereq: Graduate standing (Grad or Non-Degree Grad)