CIVIL ENGINEERING (CVNG)

CVNG 1000 - Intro to Civil Engineering
2 Credits
An introduction to Civil Engineering profession that consists of a series of project-based learning modules designed to explore various specialty areas within Civil Engineering. Offered every spring semester.
Prerequisite(s): CVNG 1001* with a grade of C- or higher; SE 1700 with a grade of C- or higher

* Concurrent enrollment allowed.
Attributes: UUC:Creative Expression

CVNG 1001 - Civil Engineering Modeling
2 Credits
Introduction to engineering drawing and computer aided drafting techniques using Autodesk Civil 3D and Revit. Offered every spring semester.
Corequisite(s): CVNG 1000

CVNG 1010 - Freshman Engineering I
1 Credit
An introduction to Civil Engineering profession that consists of a series of project-based learning modules designed to explore various specialty areas within Civil Engineering. Offered every fall semester.

CVNG 1020 - Freshman Engineering II
1 Credit
Introduction to engineering drawing and computer aided drafting techniques. Offered every spring semester.
Prerequisite(s): CVNG 1010 with a grade of C- or higher

CVNG 1500 - Civil Engineering Computing
3 Credits
Introduction to computer programming tools applicable to Civil Engineering, including Matlab/Mathcad, advanced Excel, and 3-D CAD applications. (Offered every Spring)
Prerequisite(s): (CVNG 1020 with a grade of C- or higher or MATH 1510* with a grade of C- or higher)

* Concurrent enrollment allowed.

CVNG 2010 - GIS and Surveying in Civil Engineering
3 Credits
This course discusses the fundamental concepts of geographic information system (GIS) at different scales and resolutions. Spatial analysis methods and software are used to solve problems with data collected in the field and other sources. GIS and surveying topics are presented in the same context. The course is complemented with a database development and analysis lab that includes remote sensing data, basic and differential GPS, and traditional surveying to prepare students for today's growing business needs in the civil engineering industry.

CVNG 2017 - Spanish Civil Architectural Infrastructure: Ancient and Modern
0-3 Credits
A study of civil engineering, architectural, and construction practices within the Spanish civilization with emphasis on comparisons of the old and the new. The course is focused on inter-relationships between human and built environment: aqueducts, canals, dams, bridges, highways. Includes a 2-week field trip in the Spanish country side; with academic seminars at the SLU-Madrid campus. Instructor approval required. [Independent study, experiential learning, 0-3 credits].

CVNG 2020 - GIS and Surveying in Civil Engineering Lab
1 Credit
Introduction to data collection techniques used in geospatial analysis in civil engineering. Data types include, vector and raster imagery, LiDAR, GPS, and traditional surveying. Hands-on training of equipment [total station, GPS receivers with differential correction, LiDAR scanners (demo)] and other data collection techniques.
Prerequisite(s): CVNG 1000 with a grade of C- or higher

CVNG 2070 - Construction & Project Management
3 Credits
An introduction to basic concepts of civil engineering project management, business and leadership. Topics include role of a project manager, project selection, cost estimating, using analytical techniques for project planning and scheduling, risk management, legal issues in engineering projects, your role as a safety leader, proposal preparation, and understanding the importance of professional licensure and ethics. Offered every fall semester.
Prerequisite(s): CVNG 1001* with a grade of C- or higher

* Concurrent enrollment allowed.

CVNG 2100 - Statics
0 or 3 Credits
Study of force systems acting on particles and rigid bodies, 2-D and 3-D equilibrium, trusses, frames machines, shear and moment diagrams, friction, centroids, area moment of inertia.
Prerequisite(s): PHYS 1610*

* Concurrent enrollment allowed.

CVNG 2500 - Civil Engineering Computing
3 Credits
Introduction to computer programming tools applicable to Civil Engineering, including Matlab/Mathcad, advanced Excel, and 3-D CAD applications. (Offered every Fall)
Prerequisite(s): CVNG 1000 with a grade of C- or higher; (MATH 1510 with a grade of C- or higher or SLU Math Placement with a minimum score of 1520)

CVNG 2910 - Co-Op with Industry
0 Credits (Repeatable for credit)
Prerequisite(s): CORE 1000; CORE 1500*

* Concurrent enrollment allowed.
Attributes: UUC:Reflection-in-Action

CVNG 2930 - Special Topics
3 Credits (Repeatable for credit)

CVNG 2980 - Independent Study in Civil Engineering
1 or 3 Credits (Repeatable for credit)

CVNG 3010 - Structural Analysis
3 Credits
Analysis of statically determinate structures including influence lines. Deformations using different techniques. Analysis of statically indeterminate structures using the force method and displacement method.
Prerequisite(s): (ESCI 3100, MENG 3105, or CVNG 3105X)
Corequisite(s): CVNG 3020

CVNG 3020 - Structural Analysis Lab
1 Credit
Application of methods and computational tools used for the analysis of structures.
Corequisite(s): CVNG 3010

CVNG 3030 - Civil Engineering Materials
1 Credit
An overview of the physical and mechanical properties of various civil engineering materials, including steel, aggregate, portland cement concrete, asphalt cement concrete, wood, and fiber-reinforced composites. Lecture section provides presentation of and theoretical background of those materials.
Prerequisite(s): (ESCI 3100, MENG 3105, or CVNG 3105X)

CVNG 3031 - Civil Engineering Materials Laboratory
2 Credits
An overview of the physical and mechanical properties of various civil engineering materials, including steel, aggregate, portland cement concrete, asphalt cement concrete, wood, and fiber-reinforced composites. Laboratory section provides hands-on experience of testing methods used on those materials.
Prerequisite(s): (ESCI 3100, MENG 3105, or CVNG 3105X)
Corequisite(s): CVNG 3030

CVNG 3040 - Sustainability and Environmental Engineering
3 Credits
Course provides an overview of sustainability and environmental engineering principles. Topics include: population, environmental impact, and resource depletion; environmental laws; biodiversity and ecosystem functioning; climate change, air pollution, and ozone depletion; solid-waste management, hazardous and nuclear waste management; water resource and pollution management; and water and wastewater treatment and systems. (Offered every Fall)
Prerequisite(s): (CHEM 1070 with a grade of C- or higher or CHEM 1110 with a grade of C- or higher)
Corequisite(s): CVNG 3041
Attributes: Environmental Science Elective, UUC:Dignity, Ethics & Just Soc, Urban Poverty - Applied

CVNG 3041 - Sustainability and Environmental Engineering Lab
1 Credit
Course provides an overview of environmental testing methods, including dissolved oxygen, BOD, pH and alkalinity, conductivity, plate counts, and turbidity. (Offered every Fall)
Prerequisite(s): CHEM 1115 with a grade of C- or higher
Corequisite(s): CVNG 3040
Attributes: Environmental Science Elective

CVNG 3070 - Engineering Project Management
2 Credits
An introduction to basic concepts of management, business, public policy, and leadership. Topics include engineering economics and cost estimating methods, including labor, material, equipment and indirect costs; analytical techniques for project planning and scheduling; legal issues in engineering projects, including zoning regulations, proposals, and contracts; and understanding the importance of professional licensure. Offered every fall semester.

CVNG 3090 - Geotechnical Engineering
3 Credits
This course is an introduction to soil properties and analysis techniques for geotechnical applications. Topics include soil formations, mass-volume relationships, soil classification, effective stress, compaction, seepage, soil deformation, sate of stress, consolidation, strength, and failure. (Offered every Spring)
Prerequisite(s): CVNG 3030 with a grade of C- or higher
Corequisite(s): CVNG 3100

CVNG 3100 - Geotechnical Engineering Lab
1 Credit
Overview and use of measurements methods that can evaluate the properties of soils. Experiments include grain size distribution and soil classification, Atterberg Limits, compaction, permeability, consolidation, sear strength, and unconfined compressive strength. (Offered every Spring)
Corequisite(s): CVNG 3090

CVNG 3105X - Mechanics of Solids
3 Credits
Stress and deformation due to axial load, torsion, bending and shear; properties of materials; statically indeterminate problems, analysis of plane stress and strain; combined loading; pressure vessels; beam deflections.

CVNG 3110 - Transportation Engineering
3 Credits
Introduction to transportation analysis and design. Course includes topics on road user and vehicle characteristics; geometric design of roadways, including horizontal and vertical alignment and cross-sectional elements; and signalized intersections. Also included is an Introduction to traffic engineering and transportation planning. (Offered every Spring)
Prerequisite(s): MATH 3850 with a grade of C- or higher
Corequisite(s): CVNG 3120

CVNG 3120 - Transportation Engineering Lab
1 Credit
Overview and use of measurement methods that can evaluate traffic flow and pavement condition and an introduction to computational methods used in transportation analysis and design. (Offered every Spring)
Corequisite(s): CVNG 3110

CVNG 3130 - Hydraulic Engineering
3 Credits
Hydraulic and hydrological analysis applicable to civil engineering design. Topics include pressure pipe system analysis and design, open channel flow analysis and design, groundwater flow fundamentals ad well design, hydrologic processes, storm water system analysis and design, and sanitary sewer analysis and design. (Offered every Spring)
Prerequisite(s): (ESCI 3200 or MENG 3200)
Corequisite(s): CVNG 3140

CVNG 3140 - Hydraulic Engineering Lab
1 Credit
Overview and use of measurement methods that can evaluate hydraulic and hydrologic conditions and an introduction to computational methods used hydraulic and hydrologic analysis and design. (Offered every Spring)
Corequisite(s): CVNG 3130

CVNG 3150 - Introduction to Structural Design
3 Credits
Introduction to structural design codes and provisions. Loads and loads combinations. Theory and design of reinforced concrete structures: beams, columns, slabs, walls and buildings. Theory and design of simple steel structural members and connection.
Prerequisite(s): CVNG 3010 with a grade of C- or higher; CVNG 3030 with a grade of C- or higher

CVNG 3160 - Structural Design Lab
1 Credit
Companion laboratory to Introduction to Structural Design course. Focus is on the application of design codes and provisions through project-based learning activities.
Corequisite(s): CVNG 3150

CVNG 3910 - Co-Op with Industry
0 Credits (Repeatable for credit)
Prerequisite(s): CORE 1000; CORE 1500*

* Concurrent enrollment allowed.
Attributes: UUC:Reflection-in-Action

CVNG 3915 - Internship with Industry
1-3 Credits (Repeatable for credit)
Field-based course. This course is an experiential learning course, which takes place in the place with a partner in industry. It is intended to be in partnership between the student, industry, and faculty.
Prerequisite(s): CORE 1500*; CORE 1000

* Concurrent enrollment allowed.
Attributes: UUC:Reflection-in-Action

CVNG 3930 - Special Topics
1-3 Credits (Repeatable for credit)

CVNG 3980 - Independent Study in Civil Engineering
1 or 3 Credits (Repeatable for credit)

CVNG 4010 - Senior Engineering
1 Credit
Review of topics related to FE exam. Offered every spring semester.

CVNG 4020 - Advanced Soil Mechanics
3 Credits
An overview of the origin, nature, fabric, structure and classification of soils is presented. The water effects on soils including: capillarity, shrinkage, swelling, permeability and the concept of effective stresses principle are covered as fundamentals to soil behavior. Stresses in soil, stress-strain relationships, stress paths, and failure criteria are discussed in detail. The course provides an emphasis on the topics of consolidation and shear strength of soils. Finally, these two topics will be presented within a common framework as an introduction to Critical State Soil Mechanics.
Corequisite(s): CVNG 3090

CVNG 4030 - Foundation Engineering
3 Credits
Application of the fundamental concepts of soil behavior to evaluate, select, and design shallow and deep foundation systems. Topics include the design and analysis of footing, mat, pier, and pile foundations. Professional development elective.
Prerequisite(s): CVNG 3090 with a grade of C- or higher

CVNG 4035 - GeoSolutions for Climate Change
3 Credits
Application of the fundamental concepts of earth materials in the context of the human and built environment. The principles of soil and rock mechanics that apply to earth reshaping our world. The impact of climate change on natural and anthropogenic systems and how to become more resilient. Topics include soil and rock types, material properties, water interaction, changes in loading, saturation, and changes in material properties.
Attributes: Environmental Science Elective

CVNG 4050 - Advanced Structural Analysis
3 Credits (Repeatable for credit)
Direct stiffness method for analysis of two-dimensional trusses and frames, equivalent nodal forces, thermal and settlement effect, principal of virtual work, space trusses, grid structures, static condensation, Lagrange multipliers, tapered elements.
Prerequisite(s): CVNG 3010 with a grade of C- or higher

CVNG 4060 - Structural Systems Design
3 Credits
Introduction to and use of ASCE 7 – "Minimum Design Loads and Associated Criteria for Buildings and Other Structures" to analyze and design various structural systems.
Prerequisite(s): CVNG 3010 with a grade of C- or higher; CVNG 3150 with a grade of C- or higher

CVNG 4070 - Structural Dynamics
3 Credits
Single degree of freedom systems, lumped-mass multi-degree systems, and multi degree of freedom systems. Numerical evaluation of system responses due to blasts, wind, and earthquake loading. Applications.
Prerequisite(s): CVNG 3010 with a grade of C- or higher

CVNG 4070X - Linear Vibrations
3 Credits
Single and two degrees-of-freedom with and without damping, vibration dampers and absorbers; model properties of vibrating systems; vibration of lumped parameter and continuous systems; approximate numerical methods and digital computation. Review of test equipment and methods.

CVNG 4090 - Advanced Reinforced Concrete
3 Credits (Repeatable for credit)
Advanced topics in flexural design; torsion in beams; behavior and design of slender columns; biaxial bending of columns; design of two way slabs; inelastic analysis of flexural members; use of strut and tie analysis; yield line analysis; design of mat foundations.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4100 - Design of Masonry Structures
3 Credits
Theory and design of low-rise masonry structures. Materials and assembly types, constructability considerations, structural masonry components, and model code requirements to ensure adequate load resisting buildings.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4110 - Advanced Steel Design
3 Credits
Interpretation of current codes as related to the physical behavior of steel structures. Design of structural steel members: tension, compression, flexural and beam-columns. Design of connections.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4120 - Design of Timber Structures
3 Credits
Theory and design of timber structures and overview of the National Design Specification for Wood Construction.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4130 - Bridge Engineering
3 Credits
Structural systems for bridges, loading, analysis by influence lines, slab and girder bridges, composite design, pre-stressed concrete, rating of existing bridges, specifications and economic factors.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4150 - Prestressed Concrete
3 Credits
Theory and analysis of prestressed concrete members by various methods of prestressing; design of simple and continuous beams and slabs' prestress losses; composite beams. Extensive study of materials used in prestressed concrete. Precast concrete systems.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4170 - Seismic Design
3 Credits
Theory, analysis, and design of building structures under earthquake loading. Application of current codes and standards related to steel, concrete, masonry, and wood structures.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 4190 - Sustainable Land Development Engineering
3 Credits
Introduction to land development engineering and urban planning; site design and sediment control; transportation planning and roadway design; water resource and waste disposal issues; ecological impact analysis' application sustainable development principles to land development projects at local and regional scales.

CVNG 4210 - Sustainable Water Resources Management
3 Credits
Water Management and alternative analysis considering water resource, legal, political, and ecological issues; determination and forecasting of water demand; supply and estimating drought impacts resulting from cycle and permanent shifts in the climate.
Prerequisite(s): CVNG 2030 with a grade of C- or higher; CVNG 3130 with a grade of C- or higher

CVNG 4250 - Water Treatment Processes
3 Credits
The purpose of this course is to provide the student with a qualitative and quantitative understanding of the physical and chemical unit operations commonly used in water treatment (including drinking water and groundwater, as well as aspects of municipal and industrial wastewater). The course will provide the student with a design experience of individual unit operations. Course covers principles of physical and chemical environmental engineering processes, including sedimentation, filtration, gas transfer, aeration, absorption, ion exchange, membrane processes, coagulation, flocculation, precipitation, oxidation, reduction, and disinfection. Process modeling and analysis applications in treatment of water, wastewater, industrial wastes, vapor treatment, and soil remediation. A general chemistry or biology, or related course are recommended. Introductory course in environmental engineering or environmental science is recommended.
Attributes: Environmental Science Elective

CVNG 4260 - Environmental Solutions in Developing Countries
3 Credits
The course is designed for students of all majors (engineering, science, health, and others) and covers technology, education, and social approaches to successful WASH (Water, Sanitation and Hygiene) projects in the developing world. The course covers technical, social and economic aspects of successful humanitarian projects. This includes appropriate safe water, sanitation, air pollution technologies, and public health principles, for developing nations. Additionally, the course focuses in detail on social and educational approaches, and project management principles required for successful project implementation. In addition to classroom presentations and discussion, students will participate in a variety of field activities such as use of a wide variety of field tests for chemical and biological water quality; use and testing of common water and sanitation technologies used in developing nations (e.g., chemical disinfection and filtration technologies, solar disinfection technologies); testing and surveying using handheld GPS; and other projects. The topic spans social and technical.

CVNG 4270 - Green Infrastructure
3 Credits
This course provides an overview of fundamental science, engineering, and ecological principles for designing green infrastructure for stormwater management. Students will design green infrastructure based on current practices, perform engineering calculations to calculate its performance and develop critical thinking skills needed to design innovative or "futuristic" green infrastructures that would not only mitigate the adverse impact of climate change but also remain resilient under extreme weather conditions expected during climate change.
Corequisite(s): CVNG 3040,CVNG 3090,CVNG 3130
Attributes: Sustainability Focused

CVNG 4330 - Open-Channel Flow
3 Credits
Physical principles that govern the flow of water in open channels, analytical methods to describe and predict behavior of open-channel flow using modern computational tools, application of these principles for engineering solutions. (Offered every Fall)
Prerequisite(s): CVNG 3130 with a grade of C- or higher

CVNG 4350 - Hydraulic Modeling
3 Credits
Hydraulic Modeling Techniques with a focus on Open-Channel Flow Applications. (Offered every Spring)
Prerequisite(s): CVNG 3130 with a grade of C- or higher

CVNG 4370 - River Engineering
3 Credits
River engineering concepts including sediment transport, channel classification, fluvial geomorphology, stable channel design, and design of revetment. (Offered each Fall)
Prerequisite(s): CVNG 3130 with a grade of C- or higher
Attributes: Environmental Science Elective

CVNG 4450 - Traffic Engineering
3 Credits
Design, analysis and use of traffic control devices. Traffic administration, traffic flow theory, and highway capacity. An introduction to computer and traffic engineering. Acquisition, evaluation, statistical analysis and reporting of traffic engineering date used to design, evaluate and operate transportation systems.
Prerequisite(s): CVNG 3110 with a grade of C- or higher

CVNG 4460 - Multimodal Roadway Safety
3 Credits
This is an introduction to the fundamentals of roadway safety. At the end of this course students will be able to define nominal and substantive roadway safety. The students are expected to comprehend and explain network screening and countermeasure selection methods. Students are expected to apply highway safety manual procedures to propose safety improvement alternatives and to evaluate the effectiveness of the proposed alternatives. Other topics covered in the course include statistical applications in roadway safety, pedestrian and cyclist safety, conflict studies and crash surrogates.
Prerequisite(s): CVNG 3110 with a grade of C- or higher

CVNG 4470 - Urban Transportation Planning
3 Credits
Prerequisite(s): CVNG 3110 with a grade of C- or higher

CVNG 4480 - Traffic Simulation and Modelling
3 Credits
This course introduces students to theory and application of traffic simulation and modelling. Students are expected to explain traffic stream models, car following models, network assignment models and outline the steps for developing traffic simulation models for traffic impact studies. Through fieldwork and hands-on activities, students will be able to code and calibrate transportation facilities in microscopic traffic simulation software and analytical tools.
Prerequisite(s): CVNG 3110 with a grade of C- or higher

CVNG 4500 - Capstone Design I
3 Credits
Interdisciplinary teams working on an open-ended project. Topics include application of civil engineering principles to design problems with an emphasis on large-scale problem solving, engineering professional practice and ethics, and sustainability principles. Written, graphical and oral communications will be an integral part of the course.
Prerequisite(s): (CVNG 3040 with a grade of C- or higher, CVNG 3090 with a grade of C- or higher, CVNG 3110 with a grade of C- or higher, CVNG 3130 with a grade of C- or higher, and CVNG 3150 with a grade of C- or higher); CVNG 3090 with a grade of C- or higher; CVNG 3110 with a grade of C- or higher; CVNG 3130 with a grade of C- or higher; CVNG 3150 with a grade of C- or higher; CVNG 3040 with a grade of C- or higher; CORE 1900; CORE 1900; CORE 1500; CORE 1200*; CORE 2500*; CORE 1000

* Concurrent enrollment allowed.
Attributes: UUC:Self in the World, UUC:Writing Intensive

CVNG 4510 - Capstone Design II
3 Credits
Continuation of CVNG 4500 (Offered every Spring)
Prerequisite(s): Minimum Earned Credits of 60; CORE 1500*; CORE 1000

* Concurrent enrollment allowed.
Attributes: UUC:Collaborative Inquiry

CVNG 4910 - Co-Op with Industry
0 Credits (Repeatable for credit)
Prerequisite(s): CORE 1500*; CORE 1000

* Concurrent enrollment allowed.
Attributes: UUC:Reflection-in-Action

CVNG 4915 - Internship with Industry
1-3 Credits (Repeatable for credit)
Field-based course. This course is an experiential learning course, which takes place in the place with a partner in industry. It is intended to be in partnership between the student, industry, and faculty.
Prerequisite(s): CORE 1500*; CORE 1000

* Concurrent enrollment allowed.
Attributes: UUC:Reflection-in-Action

CVNG 4930 - Special Topics
0-3 Credits (Repeatable for credit)
A one-time course on a particular topic or a trial course that is expected to become a standard course with its own unique course number.

CVNG 4980 - Advanced Independent Study in Civil Engineering
1-3 Credits (Repeatable for credit)

CVNG 5010 - Scholarly Practices in Engineering
3 Credits
This course provides graduate students with foundational skills for academic and professional contexts. Students will design and execute literature searches using discipline-specific databases and reference management tools and subsequently synthesize information from multiple sources to write technical reports. The course covers quantitative, qualitative, and mixed research methods, with emphasis on experimental design principles that ensure valid and reliable outcomes. Students will design data visualizations to communicate key insights and develop oral presentation skills for academic settings. Course content includes ethical research conduct, evaluation of AI tools in scholarly work, analysis of research proposal and manuscript structures, and development of data management plans. Students will also identify project management techniques and teamwork principles applicable to scholarly collaboration.

CVNG 5020 - Advanced Soil Mechnanics
3 Credits
An overview of the origin, nature, fabric, structure and classification of soils is presented. The water effects on soils including: capillarity, shrinkage, swelling, permeability and the concept of effective stresses principle are covered as fundamentals to soil behavior. Stresses in soil, stress-strain relationships, stress paths, and failure criteria are discussed in detail. The course provides an emphasis on the topics of consolidation and shear strength of soils. Finally, these two topics will be presented within a common framework as an introduction to Critical State Soil Mechanics.
Corequisite(s): CVNG 3090

CVNG 5030 - Foundation Engineering
3 Credits
Application of the fundamental concepts of soil behavior to evaluate, select, and design shallow and deep foundation systems. Topics include the design and analysis of footing, mat, pier, and pile foundations.

CVNG 5035 - GeoSolutions for Climate Change
3 Credits
Application of the fundamental concepts of earth materials in the context of the human and built environment. The principles of soil and rock mechanics that apply to earth reshaping our world. The impact of climate change on natural and anthropogenic systems and how to become more resilient. Topics include soil and rock types, material properties, water interaction, changes in loading, saturation, and changes in material properties.
Attributes: Environment Geoscience GR Elec

CVNG 5050 - Advanced Structural Analysis
3 Credits
Direct stiffness method for analysis of two-dimensional trusses and frames, equivalent nodal forces, thermal and settlement effect, principal of virtual work, space trusses, grid structures, static condensation, Lagrange multipliers, tapered elements. Prerequisite: CVNG 301 or equivalent.

CVNG 5060 - Structural Systems Design
3 Credits
Introduction to and use of ASCE 7 – "Minimum Design Loads and Associated Criteria for Buildings and Other Structures" to analyze and design various structural systems.

CVNG 5070 - Structural Dynamics
3 Credits
Single degree of freedom systems, lumped-mass multi-degree systems, and multi degree of freedom systems. Numerical evaluation of system responses due to blasts, wind, and earthquake loading. Applications.

CVNG 5090 - Advanced Reinforced Concrete
3 Credits
Advanced topics in flexural design; torsion in beams; behavior and design of slender columns; biaxial bending of columns; design of two way slabs; inelastic analysis of flexural members; use of strut and tie analysis; yield line analysis; design of mat foundations.

CVNG 5110 - Advanced Steel Design
3 Credits
Interpretation of current codes as related to the physical behavior of steel structures. Design of structural steel members: tension, compression, flexural and beam-columns. Design of connections.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 5130 - Bridge Engineering
3 Credits
Structural systems for bridges, loading, analysis by influence lines, slab and girder bridges, composite design, pre-stressed concrete, rating of existing bridges, specifications and economic factors.

CVNG 5150 - Prestressed Concrete
3 Credits
Theory and analysis of prestressed concrete members by various methods of prestressing; design of simple and continuous beams and slabs' prestress losses; composite beams. Extensive study of materials used in prestressed concrete. Precast concrete systems.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 5170 - Seismic Design
3 Credits
Theory, analysis, and design of building structures under earthquake loading. Application of current codes and standards related to steel, concrete, masonry, and wood structures.
Prerequisite(s): CVNG 3150 with a grade of C- or higher

CVNG 5190 - Sustainable Land Development Engineering
3 Credits
Introduction to land development engineering and urban planning; site design and sediment control; transportation planning and roadway design; water resource and waste disposal issues; ecological impact analysis' application sustainable development principles to land development projects at local and regional scales.

CVNG 5210 - Sustainable Water Resources Management
3 Credits
Water Management and alternative analysis considering water resource, legal, political, and ecological issues; determination and forecasting of water demand; supply and estimating drought impacts resulting from cycle and permanent shifts in the climate.
Attributes: Environment Geoscience GR Elec

CVNG 5250 - Water Treatment Processes
3 Credits
The purpose of this course is to provide the student with a qualitative and quantitative understanding of the physical and chemical unit operations commonly used in water treatment (including drinking water and groundwater, as well as aspects of municipal and industrial wastewater). The course will provide the student with a design experience of individual unit operations. Course covers principles of physical and chemical environmental engineering processes, including sedimentation, filtration, gas transfer, aeration, absorption, ion exchange, membrane processes, coagulation, flocculation, precipitation, oxidation, reduction, and disinfection. Process modeling and analysis applications in treatment of water, wastewater, industrial wastes, vapor treatment, and soil remediation. A general chemistry or biology, or related course are recommended. Introductory course in environmental engineering or environmental science is recommended.

CVNG 5260 - Environmental Solutions in Developing Countries
3 Credits
The course is designed for students of all majors (engineering, science, health, and others) and covers technology, education, and social approaches to successful WASH (Water, Sanitation and Hygiene) projects in the developing world. The course covers technical, social and economic aspects of successful humanitarian projects. This includes appropriate safe water, sanitation, air pollution technologies, and public health principles, for developing nations. Additionally, the course focuses in detail on social and educational approaches, and project management principles required for successful project implementation. In addition to classroom presentations and discussion, students will participate in a variety of field activities such as use of a wide variety of field tests for chemical and biological water quality; use and testing of common water and sanitation technologies used in developing nations (e.g., chemical disinfection and filtration technologies, solar disinfection technologies); testing and surveying using handheld GPS; and other projects. The topic spans social and technical.

CVNG 5270 - Green Infrastructure
3 Credits
This course provides an overview of fundamental science, engineering, and ecological principles for designing green infrastructure for stormwater management. Students will design green infrastructure based on current practices, perform engineering calculations to calculate its performance and develop critical thinking skills needed to design innovative or "futuristic" green infrastructures that would not only mitigate the adverse impact of climate change but also remain resilient under extreme weather conditions expected during climate change.
Attributes: Environment Geoscience GR Elec, Sustainability Focused

CVNG 5330 - Open-Channel Flow
3 Credits
Physical principles that govern the flow of water in open channels, analytical methods to describe and predict behavior of open-channel flow using modern computational tools, application of these principles for engineering solutions. (Offered every Fall)
Attributes: Environment Geoscience GR Elec

CVNG 5350 - Hydraulic Modeling
3 Credits
Hydraulic Modeling Techniques with a focus on Open-Channel Flow Applications. (Offered every spring)
Attributes: Environment Geoscience GR Elec

CVNG 5370 - River Engineering
3 Credits
River engineering concepts including sediment transport, channel classification, fluvial geomorphology, stable channel design, and design of revetment. (Offered every Fall)
Attributes: Environment Geoscience GR Elec

CVNG 5450 - Traffic Engineering
3 Credits
Design, analysis and use of traffic control devices. Traffic administration, traffic flow theory, and highway capacity. An introduction to computer and traffic engineering. Acquisition, evaluation, statistical analysis and reporting of traffic engineering date used to design, evaluate and operate transportation systems.
Prerequisite(s): CVNG 3110 with a grade of C- or higher

CVNG 5460 - Multimodal Roadway Safety
3 Credits
This is an introduction to the fundamentals of roadway safety. At the end of this course students will be able to define nominal and substantive roadway safety. The students are expected to comprehend and explain network screening and countermeasure selection methods. Students are expected to apply highway safety manual procedures to propose safety improvement alternatives and to evaluate the effectiveness of the proposed alternatives. Other topics covered in the course include statistical applications in roadway safety, pedestrian and cyclist safety, conflict studies and crash surrogates.

CVNG 5470 - Urban Transportation Planning
3 Credits
Prerequisite(s): CVNG 3110 with a grade of C- or higher

CVNG 5480 - Traffic Simulation and Modelling
3 Credits
This course introduces students to theory and application of traffic simulation and modelling. Students are expected to explain traffic stream models, car following models, network assignment models and outline the steps for developing traffic simulation models for traffic impact studies. Through fieldwork and hands-on activities, students will be able to code and calibrate transportation facilities in microscopic traffic simulation software and analytical tools.

CVNG 5910 - Co-op with Industry
1-6 Credits (Repeatable for credit)

CVNG 5915 - Internship with Industry
1-3 Credits (Repeatable for credit)

CVNG 5930 - Special Topics
1-3 Credits (Repeatable for credit)
A one-time course on a particular topic or a trial course that is expected to become a standard course with its own unique course number.

CVNG 5960 - Masters Project
1-3 Credits (Repeatable for credit)
Masters Project is for students in the MS Non-Thesis degree program who will conduct a small project under the supervision of their Faculty Advisor. No more than 3 hours will be devoted to the Project.

CVNG 5980 - Graduate Independent Study in Civil Engineering
1 or 3 Credits (Repeatable for credit)

CVNG 5990 - Thesis Research
0-6 Credits (Repeatable for credit)
Research that leads to a Master's Thesis and final defense of the Thesis.

CVNG 6930 - Special Topics
1-6 Credits (Repeatable for credit)

CVNG 6980 - Graduate Independent Study in Civil Engineering
1 or 3 Credits (Repeatable for credit)

CVNG 6990 - Doctoral Dissertation Research
0-6 Credits (Repeatable for credit)
A non-classroom course in which a student explores a topic that is related to the student's doctoral work and career goals.