

# CIVIL, ENVIRONMENTAL & ARCHITECTURAL ENGINEERING

## Civil Engineering

Civil engineering offers a wide range of careers for students interested in the planning, design, and construction management of facilities essential to modern life in both the public and private sectors. Varying widely in nature, size and scope, such facilities include buildings, bridges, tunnels, highways, transit systems, dams, airports, irrigation projects, water treatment and distribution facilities, waste treatment and processing facilities, structures for space exploration, and offshore engineering designs applications.

In the coming decades, almost two billion more people will populate earth in both developed and developing countries. This growth will create unprecedented demands and opportunities for new methods and innovations in energy production, food supply, land development, water treatment, transportation systems, materials processing, waste disposal, healthcare delivery, environmental preservation and structural designs. Civil engineers play both direct and indirect roles in meeting many of these needs, with the goal of providing and improving the quality and infrastructure of life.

## Environmental Engineering

Environmental engineering plays a vital role in maintaining the quality of both public health and the natural environment. Environmental engineering encompasses the scientific assessment and development of sustainable engineering solutions to environmental problems impacting the biosphere and land, water, and air quality. Environmental issues affect almost all commercial and industrial sectors, and are a central concern for the public, for all levels of government and in international relations.

In common with other engineering fields, courses in solid mechanics, fluid dynamics, and thermal sciences are central to the environmental engineering degree. Course work specific to environmental engineering includes environmental chemistry and microbiology, as well as treatment processes and approach.

## Architectural Engineering

Architectural engineering prepares students for leadership careers in the building design, consulting, construction, and management industry and for research at the graduate level on building- and sustainability-related topics. In particular, the architectural engineering program prepares students to design, build and operate facilities that improve our quality of life. This course of study fulfills the academic requirements for registration as a professional engineer.

The architectural engineering curriculum is recommended for those wishing to specialize within the building industry in engineering design (heating, cooling, illumination, electrical, solar, and structures) or construction and contracting (facilities management). Architectural engineering students may select from several concentration areas, including: structural systems; mechanical systems (heating, ventilating and air conditioning); lighting and electrical systems; and construction engineering and management.

Course codes for these programs are AREN, CVEN and EVEN.

## Bachelor's Degrees

- Architectural Engineering - Bachelor of Science (BSARE) ([catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/architectural-engineering-bachelor-science-bsare](https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/architectural-engineering-bachelor-science-bsare))
- Civil Engineering - Bachelor of Science (BS) ([catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/civil-engineering-bachelor-science-bs](https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/civil-engineering-bachelor-science-bs))
- Environmental Engineering - Bachelor of Science (BS) ([catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/environmental-engineering-bachelor-science-bs](https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/environmental-engineering-bachelor-science-bs))

## Minors

- Architectural Engineering - Minor ([catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/architectural-engineering-minor](https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/architectural-engineering-minor))
- Civil Engineering - Minor ([catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/civil-engineering-minor](https://catalog.colorado.edu/undergraduate/colleges-schools/engineering-applied-science/programs-study/civil-environmental-architectural-engineering/civil-engineering-minor))

## Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

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Distinguished Professor; PhD, University of California, Berkeley

Amy, Gary L.  
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## Courses

### Architectural Engineering

#### AREN 1027 (3) Engineering Drawing

Introduces engineering drawing including sections and dimensioning, print readings, computer 3D, and building information modeling (BIM).  
**Requisites:** Restricted to Engineering Physics (EPEN), Architectural (AREN), General Engineering (GEEN) or Civil (CVEN) Engineering majors only.

**Additional Information:** Departmental Category: Miscellaneous

#### AREN 1037 (3) Building Information Modeling

Learn to develop and communicate physical information using three-dimensional graphical systems including Computer-Aided Design (CAD) and Building Information Models (BIM). Learn to dimension and scale physical systems and interpret scaled drawings. Get experience with industry standard software tools (REVIT) used to produce design and construction documents, and apply BIM and CAD tools in a project producing scaled 3-D drawings.

**Additional Information:** Departmental Category: Miscellaneous

#### AREN 1316 (1) Introduction to Architectural Engineering

Surveys the broad subject of architectural engineering and professional practices. Includes professional design services, design documents, methods of construction delivery, materials for construction, codes and standards, life safety, professional ethics, structural systems, mechanical systems, electrical systems, and building systems integration.

**Requisites:** Restricted to students with 0-56 (Freshmen or Sophomore) College of Engineering majors only.

**Additional Information:** Departmental Category: Miscellaneous

#### AREN 2050 (3) Building Materials and Systems

Covers the broad subject of building materials and systems. Includes a practical approach to assembly details, methods of construction, codes, foundations, steel, concrete, masonry, cladding, doors and windows, interiors, finishes, mechanical, plumbing, electrical, life safety and conveyance. Includes investigation of an existing facility along with a team presentation trends in commercial building construction.

**Requisites:** Restricted to students with 27-180 credits (Sophomores, Juniors or Seniors) Civil (CVEN) or Architectural (AREN) or GEEN (General) or Applied Mathematics (AMEN) majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

#### AREN 2110 (3) Thermodynamics

Explores fundamental principles of thermodynamics, including first and second law of thermodynamics, thermophysical properties, power and refrigeration cycles, gas mixtures and psychrometrics.

**Requisites:** Requires a prereq course of PHYS 1110 (min grade C-) and a prereq or coreq course of APPM 1360 or MATH 2300 (min grade C-). Restricted to AREN, CVEN or EVEN, GEEN, AMEN or EVENCVEN Concurrent Degree majors only.

**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence  
Arts Sci Gen Ed: Distribution-Natural Sciences

Departmental Category: Building Systems Engineering

**AREN 2120 (3) Fluid Mechanics and Heat Transfer**

Explores fundamental principles of fluid mechanics and heat transfer. Topics include fluid statics, momentum and energy conservations; laminar and turbulent viscous flows; conduction, convection and radiation heat transfer. Emphasizes topics and problems that are important to Architectural Engineers including flow of fluids in pipes and ducts, heat transfer in buildings and building systems.

**Requisites:** Requires prerequisite courses of APPM 2350 or MATH 2400, and AREN 2110 or GEEN 3852 or MCEN 3012 or ASEN 2002 (all minimum grade C-). Requires corequisite course of APPM 2360. Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 2830 (1-3) Special Topics**

Supervised study of special topics of interest to students under instructor guidance.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Special Topics

**AREN 3010 (3) Energy Efficient Buildings**

Lecture course on the analysis and design of buildings and their systems to satisfy the requirements for a comfortable and healthy indoor environment. Examines psychometrics, thermal comfort, building heating and cooling loads, fluid flow basics, and HVAC components and systems.

**Requisites:** Requires prerequisite courses of AREN 2120 or MCEN 3021 and 3022 and AREN 2050 (all minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 3050 (3) Environmental Systems for Buildings 1**

Explores operations and architectural design strategies of environmental (climate) control systems in buildings with a focus on sustainability and resource efficiency. Topics include thermal comfort and indoor air quality, building thermal and moisture loads, HVAC equipment and systems and active and passive thermal strategies in buildings.

**Requisites:** Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Program in Environmental Design major or minor students only. College of Engineering majors are excluded from this course.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 3060 (3) Environmental Systems for Buildings 2**

Explores operations and architectural design strategies of plumbing, power distribution, renewable electricity generation, illumination, daylighting, acoustical control, vertical transportation, fire protection and telecommunication systems in buildings with a focus on sustainability and resource efficiency.

**Requisites:** College of Engineering majors are excluded from this course.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 3140 (3) Illumination Laboratory**

Introduces the measurement of photometric and psychophysical quantities used in lighting. Experience is acquired in using light measurement instruments to evaluate lighting equipment and luminous environments. Taught intermittently.

**Requisites:** Requires prerequisite course of AREN 3540 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 3540 (3) Illumination I**

Studies the fundamentals of architectural illumination. Introduces and applies basic principles and vocabulary to elementary problems in the lighting of environments for the performance of visual work and the proper interaction with architecture.

**Requisites:** Requires prerequisite course of CHEN 1310 or CSCI 1300 or CSCI 1320 or ECEN 1310 and APPM 2350 or MATH 2400 (all minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4010 (3) Energy System Modeling and Control**

Engineering course devoted to building automation and control systems. Topics include HVAC control technology and strategies, measurement and device technologies, analysis and modeling of dynamic systems, simulation of conventional and advanced control approaches, assessment of control loop performance and hands-on direct digital control (DDC) programming exercises as used in current building control practice.

**Equivalent - Duplicate Degree Credit Not Granted:** AREN 5010

**Requisites:** Requires prerequisite course of AREN 4110 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4035 (3) Architectural Structures 1**

Analyzes basic structural systems. Covers principles of mechanics and mechanical properties of materials and analysis and design of trusses, arches, and cable structures. For nonengineering students; does not apply toward an engineering degree.

**Requisites:** Requires prerequisite course of PHYS 1110 or PHYS 2010 and APPM 1350 or MATH 1300 (all minimum grade C-). Restricted to students with 57-180 credits (Junior or Senior) Program in Environmental Design majors only.

**Additional Information:** Departmental Category: Structures

**AREN 4045 (3) Architectural Structures 2**

Analyzes basic structural systems. Covers principles of mechanics as applied to the design of flexural members, columns, continuous beams, and rigid frames. For nonengineering students; does not apply toward an engineering degree.

**Requisites:** Requires prerequisite course of AREN 4035 (minimum grade C-).

**Additional Information:** Departmental Category: Structures

**AREN 4110 (3-4) HVAC System Design**

Applies engineering principles to the design of heating, ventilating and air conditioning (HVAC) systems for buildings. Covers HVAC systems description, load estimation, psychometrics, coils and heat exchangers, air and water distribution systems and primary equipment and systems.

**Equivalent - Duplicate Degree Credit Not Granted:** AREN 5110

**Requisites:** Requires prerequisite course of AREN 3010 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4130 (3) Optical Design for Illumination and Solid State Lighting**

Covers the optical design process for illumination-based optics, emphasis on applications in architectural lighting. In-depth coverage of luminaire photometry, lamps, materials, manufacturing methods, product performance requirements. Projects utilize optical design software and include a variety of lamp types including LEDs using both reflector/lens optics.

**Equivalent - Duplicate Degree Credit Not Granted:** AREN 5130

**Requisites:** Requires prerequisite course of AREN 3540 (minimum grade C-). Restricted to Architectural (AREN) or Civil (CVEN) Engineering majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4315 (3) Design of Masonry Structures**

Covers modern masonry construction; properties and behavior of the reinforced masonry component materials, clay and concrete masonry units, mortar, grout, and steel reinforcement; vertical and lateral load types and intensities; and design of reinforced masonry walls, beams and columns by the strength design method.

**Requisites:** Requires prerequisite course of CVEN 3525 (minimum grade C-).

**Additional Information:** Departmental Category: Structures

**AREN 4317 (5) Architectural Engineering Design**

Provides a capstone experience to AREN students. Students design a modest commercial building and complete an integrated engineering design of the building systems executed for the conceptual, schematic, and design development phases. Students' teams work on structural, mechanical, electrical/lighting, and construction engineering management design. Each stage produce a professional-quality design document. Faculty and industry mentors participate in the teaching and evaluation of designs.

**Requisites:** Requires prerequisite courses of ARCH 4010 and (CVEN 3256 and AREN 4506) or (AREN 4550 and AREN 4570) or (CVEN 4161 and CVEN 4555) or (AREN 4110 and AREN 4890) (all minimum grade C-).

**Additional Information:** Departmental Category: Miscellaneous

**AREN 4506 (3) Pre-construction Estimating and Scheduling**

Covers project management estimating and scheduling methods with an emphasis on the techniques used to create pre-construction estimates and schedules for architectural and civil engineering projects.

**Requisites:** Requires prerequisite course of CVEN 3246 (minimum grade C-). Restricted to students with 57-180 credits (Junior or Senior) Architectural (AREN), Civil (CVEN) or General (GEEN) Engineering majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Construction

**AREN 4530 (3) Advanced Lighting Design**

Intended to help students understand light as a medium in design, begin the formulation of a philosophical perspective for its application, and continue to develop the skills required to design and implement lighting systems. Knowledge from previous lighting classes (Illumination I and Illumination II) is essential to this course.

**Requisites:** Requires prerequisite courses of AREN 3540 and AREN 4550 (all minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4540 (3) Exterior Lighting Systems**

Engages students in exploring and solving lighting problems for exterior environments. Provides an understanding of the design criteria and lighting equipment used in three primary exterior applications: parking lots and roadways, floodlighting of buildings, and sports facilities. Taught intermittently.

**Equivalent - Duplicate Degree Credit Not Granted:** AREN 5540

**Requisites:** Requires prerequisite course of AREN 3540 (minimum grade C-).

**Recommended:** Prerequisite AREN 4550.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4550 (3) Illumination 2**

Applies the principles studied in Illumination 1. Provides further study in architectural lighting design methods. Uses lighting studio work to develop a broad knowledge of lighting equipment, design methods, and their application in a series of practical design problems in modern buildings.

**Requisites:** Requires prerequisite course of AREN 3540 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4560 (3) Luminous Radiative Transfer**

Teaches fundamentals of radiative exchange as applied to illumination engineering. Describes and uses principal numerical techniques for radiative transfer analysis. Applies techniques to lighting design and analysis.

**Requisites:** Requires prerequisite course of AREN 3540 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4570 (3) Building Electrical Systems Design 1**

Introduces the generation and distribution of electrical power. Focuses on understanding the loads, control, and protection of secondary electrical distribution systems in building. Applies the national electric code to residential and commercial buildings.

**Requisites:** Requires prerequisite course of ECEN 3030 (minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4580 (3) Daylighting**

Applies the fundamental principles of illumination engineering to architectural daylighting design, exploring the quantitative methods and tools used to develop daylighting designs and evaluate their performance. Topics include solar and sky modeling, luminous radiative transfer, design methods, and controls for integration with electric lighting systems.

**Requisites:** Requires prerequisite course of AREN 3540 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering



**AREN 4590 (3) Computer Graphics in Lighting Engineering**

Studies the numerical methods and computer implementation of computer graphics visualization for architectural lighting engineering and design. Implements finite element radiative transfer and ray-tracing in computer programs. Studies the use of computer graphics visualization in lighting analysis. Taught intermittently.

**Requisites:** Requires prerequisite courses of AREN 3540 and AREN 4560 (minimum grade C-).

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4606 (3) Construction Project Execution and Control**

Integrates project execution and control techniques for construction scope, cost and schedule. Includes progress measurement, resource planning, earned value methods, productivity, risk management methods and key contract clauses.

**Requisites:** Requires prerequisite courses of CVEN 3246 and AREN 4506 (all minimum grade C-). Restricted to students with 57-180 credits (Junior or Senior) Civil (CVEN), Architectural (AREN) or General (GEEN) Engineering majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Construction

**AREN 4830 (1-3) Special Topics for Seniors/Grads**

Supervised study of special topics of interest to students under instructor guidance. Department consent required.

**Repeatable:** Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Special Topics

**AREN 4849 (1-3) Independent Study**

Offers an independent, in-depth study, research or design in a selected area of architectural engineering. Offerings are coordinated with individual faculty. Students should consult the Department of Civil, Environmental, and Architectural Engineering.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Special Topics

**AREN 4890 (3) Sustainable Building Design**

Introduces green building design procedure/approach and provides insight into evolving design principles; explores aspects of building thermal/energy performance, indoor/outdoor environmental quality, occupant comfort and climate relevant to building design (structures not covered); emphasizes both comprehensive understanding and practical applications of sustainable building design strategies; applies prevailing simulation tools to assist green building design.

**Equivalent - Duplicate Degree Credit Not Granted:** AREN 5890

**Requisites:** Requires a prerequisite course of AREN 3010 (minimum grade C-). Restricted to students with 87-180 credits (Senior, Fifth Year Senior) College of Engineering students only.

**Additional Information:** Departmental Category: Building Systems Engineering

**AREN 4990 (3) Compu Fluid Dynamics (CFD) Analysis for Built/Natural Envmnts**

Explores the fundamentals of simulating/analyzing civil and architectural environments with Computational Fluid Dynamics (CFD) method.

Run with two parallel sessions: fundamentals and applications, with fundamental lectures presenting the principles of CFD technologies, and application sessions demonstrating the application of CFD for resolving building and environmental engineering problems (different than MCEN/ASEN) with hands-on exercises.

**Equivalent - Duplicate Degree Credit Not Granted:** AREN 5990

**Requisites:** Requires prerequisite course of AREN 2120 and APPM 2360 (all minimum grade C-). Restricted to students with 57-180 credits (Junior or Senior) College of Engineering majors only.

**Additional Information:** Departmental Category: Building Systems Engineering

**Civil Engineering****CVEN 1027 (3) Civil Engineering Drawing**

Develops drawing and drafting skills for civil engineering projects in both hand drawing and software tools. Students will learn to read and interpret design and construction drawings.

**Requisites:** Restricted to Civil Engineering (CVEN) majors only.

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 1317 (1) Introduction to Civil and Environmental Engineering**

Surveys the broad subject of civil and environmental engineering and professional practice. Includes the subdisciplines of structures, water resources, geotechnics, transportation, environment, and construction. Discusses professional ethics, important skills for engineers, and the engineering design process as it fulfills multiple objectives.

**Requisites:** Restricted to students with 0-56 (Freshmen or Sophomore) College of Engineering majors only.

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 1837 (1-3) Special Topics**

Supervised study of special topics of interest to student under instructor guidance.

**Repeatable:** Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 2012 (3) Introduction to Geomatics**

Presents basic techniques of land and construction surveying, including measurement of position, elevation, orientation and length of lines, area, volume and layout calculations. Optical, GPS and GIS equipment and methods are included.

**Requisites:** Restricted to Architectural (AREN) or Civil (CVEN) or General (GEEN) Engineering majors only.

**Additional Information:** Departmental Category: Surveying and Transportation

**CVEN 2121 (3) Analytical Mechanics 1**

Applies mechanics to the study of static equilibrium of rigid and elastic bodies. Includes composition/resolution of forces; moments/couples; equivalent force systems; free-body diagrams; equilibrium of particles and rigid bodies; forces in trusses/beams; frictional forces; first/second moments of area; moments and products of inertia.

**Equivalent - Duplicate Degree Credit Not Granted:** GEEN 2851 and MCEN 2023

**Requisites:** Requires a prereq course of PHYS 1110 (min grade C-). Requires a prereq or coreq course of APPM 2350 or MATH 2400 (min grade C-). Restricted CVEN or EVEN or AREN or AMEN or EPEN or GEEN majors with a CIV, ENR or ARC subplan.

**Additional Information:** Departmental Category: Mechanics

**CVEN 2837 (1-3) Special Topics**

Supervised study of special topics of interest to student under instructor guidance.

**Repeatable:** Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 3022 (3) Construction Surveying**

Studies construction and highway surveying, horizontal and vertical curves, earthwork, and analysis of data.

**Requisites:** Requires prerequisite course of CVEN 2012 (minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Surveying and Transportation

**CVEN 3032 (3) Photogrammetry**

Familiarizes students with characteristics of aerial photographs. Measures and interprets aerial photos for planimetric, topographic, hydrological, soil, and land use surveys. Analyzes and presents field measurements over extensive reaches.

**Additional Information:** Departmental Category: Surveying and Transportation

**CVEN 3111 (3) Analytical Mechanics 2**

Studies the motion (kinematics) of particles and rigid bodies, and the forces that cause the motion (kinetics). Newton's laws as well as energy methods are used to study the motion of particles and rigid bodies in two and three dimensions.

**Requisites:** Requires prerequisite courses of CVEN 2121 or GEEN 2851 or ASEN 2001 or MCEN 2023 (all minimum grade C-). Restricted to AREN, CVEN, EVEN, or GEEN majors only.

**Additional Information:** Departmental Category: Mechanics

**CVEN 3141 (2) Engineering Materials Lab**

**Additional Information:** Departmental Category: Mechanics

**CVEN 3161 (3) Mechanics of Materials 1**

Addresses concepts of stress and strain; material properties, axial loading, torsion, simple bending, and transverse shear; analysis of stress and strain; and deflections of beams. Includes selected experimental and computational laboratories.

**Equivalent - Duplicate Degree Credit Not Granted:** MCEN 2063

**Requisites:** Requires prereq CVEN 2121 or GEEN 2851 or ASEN 2001 or MCEN 2023 (all min grade C-). Requires coreq APPM 2360. Restricted to Architectural (AREN) or Civil (CVEN) or Environmental (EVEN) or General (GEEN) Engineering majors with a CIV, ENR or ARC subplan

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Mechanics

**CVEN 3227 (3) Probability, Statistics and Decision**

Introduces uncertainty based analysis concepts and applications in the planning and design of civil engineering systems emphasizing probabilistic, statistics, and design concepts and methods.

**Requisites:** Restricted to students with 57-180 credits (Junior or Senior) College of Engineering students only.

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 3246 (3) Introduction to Construction**

Provides a broad view of concerns, activities, and objectives of people involved in construction: the owner, architect/engineer, contractor, labor and inspector. Interactive gaming situation relates these people to the construction contract, plans/specifications, estimates/bids, scheduling, law and financial management. Students with a Business School Real Estate emphasis may be considered for this course.

**Requisites:** Restricted to students with 36+ units, Civil (CVEN) or Architectural (AREN), Environmental (EVEN) or General (GEEN) Engineering majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Construction

**CVEN 3256 (3) Construction Equipment and Methods**

Integrated study of construction equipment, methods, and economics. Topics include equipment productivity, equipment selection, and construction engineering design within economic constraints. Examples include earthmoving, concrete formwork, and temporary construction.

**Requisites:** Requires prerequisite course of CVEN 3246 (minimum grade C-). Restricted to Architectural (AREN) or Civil (CVEN) or General (GEEN) Engineering majors only.

**Additional Information:** Departmental Category: Construction

**CVEN 3313 (3) Theoretical Fluid Mechanics**

Basic principles of fluid mechanic. Covers fluid properties, hydrostatics, fluid flow concepts, including continuity, energy, momentum, dimensional analysis and similitude and flow in closed conduits.

**Equivalent - Duplicate Degree Credit Not Granted:** CHEN 3200 and MCEN 3021

**Requisites:** Requires prerequisite course of CVEN 2121 or GEEN 2851 or ASEN 2001 or MCEN 2023 (all minimum grade C-). Restricted to Civil (CVEN) or Environmental (EVEN) majors, or General (GEEN) Engineering majors with a CIV or ENR subplan.

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 3323 (3) Hydraulic Engineering**

Studies hydraulic engineering theory and applications. Topics include incompressible flow in conduits, pipe system analysis and design, open channel flow, flow measurement, analysis and design of hydraulic machinery.

**Requisites:** Requires prerequisite course of CVEN 3313 or MCEN 3021 or GEEN 3853 or AREN 2120 or CHEN 3200 (all minimum grade C-). Restricted to Civil (CVEN), Environmental (EVEN), Architectural (AREN) or General (GEEN) Engineering majors only.

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 3414 (3) Fundamentals of Environmental Engineering**

Emphasizes chemical, ecological and hydrological fundamentals and importance of mass and energy balances in solving environmental engineering problems related to water quality, water and wastewater treatment, air pollution, solid and hazardous waste management, sustainability and risk assessment.

**Requisites:** Requires prereq courses of CHEN 1211 and CHEM 1221 or CHEM 1113 and CHEM 1114 or MCEN 1024 and APPM 1360 or MATH 2300 (all min grade C-). Restricted to CVEN, AREN, EVEN, MCEN, CHEN, GEEN or AMEN majors only.

**Additional Information:** Departmental Category: Environmental

**CVEN 3424 (3) Water and Wastewater Treatment**

Introduces design and operation of facilities for treatment of municipal water supplies and wastewater. Provides an engineering application of physical, chemical, and biological unit processes and operations for removal of impurities and pollutants. Involves an integrated design of whole treatment systems combining process elements.

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-).

**Additional Information:** Departmental Category: Environmental

**CVEN 3434 (3) Introduction to Applied Ecology**

Emphasizes the integration of physical, chemical and biological processes in controlling terrestrial and aquatic ecosystems. Ecosystem concepts are applied to current environmental and water quality problems. Includes field trips and a group project.

**Equivalent - Duplicate Degree Credit Not Granted:** ENVS 3434

**Requisites:** Prereq courses of CHEN 1211 and CHEM 1221 or CHEM 1113 and CHEM 1114 or CHEM 1400 or CHEM 1351; (all min C-). Restricted to students with 57-180 credits (Junior or Senior) Civil (CVEN), Environmental (EVEN) or Architectural Eng (AREN) or (GEEN) mjrs.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences  
Departmental Category: Environmental

**CVEN 3525 (3) Structural Analysis**

Studies structural analysis of statically determinate and indeterminate systems, deflections, energy methods, and force and stiffness methods.

**Requisites:** Requires prerequisite course of CVEN 3161 or MCEN 2063 (minimum grade C-). Restricted to Civil (CVEN), Environmental (EVEN), Architectural (AREN), General (GEEN) or Applied Mathematics (AMEN) majors only.

**Additional Information:** Departmental Category: Structures

**CVEN 3602 (3) Transportation Systems**

Introduces the principles of transportation systems with a focus on highway engineering and traffic analysis. Provides the basic skill set that will allow students to solve transportation problems related with highway design and traffic control and analysis. Provides an introduction to technology, operating characteristics, and relative merits of highway, airway, waterway, railroad, pipeline, and convey or transportation systems.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Surveying and Transportation

**CVEN 3698 (3) Engineering Geology**

Highlights the role of geology in engineering minerals; rocks; surficial deposits; rocks and soils as engineering materials; distribution of rocks at and below the surface; hydrologic influences; geologic exploration of engineering sites; geologic hazards; mapping; and geology of underground excavations, slopes, reservoirs and dam sites.

**Requisites:** Requires a prerequisite or corequisite course of CVEN 2121 or GEEN 2851 or ASEN 2001 or MCEN 2023 and APPM 2350 or MATH 2400 (all minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Geotechnical

**CVEN 3708 (3) Geotechnical Engineering 1**

Covers basic engineering characteristics of geological materials; soil and rock classifications; site investigation; physical, mechanical, and hydraulic properties of geologic materials; the effective stress principle; soil and rock improvement; seepage analysis; stress distribution; and consolidation and settlement analyses. Selected experimental and computational laboratories.

**Requisites:** Requires prerequisite course of CVEN 3161 or MCEN 2063 (minimum grade C-). Restricted to Civil (CVEN), Environmental (EVEN), Architectural (AREN), General (GEEN) or Applied Mathematics (AMEN) majors only.

**Additional Information:** Departmental Category: Geotechnical

**CVEN 3718 (3) Geotechnical Engineering 2**

Covers stress analysis and plastic equilibrium, shear strength of soil, bearing capacity, lateral earth pressures, slope stability and underground construction. Analysis and design of shallow and deep foundations, retaining walls and other earth and rock structures. Selected experimental and computational laboratories.

**Requisites:** Requires prerequisite course of CVEN 3708 (minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Geotechnical

**CVEN 3837 (1-3) Special Topics**

Supervised study of special topics of interest to student under instructor guidance.

**Repeatable:** Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 4147 (3) Civil Engineering Systems**

Theory and application of the principles of engineering economics and classical and metaheuristic optimization techniques for evaluating problems in civil and environmental engineering.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5147

**Requisites:** Restricted to students with 87-180 credits (Senior, Fifth Year Senior) College of Engineering majors only.

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 4157 (3) A Systems Approach to Global Engineering**

Introduces engineering students to the global context in which engineers are asked to operate in the 21st century using system dynamics tools and other decision-making tools (network analysis, agent based modeling, etc.) necessary to analyze the uncertainty and complexity inherent in global projects.

**Equivalent - Duplicate Degree Credit Not Granted:** EDEN 4147, CVEN 5157 and EDEN 5147



**CVEN 4161 (3) Mechanics of Materials 2**

Covers advanced topics in the mechanics of solids. Some topics such as asymmetric bending of beams, torsion of non-circular cross-sections, are extensions of topics seen in CVEN 3161. Others like 3-D stress and strain analysis, failure theories and stability of columns and frames are new. Includes selected laboratory experiments.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5161

**Requisites:** Requires prerequisite course of CVEN 3161 (minimum grade C-).

**Additional Information:** Departmental Category: Mechanics

**CVEN 4323 (3) Water Resources Engineering Design**

Studies principles and techniques of water resources engineering design. Introduces environmental modeling under uncertainty, stormwater design, precipitation estimation and flow routing. Surveys hydropower, reservoir management and water resources economics.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5423

**Requisites:** Restricted to students with 57-180 credits (Junior or Senior) College of Engineering students only.

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 4333 (3) Engineering Hydrology**

Studies engineering applications of principles of hydrology, including hydrologic cycle, rainfall and runoff, groundwater, storm frequency and duration studies, stream hydrography, flood frequency, and flood routing.

**Requisites:** Requires prerequisite course of CVEN 3313 or AREN 2120 or CHEN 3200 or GEEN 3853 or MCEN 3021 (all minimum grade C-).

Requires prerequisite or corequisite course of CVEN 3227 or APPM 4570 or MCEN 3047 or MCEN 3208 or CHEN 3010.

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 4353 (3) Groundwater Engineering**

Studies the occurrence, movement, extraction for use, and quantity and quality aspects of groundwater. Introduces and uses basic concepts to solve engineering and geohydrologic problems.

**Requisites:** Requires prerequisite course of CVEN 3313 or MCEN 3021 or CHEN 3200 or GEEN 3853 (minimum grade C-).

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 4383 (3) Applied Groundwater Modeling**

Studies analytical and numerical methods for solving problems of groundwater flow and chemical transport. Emphasizes fundamental modeling techniques and the relationship between the physical system and the model results. Applies models and modeling techniques to solve problems in ground water hydrology using contemporary software.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5383

**Recommended:** Prerequisite CVEN 4353.

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 4404 (3) Water Chemistry**

Introduces chemical fundamentals of inorganic aqueous compounds and contaminants in lecture and laboratory. Lecture topics include thermodynamics and kinetics of acids and base reactions, carbonate chemistry, air-water exchange, precipitation, dissolution, complexation, oxidation-reduction and sorption.

**Equivalent - Duplicate Degree Credit Not Granted:** EVEN 4404

**Requisites:** Requires prerequisite courses of CHEN 1211 or CHEM 1113 and CHEM 1133 (all minimum grade C-). Restricted to Civil (CVEN) or Environmental (EVEN) or General (GEEN) Engineering majors only.

**Additional Information:** Departmental Category: Environmental

**CVEN 4414 (1) Water Chemistry Laboratory**

Reinforces chemical fundamentals of inorganic aqueous compounds and contaminants from CVEN/EVEN 4404 in laboratory experiments and reports. Topics include acids and bases, carbonate chemistry (alkalinity) and other water chemistry characteristics (hardness, dissolved oxygen); precipitation, complexation and oxidation-reduction reactions; and laboratory techniques and reporting.

**Equivalent - Duplicate Degree Credit Not Granted:** EVEN 4414

**Requisites:** Requires prerequisite courses of CHEN 1211 or CHEM 1113 and CHEM 1133 (all minimum grade C-). Requires corequisite course of CVEN 4404. Restricted to Civil (CVEN) or Environmental (EVEN) Engineering majors only.

**Additional Information:** Departmental Category: Environmental

**CVEN 4424 (3) Environmental Organic Chemistry**

Examines the fundamental physical and chemical transformations affecting the fate and transport of organic contaminants in natural and treated waters. Emphasizes quantitative approach to solubility, vapor pressure, air-water exchange, sorption, hydrolysis and redox reactions, and photodegradation.

**Equivalent - Duplicate Degree Credit Not Granted:** EVEN 4424

**Requisites:** Requires prerequisite course of CHEN 1211 or CHEM 1113 or CHEM 2100 (minimum grade C-).

**Additional Information:** Departmental Category: Environmental

**CVEN 4434 (4) Environmental Engineering Design**

Examines the design of facilities for the treatment of municipal water and wastewater, hazardous industrial waste, contaminated environmental sites and sustainable sanitation in developing countries. Economic, societal and site specific criteria impacting designs are emphasized.

**Equivalent - Duplicate Degree Credit Not Granted:** EVEN 4434

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-).

**Additional Information:** Departmental Category: Environmental

**CVEN 4464 (3) Environmental Engineering Processes**

Develops and utilizes analytic solutions for environmental process models that can be used in a) reactor design for processes used in the treatment of water, wastewater and hazardous waste and b) process analysis of natural systems, such as streams and groundwater flow. Models facilitate the tracking of contaminants in engineered and natural systems.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5464 and EVEN 4464

**Requisites:** Requires prerequisite or corequisite courses of CVEN 3414 and CVEN 3313 or CHEN 3200 or GEEN 3853 or MCEN 3021 or AREN 2120 (all minimum grade C-).

**Additional Information:** Departmental Category: Environmental

**CVEN 4474 (3) Hazardous and Industrial Waste Management**

Evaluates processes used for treatment of wastes requiring special handling and disposal: toxic organic chemicals, heavy metals, acidic, caustic and radioactive waste material. Discusses techniques for destruction, immobilization and resource recovery and assessment of environmental impact of treatment process end products.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5474

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Environmental

**CVEN 4484 (3) Introduction to Environmental Microbiology**

Surveys microbiology topics germane to modern civil and environmental engineering. Provides fundamentals needed to understand microbial processes and ecology in engineered and natural systems and reviews applications emphasizing the interface between molecular biology and classical civil engineering.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5484 and EVEN 4484

**Requisites:** Requires prerequisite courses of CHEN 1211 and CHEM 1221 or CHEM 1113 and CHEM 1114 and APPM 2350 or MATH 2400 (all minimum grade C-).

**Additional Information:** Departmental Category: Environmental

**CVEN 4511 (3) Introduction to Finite Element Analysis**

Covers systematic formulation of finite element approximation and isoparametric interpolation (weighted residual and energy methods, triangular and quadrilateral elements). Includes computation applications to the solution of one- and two-dimensional stress-deformation problems and steady and transient heat conduction.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5511

**Requisites:** Requires prerequisite courses of CVEN 3161, CVEN 3525, APPM 2360 or MATH 3130 and MATH 4430 (all minimum grade C-).

**Additional Information:** Departmental Category: Mechanics

**CVEN 4525 (3) Matrix Structural Analysis**

Covers matrix formulation of principles of structural analysis and development of direct stiffness and flexibility methods for analysis of 2D and 3D structures. Variational formulation of the finite element method. Geometric nonlinearity. Familiarity with Matlab programming is expected.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5525

**Requisites:** Requires prerequisite course of CVEN 3525 (minimum grade C-).

**Additional Information:** Departmental Category: Structures

**CVEN 4535 (1-3) Construction Materials**

Introduces material science of engineering materials, such as atomic and crystal structures, defects and phase diagrams; discusses in detail three construction materials: steel, Portland cement concrete and asphalt concrete including classification and composition, engineering properties and testing methods (with three lab sessions). Covers basic of three materials: wood, fiber reinforced polymers and masonry.

**Repeatable:** Repeatable for up to 3.00 total credit hours.

**Requisites:** Requires a prerequisite course of CVEN 3161 or MCEN 2063 (minimum grade C-). Restricted to College of Engineering majors only.

**Additional Information:** Departmental Category: Structures

**CVEN 4537 (3) Numerical Methods in Civil Engineering**

Introduces the use of numerical methods in the solution of civil engineering problems, emphasizing obtaining solutions with high-speed electronic computers. Applies methods to all types of civil engineering problems.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5537

**Requisites:** Restricted to students with 87-180 credits (Senior, Fifth Year Senior).

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 4545 (3) Steel Design**

Applies basic principles of structural engineering and mechanics to design of steel structures; design of tension members, columns, beams, open-web joists, steel decks, bolts, bolted connections, welding processes, and welded connections.

**Requisites:** Requires prerequisite course of CVEN 3525 (minimum grade C-).

**Additional Information:** Departmental Category: Structures

**CVEN 4554 (3) Fundamentals of Air Quality Management**

Introduces engineering methods for the study of air quality. Topics include: indoor air quality, greenhouse gases, dispersion modeling, source apportionment modeling, chemistry of combustion, pollution sources and controls, human exposure to air pollutants. A focus on Engineering for Developing Communities runs throughout. Elective for the EVEN air quality track or an environmental concentration course for CVEN.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5554

**Requisites:** Requires prerequisite courses of APPM 2360 or MATH 2130 and MATH 3430 and CVEN 3313 or CHEN 3200 or MCEN 3021 (all minimum grade C-).

**Additional Information:** Departmental Category: Environmental

**CVEN 4555 (3) Reinforced Concrete Design**

Applies basic principles of structural engineering and mechanics to the design of reinforced concrete structures, including design of beams, columns, slabs, and footings; continuous beams and frames; cast-in-place buildings.

**Requisites:** Requires prerequisite course of CVEN 3525 (minimum grade C-).

**Additional Information:** Departmental Category: Structures

**CVEN 4565 (3) Design of Wood Structures**

Applies basic principles of structural engineering and mechanics to the design of wood structures, including the design and analysis of columns, trusses, beams and connections using dimensional lumber, glulam and cross-laminated timber.

**Requisites:** Requires prerequisite course of CVEN 3525 (minimum grade C-).

**Additional Information:** Departmental Category: Structures

**CVEN 4594 (3) Water Reuse and Reclamation**

Explores development of a safe, reliable and acceptable program for reusing impaired waters. As fresh water becomes scarcer around the world, communities are looking for security through development of new water resources. Reuse of impaired water is one solution to the growing water crisis. Focus is on advanced treatment technologies with emphasis on public perception, economics and regulations.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5594

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-). Restricted to College of Engineering students with 57-180 credits (Juniors or Seniors).

**Recommended:** Prerequisite CVEN 3424.

**Additional Information:** Departmental Category: Environmental

**CVEN 4718 (3) Mechanics and Dynamics of Glaciers**

Develops a quantitative physical basis for understanding the functions of snow, ice and glaciers in the environment, with emphasis on developing an understanding of continuum mechanics and thermodynamics and their application to Earth systems.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5718

**Requisites:** Requires prerequisite courses of APPM 2350 or MATH 2400 and APPM 2360 and AREN 2110 or GEEN 3852 or MCEN 3012 or ASEN 2002 and CHEN 1310 or CSCI 1300 or CSCI 1310 or CSCI 1320 or ECEN 1310 (all minimum grade C-).

**Additional Information:** Departmental Category: Geotechnical

**CVEN 4728 (3) Foundation Engineering**

Focuses on geotechnical design of shallow and deep foundations, including spread footings, mats, driven piles and drilled piers. Coverage includes bearing capacity, settlement, group effects and lateral load capacity of the various foundation types. Additional topics include subsurface exploration, construction of deep foundations and analysis of pile behavior using wave equation and dynamic monitoring methods.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 5728

**Requisites:** Requires prerequisite course of CVEN 3718 (minimum grade C-).

**Additional Information:** Departmental Category: Geotechnical

**CVEN 4833 (1-3) Special Topics**

**Repeatable:** Repeatable for up to 18.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to students with 57-180 credits (Juniors or Seniors).

**Additional Information:** Departmental Category: Fluid Mechanics and Water Resources

**CVEN 4834 (1-3) Special Topics**

Department consent required.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to College of Engineering (ENGRU) undergraduates only.

**Additional Information:** Departmental Category: Environmental

**CVEN 4835 (1-3) Special Topics**

**Repeatable:** Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Structures

**CVEN 4836 (1-3) Special Topics**

Offers a supervised study of special topics, under instructor guidance.

**Repeatable:** Repeatable for up to 3.00 total credit hours.

**CVEN 4837 (1-3) Special Topics**

Supervised study of special topics of interest to students under instructor guidance.

**Repeatable:** Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 4838 (1-3) Special Topics**

**Repeatable:** Repeatable for up to 9.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Geotechnical

**CVEN 4839 (3-6) Special Topics for Seniors**

Offers a supervised study of special topics, under instructor guidance. Department consent required.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Special Topics

**CVEN 4849 (1-3) Independent Study**

Involves an independent, in-depth study, research, or design in a selected area of civil or environmental engineering. Offerings are coordinated with individual faculty. Students should consult the Department of Civil, Environmental, and Architectural Engineering.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Additional Information:** Departmental Category: Special Topics

**CVEN 4897 (2) Professional Issues in Civil Engineering**

Educates students about the knowledge and skills required for professional civil engineers. Students learn about the path to a professional license, prepare for the FE exam, analyze a situation involving multiple conflicting ethical interests, identify aspects of sustainability in civil engineering projects, and understand the role of project management, public policy, business and public administration, and leadership in civil engineering.

**Requisites:** Restricted to students with 87-180 credits (Seniors) Civil (CVEN), Environmental (EVEN), or Architectural Engineering (AREN) majors only.

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Miscellaneous

**CVEN 4899 (4) Civil Engineering Senior Project Design**

Provides a simulated real world design and construction planning experience where teams integrate across multiple civil engineering sub-disciplines to create a solution that satisfies multiple constraints, including design, client requirements, budget, schedule, technical, regulatory, and societal. Final deliverables include: detailed design drawings, specifications, cost estimate, project schedule, construction plan, oral and written presentation.

**Repeatable:** Repeatable for up to 4.00 total credit hours.

**Requisites:** Restricted to students with 87-180 credits (Senior) Civil (CVEN) or General (GEEN) engineering majors only.

**Additional Information:** Departmental Category: Special Topics

**CVEN 4969 (3) Water and Sanitation in Developing Countries**

Studies the design and fundamentals behind effective treatment processes and engineering solutions targeted for developing countries. Approaches to clean water and sanitation in lesser industrialized countries often demand alternative solutions to those developed for industrialized societies. Explores issues and solutions developed to tackle these problems.

**Equivalent - Duplicate Degree Credit Not Granted:** EVEN 4969

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-). Restricted to students with 57-180 credits (Juniors or Seniors).

**Grading Basis:** Letter Grade

**Additional Information:** Departmental Category: Environmental

**Environmental Engineering****EVEN 1000 (1) Introduction to Environmental Engineering**

Introduces first-year students to the environmental engineering program from an academic and a career perspective. Covers air quality, applied ecology, chemical processing, energy, engineering for developing communities, environmental remediation, and water resources and treatment. Includes reading and writing on the history of environmental engineering, major environmental issues, and professional ethics.

**Requisites:** Restricted to students with 0-60 units completed. Restricted to Environmental Engineering (EVEN) majors only.

**EVEN 1001 (3) Environmental Engineering 101: An Introduction to Pollution Science**

Surveys the science and engineering needed to understand the environmental and energy challenges which face urbanizing society: air and water pollution, climate change, and mining. Introduces how environmental engineers leverage basic science concepts to reduce pollution and optimize energy use. Analyzes how the mainstream media presents the environmental science of climate change and modern environmental disasters.

**EVEN 2840 (1-3) Independent Study: General Topics**

General topics relating to environmental engineering. One-on-one assistance with an instructor.

**EVEN 3012 (3) Environmental Engineering Thermodynamics**

Introduces students to fundamentals of thermodynamics. Includes focused coverage of the laws of thermodynamics, system energy balances, state properties (internal energy, enthalpy, entropy, etc.) and property estimation for ideal gases and steam. Additionally, this course will introduce the following concepts: thermodynamic cycles, chemical reaction thermodynamics, psychrometrics, process devices (pumps, heat exchangers, etc.) and reversibility.

**Requisites:** Requires prerequisite courses of PHYS 1110 and APPM 1360 and CHEN 1211 (all minimum grade C-).

**Grading Basis:** Letter Grade

**EVEN 3550 (3) Sustainability Principles for Engineers**

An introduction to sustainability principles in the field of environmental engineering. Students will apply these principles to engineering problems in order to evaluate the environmental, economic and social implications of engineering and design decisions. Topics include definitions of sustainability, main engineering sustainability challenges (e.g., water, climate and materials), pollution generation and prevention and sustainability assessment tools.

**Requisites:** Requires a corequisite course of CVEN 3414. Restricted to Environmental Engineering (EVEN) majors only.

**Grading Basis:** Letter Grade

**EVEN 4100 (3) Environmental Sampling and Analysis**

Introduces students to techniques for characterization of surface water, subsurface water, soils and sediments, and air and planning of sampling and analysis efforts. Laboratories include stream sampling, drilling, monitoring well installation, water level, slug tests, air sampling.

**Requisites:** Requires prerequisite courses of CVEN 4404 and CVEN 4424 (all minimum grade C-). Restricted to Environmental Engineering (EVEN) majors only.

**EVEN 4404 (3) Water Chemistry**

Introduces chemical fundamentals of inorganic aqueous compounds and contaminants in lecture and laboratory. Lecture topics include thermodynamics and kinetics of acids and base reactions, carbonate chemistry, air-water exchange, precipitation, dissolution, complexation, oxidation-reduction and sorption.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4404

**Requisites:** Restricted to Civil (CVEN) or Environmental (EVEN) or General (GEEN) Engineering majors only

**EVEN 4414 (1) Water Chemistry Laboratory**

Reinforces chemical fundamentals of inorganic aqueous compounds and contaminants from CVEN/EVEN 4404 in laboratory experiments and reports. Topics include acids and bases, carbonate chemistry (alkalinity) and other water chemistry characteristics (hardness, dissolved oxygen); precipitation, complexation and oxidation-reduction reactions; and laboratory techniques and reporting.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4414

**Requisites:** Requires prerequisite courses of CHEN 1211 or CHEM 1113 and CHEM 1133 (all minimum grade C-). Requires corequisite course of EVEN 4404. Restricted to Civil (CVEN) or Environmental (EVEN) Engineering majors only.

**EVEN 4424 (3) Environmental Organic Chemistry**

Examines the fundamental physical and chemical transformations affecting the fate and transport of organic contaminants in natural and treated waters. Emphasizes quantitative approach to solubility, vapor pressure, air-water exchange, sorption, hydrolysis and redox reactions, and photodegradation.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4424

**Requisites:** Requires prerequisite course of CHEN 1211 or CHEM 1113 or CHEM 1271 (minimum grade C-).

**Grading Basis:** Letter Grade

**EVEN 4434 (4) Environmental Engineering Design**

Examines the design of facilities for the treatment of municipal water and wastewater, hazardous industrial waste, contaminated environmental sites and sustainable sanitation in developing countries. Economic, societal and site specific criteria impacting designs are emphasized.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4434

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-).

**Grading Basis:** Letter Grade

**EVEN 4464 (3) Environmental Engineering Processes**

Develops and utilizes analytic solutions for environmental process models that can be used in a) reactor design for processes used in the treatment of water, wastewater and hazardous waste and b) process analysis of natural systems, such as streams and groundwater flow. Models facilitate the tracking of contaminants in engineered and natural systems.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4464 and CVEN 5464

**Requisites:** Requires prerequisite courses of CVEN 3313 or CHEN 3200 or GEEN 3853 or MCEN 3021 or AREN 2120 and CVEN 3414 (all minimum grade C-).

**Grading Basis:** Letter Grade

**EVEN 4484 (3) Introduction to Environmental Microbiology**

Surveys microbiology topics germane to modern civil and environmental engineering. Provides fundamentals needed to understand microbial processes and ecology in engineered and natural systems and reviews applications emphasizing the interface between molecular biology and classical civil engineering.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4484

**Requisites:** Requires prerequisite course of CHEN 1211 and CHEM 1221 or CHEM 1113 and CHEM 1114 and APPM 2350 or MATH 2400 (minimum grade C-).

**Grading Basis:** Letter Grade

**EVEN 4830 (3) Special Topics**

**Repeatable:** Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.

**EVEN 4840 (1-3) Independent Study: General Topics**

General topics relating to environmental engineering. One-on-one assistance with an instructor.

**Repeatable:** Repeatable for up to 6.00 total credit hours.



**EVEN 4969 (3) Water and Sanitation in Developing Countries**

Studies the design and fundamentals behind effective treatment processes and engineering solutions targeted for developing countries. Approaches to clean water and sanitation in lesser industrialized countries often demand alternative solutions to those developed for industrialized societies. Explores issues and solutions developed to tackle these problems.

**Equivalent - Duplicate Degree Credit Not Granted:** CVEN 4969

**Requisites:** Requires prerequisite course of CVEN 3414 (minimum grade C-). Restricted to students with 57-180 credits (Juniors or Seniors).

**Grading Basis:** Letter Grade

**EVEN 4980 (3) Senior Thesis 1**

Provides faculty-supervised independent research in environmental engineering for students planning to complete a senior thesis. To be taken prior to EVEN 4990, during the final year before graduation. Department consent required.

**Requisites:** Restricted to students with 87-180 credits (Senior, Fifth Year Senior) Environmental Engineering (EVEN) majors only.

**EVEN 4990 (3) Senior Thesis 2**

Continuation of EVEN 4980. Consists of final phase of faculty-supervised research, the preparation of a written thesis, and an oral defense of the research to

**Requisites:** Requires prerequisite course of EVEN 4980 (minimum grade C-).