Civil Engineering

Civil engineers plan, design, supervise the construction, operate, maintain, inspect, retrofit, and manage many of the facilities and systems in both public and private sectors that are essential to modern life. The civil engineering profession is one of the most stable and most diverse of the engineering disciplines. Civil engineers are employed by consulting firms, public agencies, and start and operate their own business. Workplaces range from construction sites to design offices. Most civil engineers work with some engineering or construction aspect of private and/or public facilities, such as airports, bridges, buildings, coastal structures, dams, environmental remediation of contaminated sites, harbors, highways, offshore structures, pipelines, railroads, transportation systems, tunnels, water collection systems, water distribution systems, water and wastewater treatment facilities, and waterways. Civil engineers are on the forefront of applying the newest technology innovations in engineering and construction.

Civil engineering projects are unique because they require individual planning, analysis, design, construction supervision, performance monitoring, management and retrofitting. Civil engineering projects often require technical, governmental, legal, financial, and social evaluations. The primary objective is to provide the best service for the users while minimizing costs and other undesirable impacts.

The mission of the Zachry Department of Civil Engineering (http://engineering.tamu.edu/civil) at Texas A&M University is to prepare our graduates to become professional engineers and leaders in the civil engineering profession by providing our students with a solid education that will enable them to integrate fundamental scientific engineering principles and that will couple with the latest technological advances to facilitate the development of their problem solving skills. Additionally, the department provides opportunities for enhancement of the students’ educational experience through meaningful interactions with the profession, professionally-centered student activities and exposure to the broad field of civil engineering through seminars, practitioner visits, and Professional Day activities.

The faculty of the Zachry Department of Civil Engineering strives to ensure that our ever-evolving educational programs accomplish several objectives. First, our faculty must prepare the students to address the current and future civil engineering needs of the State of Texas, the nation and the world by being able to recognize the important geopolitical and public policy needs; and solve technical problems. In addition, the Department provides a curriculum that integrates scientific and technical knowledge with an appreciation for social, economic and political concerns. The curriculum and programs provide opportunities for our students to:

1. build leadership skills,
2. learn professionalism and ethical responsibility, and
3. develop and understanding of the need to engage in lifelong learning.

Finally, the faculty of the Zachry Department of Civil Engineering at Texas A&M University promotes the highest academic standards of excellence, quality, and ethics in both our undergraduate and graduate programs, and in doing so create both a culture of excellence and a community of scholars. Through our programs, our faculty and graduates provide local, state, national, and international leadership to a profession that must solve the civil engineering problems facing an increasingly complex society.

The program educational objectives for the undergraduate civil engineering program within the Department of Civil Engineering at Texas A&M University are to produce graduates:

1. who are prepared to enter civil engineering practice and/or continue their education through study in graduate and professional programs,
2. most of whom will become practicing civil engineers with most of these becoming licensed professional engineers, and
3. many of whom will pursue advanced studies.

The undergraduate program in civil engineering within the Zachry Department of Civil Engineering at Texas A&M is accredited by the Engineering Accreditation Commission of ABET, www.abet.org. Graduate programs in civil engineering are also available. These programs allow further specialization and offer more in-depth study to address more complex technical and management issues. Graduate degrees also offer additional employment opportunities.

Before commencing course work in the major, students must be admitted to the major or have the approval of the department.

Faculty

Appleton, Robert A, Associate Professor of the Practice
Civil Engineering
BS, Texas A&M University, 1984

Ardani, Samira, Assistant Lecturer
Civil Engineering
PHD, Texas A&M University, 2016

Aubeny, Charles P, Professor
Civil Engineering
PHD, Massachusetts Institute of Technology, 1992

Autenrieth, Robin L, Professor
Civil Engineering
PHD, Clarkson University, 1986

Barroso, Luciana R, Associate Professor
Civil Engineering
PHD, Stanford University, 1999

Batchelor, Bill, Senior Professor
Civil Engineering
PHD, Cornell University, 1976

Birely, Anna C, Assistant Professor
Civil Engineering
PHD, University of Washington, 2012

Birgisson, Bjorn, Professor
Civil Engineering
PHD, University of Minnesota, Twin Cities, 1996

Bracci, Joseph M, Professor
Civil Engineering
PHD, State University of New York at Buffalo, 1992
Brackin, Michael S, Assistant Lecturer
Civil Engineering
MS, Texas A&M University, 2010

Briaud, Jean-Louis, Professor
Civil Engineering
PHD, University of Ottawa, Canada, 1979

Brumbelow, James K, Associate Professor
Civil Engineering
PHD, Georgia Institute of Technology, 2001

Burris, Mark W, Professor
Civil Engineering
PHD, University of South Florida, 2001

Cahill, Anthony T, Associate Professor
Civil Engineering
PHD, Johns Hopkins University, 1998

Cha, Minsu, Assistant Professor
Civil Engineering
PHD, Georgia Institute of Technology, 2012

Chang, Kuang-An, Professor
Civil Engineering
PHD, Cornell University, 1999

Chellam, Shankararaman, Professor
Civil Engineering
PHD, Rice University, 1995

Chen, Hamn C, Professor
Civil Engineering
PHD, University of Iowa, 1982

Chinn, Timothy D, Professor of the Practice
Civil Engineering
BS, Texas A&M University, 1980

Chu, Kung-Hui, Associate Professor
Civil Engineering
PHD, University of California, Berkeley, 1998

Damnjanovic, Ivan, Associate Professor
Civil Engineering
PHD, The University of Texas at Austin, 2006

England, Peter S, Instructional Associate Professor
Civil Engineering
PHD, Texas Tech University, 2011

Ford, David N, Professor
Civil Engineering
PHD, Massachusetts Institute of Technology, 1995

Gao, Huilin, Assistant Professor
Civil Engineering
PHD, Princeton University, 2005

Gharaibeh, Nasir G, Associate Professor
Civil Engineering
PHD, University of Illinois at Urbana-Champaign, 1997

Grasley, Zachary C, Professor
Civil Engineering
PHD, University of Illinois at Urbana-Champaign, 2006

Hawkins, Harvey E, Professor
Civil Engineering
PHD, Texas A&M University, 1993

Hueste, Marybeth D, Professor
Civil Engineering
PHD, University of Michigan, 1997

Hurlebaus, Stefan, Professor
Civil Engineering
PHD, University of Stuttgart, Germany, 2002

Hutchinson, Richard N, Instructional Assistant Professor
Civil Engineering
MEN, Texas A&M University, 2001

Kaihatu, James M, Associate Professor
Civil Engineering
PHD, University of Delaware, 1994

Kanta, Lufthansa R, Instructional Assistant Professor
Civil Engineering
PHD, Texas A&M University, 2009

Keating, Peter B, Associate Professor
Civil Engineering
PHD, Lehigh University, 1987

Koliou, Maria, Assistant Professor
Civil Engineering
PHD, State University of New York at Buffalo, 2014

Little, Dallas N, Professor
Civil Engineering
PHD, Texas A&M University, 1979

London, Mara R, Instructional Associate Professor
Civil Engineering
PHD, The University of Texas at Austin, 2009

Lord, Dominique, Professor
Civil Engineering
PHD, University of Toronto, 2000

Lowery, Lee L, Professor
Civil Engineering
PHD, Texas A&M University, 1967

Lytton, Robert L, Professor
Civil Engineering
PHD, The University of Texas at Austin, 1967

Ma, Xingmiao, Associate Professor
Civil Engineering
PHD, Missouri University of Science and Technology, 2004

Mander, John B, Professor
Civil Engineering
PHD, University of Canterbury, 1984
Martin, Amy E, Professor
Civil Engineering
PHD, University of California, Berkeley, 1997

Medina Cetina, Zenon, Associate Professor
Civil Engineering
PHD, Johns Hopkins University, 2007

Mercier, Richard S, Professor
Civil Engineering
PHD, Massachusetts Institute of Technology, 1985

Miller, Gretchen R, Associate Professor
Civil Engineering
PHD, University of California, Berkeley, 2009

Mostafavidarani, Ali, Assistant Professor
Civil Engineering
PHD, Purdue University, 2013

Niedzwecki, John M, Professor
Civil Engineering
PHD, The Catholic University of America, 1977

Noshadravan, Arash, Research Assistant Professor
Civil Engineering
PHD, University of Southern California, 2011

Olivera, Francisco, Associate Professor
Civil Engineering
PHD, The University of Texas at Austin, 1996

Otey, Jeffrey M, Instructional Assistant Professor
Civil Engineering
MEN, Texas A&M University, 1994

Paal, Stephanie G, Assistant Professor
Civil Engineering
PHD, Georgia Institute of Technology, 2013

Pittman, Leslie W, Associate Professor of the Practice
Civil Engineering
MS, Colorado State University, 1978

Quadrifoglio, Luca, Associate Professor
Civil Engineering
PHD, University of Southern California, 2005

Rogers, Alton G, Associate Professor of the Practice
Civil Engineering
BS, Texas A&M University, 1976

Sakhaei Far, Maryam S, Assistant Professor
Civil Engineering
PHD, North Carolina State University, 2011

Sanchez Castilla, Marcelo Javier, Professor
Civil Engineering
PHD, Universidad Polytécnica de Catalunya, Spain, 2004

Scarfuto, Jessica C, Assistant Lecturer
Civil Engineering
MS, Texas A&M University, 2014

Sideris, Petros, Assistant Professor
Civil Engineering
PHD, State University of New York at Buffalo, 2012

Socolofsky, Scott A, Professor
Civil Engineering
PHD, Massachusetts Institute of Technology, 2001

Talebpour, Alireza, Assistant Professor
Civil Engineering
PHD, Northwestern University, 2015

Walewski, John A, Associate Professor of the Practice
Civil Engineering
PHD, The University of Texas at Austin, 2005

Wang, Xiubin B, Associate Professor
Civil Engineering
PHD, University of California, Irvine, 2001

Wolf, Charles M, Professor of the Practice
Civil Engineering
DEN, Texas A&M University, 2001

Wurbs, Ralph A, Senior Professor
Civil Engineering
PHD, University of California, Davis, 2004

Zhang, Yunlong, Professor
Civil Engineering
PHD, Virginia Polytechnic Institute and State University, 1996

Zollinger, Dan, Professor
Civil Engineering
PHD, University of Illinois at Urbana-Champaign, 1989

**Majors**

- Bachelor of Science in Civil Engineering (http://catalog.tamu.edu/undergraduate/engineering/civil/bs)
- Bachelor of Science in Civil Engineering, Coastal and Ocean Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/coastal-ocean-engineering-track)
- Bachelor of Science in Civil Engineering, Construction Engineering and Management Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/construction-engineering-management-track)
- Bachelor of Science in Civil Engineering, Environmental Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/environmental-engineering-track)
- Bachelor of Science in Civil Engineering, General Civil Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/general-civil-engineering-track)
- Bachelor of Science in Civil Engineering, Geotechnical Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/geotechnical-engineering-track)
- Bachelor of Science in Civil Engineering, Structural Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/structural-engineering-track)
• Bachelor of Science in Civil Engineering, Transportation Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/transportation-engineering-track)
• Bachelor of Science in Civil Engineering, Water Resources Engineering Track (http://catalog.tamu.edu/undergraduate/engineering/civil/bs/water-resources-engineering-track)

Courses

• Civil Engineering (CVEN) (p. 4)
• Environmental Engineering (EVEN) (p. 7)

Civil Engineering (p. 4)

CVEN 207 Introduction to the Civil Engineering Profession
Credit 1. 1 Lecture Hour.
Introduction to the study and practice of civil engineering; specialized subdisciplines of civil engineering; professionalism and professional registration; engineering ethics; exercises in engineering technical communications.
Prerequisite: ENGL 104.

CVEN 221 Engineering Mechanics: Statics
Credits 3. 2 Lecture Hours. 2 Lab Hours.
General principles of mechanics; concurrent force systems; statics of particles; equivalent force/moment systems; centroids and center of gravity; equilibrium of rigid bodies; trusses, frames, and machines; internal forces in structural members; friction; second moments of areas.
Prerequisites: MATH 251 or MATH 253 or registration therein; PHYS 218; admitted to major degree sequence in civil engineering.

CVEN 250 Introduction to Graphics and Visualization Applications in Civil Engineering Design
Credits 2. 1 Lecture Hour. 3 Lab Hours.
Graphical communication in the civil engineering design process; introduction to industry standard software; construction documents and contract drawings in civil engineering applications; data analysis; introduction to project visualization.

CVEN 289 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours. 0 to 4 Lab Hours.
Selected topics in an identified area of civil engineering. May be repeated for credit.
Prerequisite: Approval of department head.

CVEN 301 Environmental Engineering
Credits 3. 3 Lecture Hours.
Water quality; material balances; chemical, physical and biological processes; water quality modeling; water and wastewater treatment; air quality; solid and hazardous waste management.
Prerequisites: CHEM 107; CVEN 302 or registration therein; MATH 308 or registration therein.

CVEN 302 Computer Applications in Engineering and Construction
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Application of computers to solution of civil engineering problems using various numerical methods; structured computer programming; mathematical modeling and error analysis; solution of algebraic and differential equations; numerical differentiation and integration; curve-fitting; root-finding.
Prerequisites: ENGR 112; MATH 308 or registration therein; admitted to major degree sequence in civil engineering.

CVEN 303 Civil Engineering Measurement
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to geodetic positions, datums, map projections; theory of civil engineering measurements and errors applied to horizontal and vertical control, curves, earthwork and mapping using state-of-the-art technology for data capture; processing and presentation of result.
Prerequisite: MATH 151; admitted to major degree sequence in civil engineering.

CVEN 304 Environmental and Water Resources Engineering Lab
Credit 1. 3 Lab Hours.
Environmental measurements on physical, chemical, and biotechnological parameters of water.
Prerequisites: CVEN 301 or EVEN 301, or concurrent enrollment; CVEN 311 or concurrent enrollment; or approval of instructor.
Cross Listing: EVEN 304.

CVEN 305 Mechanics of Materials
Credits 3. 3 Lecture Hours.
Applications of conservation principles and stress/deformation relationships for continuous media to structural members; axially loaded members; thin-walled pressure vessels; torsional and flexural members; shear; moment; deflection of members; combined loadings; stability of columns; nonsymmetrical bending, shear center; indeterminate members; elastic foundations.
Prerequisites: Grade of C or better in CVEN 221, MEEN 221 or MEEN 225.

CVEN 306 Materials Engineering for Civil Engineers
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Introduction to scientific concepts of civil engineering materials; relationship between macroscopic material properties and response and microscopic properties; physical, mechanical, surface, fracture, and rheological properties of civil engineering materials including metals, composites, and polymers.
Prerequisites: CHEM 107, PHYS 208, CVEN 221, MATH 308 or registration therein; CVEN 305 or registration therein.

CVEN 307 Transportation Engineering
Credits 3. 3 Lecture Hours.
Fundamental principles and methods in planning, design, and operation of transportation systems; driver and vehicle performance capabilities; highway geometric and pavement design principles; traffic analysis and transportation planning.
Prerequisite: CVEN 302 or registration therein.

CVEN 311 Fluid Dynamics
Credits 3. 3 Lecture Hours.
Fluid properties; statics; kinematics; basic conservation principles of continuity, energy and momentum; similitude and hydraulic models; incompressible flow in pipes; fluid dynamic drag.
Prerequisites: MATH 251 and CVEN 221; CVEN 302 or registration therein.

CVEN 315 Sensor Technology for the Built Environment
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Fundamentals of sensor technology including laboratory safety, error analysis, statistical analysis, electric circuits, data acquisition, signal conditioning, signal analysis, strain gages, laser technology, image acquisition and analysis, fiber optic sensors, wireless sensors; its applications in civil engineering; and hands-on demonstrations relevant to the natural and built environment.
Prerequisites: CVEN 302, junior or senior classification, or approval of instructor.
CVEN 322 Civil Engineering Systems
Credits 3. 3 Lecture Hours.
Economic analysis and evaluation of engineering projects; application of systems analysis to civil engineering design; systems synthesis and optimization techniques; assignments apply engineering economics, statistical methods and optimization techniques to civil engineering problems.
Prerequisite: STAT 211 or registration therein; CVEN 302 or registration therein; admitted to major degree sequence in civil engineering.

CVEN 336 Fluid Dynamics Laboratory
Credit 1. 2 Lab Hours.
Introduction to laboratory techniques; calibration principles, reports and fluid measurements; determination of fluid properties; visualization of types of flow; experiments in closed conduit flow of air, water and oil; fluid drag and turbomachinery tests; open channel and gravity wave demonstrations.
Prerequisites: CVEN 311 or registration therein. Enrollment in MASE major degree sequence. Junior or senior classification or approval of instructor.

CVEN 339 Water Resources Engineering
Credits 3. 3 Lecture Hours.
Quantitative hydrology, precipitation, hydrograph analysis, reservoir and stream routing; groundwater, Darcy equation, well equation, well design; probability concepts in design; water law; dams; reservoirs; spillways; open channel and pipe network hydraulics; pumps; urban stormwater drainage; flood damage mitigation.
Prerequisite: CVEN 311.

CVEN 342 Materials of Construction
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Physical and mechanical properties of construction materials; portland cement concrete, bituminous materials, wood, ferrous and non-ferrous metals, glass, plastics and masonry units; proportioning of concrete mixtures including admixtures.
Prerequisites: CVEN 302 or registration therein; CVEN 305 and CVEN 306; ENGL 203, ENGL 210, ENGL 241 or ENGL 301.

CVEN 343 Portland Cement Concrete Materials for Civil Engineers
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Physical and chemical characteristics of Portland cement concrete systems; constituent materials; mixture proportioning; fresh concrete characteristics; hardened concrete properties; durability characteristics; and concrete construction methods.
Prerequisites: CVEN 302 or registration therein; CVEN 305 and CVEN 306; ENGL 203, ENGL 210, ENGL 241 or ENGL 301.

CVEN 345 Theory of Structures
Credits 3. 3 Lecture Hours.
Structural engineering—functions of structure, design loads, reactions and force systems; analysis of statically determinate structures including beams, trusses and arches; energy methods of determining deflections of structures; influence lines and criteria for moving loads; analysis of statically indeterminate structures including continuous beams and frames.
Prerequisites: CVEN 302 or registration therein; CVEN 305.

CVEN 349 Civil Engineering Project Management
Credits 3. 3 Lecture Hours.
Basic elements of management of civil engineering projects; roles of all participants in the process—owners, designers, contractors and suppliers; emphasis on contractual aspect of the process—project estimating, planning and controls.
Prerequisite: CVEN 302 and CVEN 322, or concurrent enrollment.

CVEN 363 Engineering Mechanics: Dynamics
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Application of first principles to model dynamic particles and rigid body systems with ordinary differential equations; solutions to models using analytical and numerical approaches; interpreting solutions/performance measures; linear vibrations; modeling of civil engineering systems and evaluating dynamic response to natural hazards.
Prerequisites: CVEN 302, CVEN 305 and MATH 308.

CVEN 365 Introduction to Geotechnical Engineering
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Physical properties of soils, classification systems, soil exploration, permeability, consolidation, compaction, and shear strength; laboratory tests conducted to determine the physical and engineering soil properties needed for application in geotechnical engineering design.
Prerequisites: CVEN 302 or registration therein; CVEN 305; ENGL 203, ENGL 210, ENGL 241 or ENGL 301.

CVEN 399 Mid-Curriculum Professional Development
Credits 0. 0 Lecture Hours. 0 Lab Hours. 0 Other Hours.
No Credit. Participation in an approved high-impact learning practice; reflection on professional outcomes from civil engineering body of knowledge; documentation of experience appropriate to eventual professional licensure; self-assessment of learning at mid-curriculum point.
Prerequisites: CVEN 207, CVEN 250, CVEN 303, CVEN 306, CVEN 311, CVEN 322, CVEN 345 and CVEN 363.

CVEN 400 Design Problems in Civil Engineering
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Applications of civil engineering principles to the design and preparation of the plans and specifications of civil engineering projects.
Prerequisites: CVEN 303, CVEN 322, CVEN 345 and CVEN 399; senior classification; or approval of instructor.

CVEN 402 Engineered Environmental Systems
Credits 3. 3 Lecture Hours.
Unit operations and processes in environmental engineering; physical, chemical and biological treatment of water and wastewater; treatment system analysis and design.
Prerequisite: CVEN 301.

CVEN 403 Applied Civil Engineering Surveying
Credits 2. 6 Lab Hours.
Application of land surveying principles; topographic surveying, boundary surveying, and construction staking through field exercises using state-of-the-art equipment and data capture/analysis techniques; preparation of topographic and boundary maps with related documents; presentation of results.
Prerequisites: CVEN 303; junior or senior classification.

CVEN 405 Construction Management of Field Operations
Credits 3. 3 Lecture Hours.
Effects of industrialization on construction methods and resultant construction management problems.
Prerequisite: CVEN 349.

CVEN 406 Environmental Protection and Public Health
Credits 3. 3 Lecture Hours.
Communicable and noncommunicable diseases; environmental risk assessment; environmental assessments; comprehensive environmental planning; small water and wastewater systems; solid waste management; hazardous spills and waste management; vector control; environmental administration.
Prerequisite: CVEN 301 or approval of instructor.
CVEN 413 Natural Environmental Systems
Credits 3. 3 Lecture Hours.
Water quality assessment of natural environmental systems; development and calibration of models to describe fate and transport of contaminants in aquatic systems; application of models to design of water quality control facilities.
Prerequisite: CVEN 301.

CVEN 417 Bituminous Materials
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Origin, production, specifications and tests of bituminous materials and paving mixtures used in construction and maintenance of roads and pavements, pavement surface properties, pavement distress and correction alternatives.
Prerequisites: Senior classification in civil engineering; CVEN 304 or CVEN 343 or approval of instructor.

CVEN 418 Highway Materials and Pavement Design
Credits 3. 3 Lecture Hours.
Theory and practice in pavement design; pavement performance; structural design of pavement layers; types of materials used in pavement layers; characterization of pavement layer materials; introduction to pavement management concepts.
Prerequisites: CVEN 307; CVEN 342 or CVEN 343.

CVEN 423 Geomatics for Civil Engineering
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Use of GIS, GPS, Survey and Remotely-sensed data integrated with predictive models for infrastructure management systems.
Prerequisite: CVEN 303 or approval of instructor.

CVEN 424 Civil Engineering Professional Practice
Credits 2. 1 Lecture Hour. 2 Lab Hours.
Professional practice issues; current civil engineering issues that impact design, construction, and operation of the civil engineer facilities; developing engineering solutions that better serve society; business and public policy concerns; life-long learning; problem solving; professional licensure.
Prerequisites: CVEN 322 and CVEN 399; senior classification in civil engineering.

CVEN 435 Geotechnical Engineering Design
Credits 3. 2 Lecture Hours. 3 Lab Hours.
A design course covering prediction of settlement, analysis of the stability of slopes, prediction of bearing capacity of shallow and deep foundations and determination of earth pressures acting on retaining structures; a general course in geotechnical engineering design for undergraduates and for graduate students not primarily interested in the geotechnical field, but desiring additional study beyond the introductory undergraduate level.
Prerequisite: CVEN 365.

CVEN 436 Case Histories in Geotechnical Engineering
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Examination of geotechnical problems through the use of case studies associated with foundations, waste disposal, slope stability, retaining structures, soil improvement and other civil engineering works.
Prerequisite: CVEN 365.

CVEN 444 Structural Concrete Design
Credits 3. 3 Lecture Hours.
Behavior, design, and detailing of reinforced concrete structural members according to the ACI Building Code Requirements; design for ultimate limit states (flexible, shear, and axial loads) and serviceability requirements (cracking and deflection); applications include continuous beams and moment frames.
Prerequisites: CVEN 345; CVEN 342 or CVEN 343 or registration therein.

CVEN 445 Matrix Methods of Structural Analysis
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Analysis of framed structures using linear algebra concepts; matrix algebra and solution of linear algebraic equations; energy principles and virtual work; stiffness; coordinate transformations; use of commercial software for structural analysis.
Prerequisites: Grade of C or better in CVEN 345 and CVEN 363.

CVEN 446 Structural Steel Design
Credits 3. 3 Lecture Hours.
Design of structural steel elements found in building structures, including tension members, compression members, beams, beam-columns and base plates; design of bolted and welded simple connections; design of bolted eccentric connections; design of bolted and welded partially and fully restrained connections.
Prerequisite: CVEN 345.

CVEN 450 AutoCAD in Civil Engineering
Credit 1. 3 Lab Hours.
CVEN 450. AutoCAD in Civil Engineering. Review and application of basic commands and operations in AutoCAD; overview of civil engineering design projects and land surveying; use of AutoCAD Civil 3D or proprietary packages for reduction of land surveying data.
Prerequisites: CVEN 250 or ENDG 105; junior or senior classification.

CVEN 451 Public Works Engineering
Credits 3. 3 Lecture Hours.
Public works engineering; service demand estimates; water, wastewater and solid waste collection systems; urban drainage; code enforcement and public decision making.
Prerequisites: CVEN 301 and CVEN 339.

CVEN 454 Urban Planning for Engineers
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Urban planning from an engineering point of view; determinants of land use patterns, planning data collection and analysis; location and design requirements for various land uses; interrelationship of transportation and land use; and methods of plan development.
Prerequisite: CVEN 307.

CVEN 455 Urban Stormwater Management
Credits 3. 3 Lecture Hours.
Hydrologic, hydraulic, and general civil engineering design and implementation of stormwater systems including drainage and detention storage facilities, floodplain regulation measures, and flood control structures; stormwater aspects of land development and public works engineering; flood hydrology and hydraulics; institutional aspects of urban stormwater management.
Prerequisite: CVEN 339 or approval of instructor.

CVEN 456 Highway Design
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Theory and practice in highway design; highway classification and design criteria, location studies, design of vertical and horizontal alignment, cross section, pavement, intersections and highway drainage elements.
Prerequisites: CVEN 307 and CVEN 399; senior classification; or approval of instructor.
CVEN 457 Urban Traffic Facilities  
Credits 3. 3 Lecture Hours.  
Driver, vehicle and roadway characteristics related to design and operation of traffic facilities; selection and design of traffic control devices and information systems for streets and highways; accident analysis and tort liability related to traffic engineering.  
Prerequisite: CVEN 307.

CVEN 458 Hydraulic Engineering of Water Distribution Systems  
Credits 3. 3 Lecture Hours.  
Pressure conduit hydraulics; design, modeling, and analysis of water conveyance and distribution systems including pipelines, pipe networks, and pumps.  
Prerequisite: CVEN 339 or approval of instructor.

CVEN 462 Engineering Hydrogeology  
Credits 3. 3 Lecture Hours.  
Groundwater in the hydrologic cycle; aquifer properties; well hydraulics, testing, and design; groundwater quality; and groundwater management and sustainability.  
Prerequisites: CVEN 311; CVEN 301 or CVEN 339; junior or senior classification; or approval of instructor.

CVEN 463 Engineering Hydrology  
Credits 3. 3 Lecture Hours.  
Occurrence, distribution and properties of natural waters of the earth; measurement and engineering analysis of hydrologic phenomena including precipitation, streamflow and groundwater; hydrologic design of water resources development and management projects.  
Prerequisite: CVEN 339.

CVEN 473 Engineering Project Estimating and Planning  
Credits 3. 2 Lecture Hours. 3 Lab Hours.  
Application of cost estimating and planning techniques for civil engineering projects; introduction to labor, materials and equipment costing; productivity analysis; indirect and general overhead costs; preparation of approximate and definitive estimates; and integration of time/cost relationships through critical path method and resource leveling.  
Prerequisites: CVEN 349; senior classification.

CVEN 483 Analysis and Design of Structures  
Credits 3. 2 Lecture Hours. 3 Lab Hours.  
Overall procedure of analysis and design including functions, loads, layouts of force systems; analysis, specifications, cost comparisons, and maintenance as applied to typical building structures.  
Prerequisites: CVEN 365 or concurrent enrollment; CVEN 399, CVEN 444 and CVEN 446; senior classification; or approval of instructor.

CVEN 485 Directed Studies  
Credits 0 to 3. 0 to 3 Other Hours.  
Research and design problems of limited scope approved on an individual basis intended to promote independent study; results of study presented in writing.  
Prerequisite: Approval of department head.

CVEN 489 Special Topics in...  
Credits 1 to 4. 0 to 4 Lecture Hours. 0 to 4 Lab Hours.  
Selected topics in an identified area of civil engineering. May be repeated for credit.  
Prerequisite: Approval of department head.

Environmental Engineering (p. 4)

EVEN 304 Environmental and Water Resources Engineering Lab  
Credit 1. 3 Lab Hours.  
Environmental measurements on physical, chemical, biological and biotechnological parameters of water.  
Prerequisites: CVEN 301 or EVEN 301, or concurrent enrollment; CVEN 311 or concurrent enrollment; or approval of instructor.  
Cross Listing: CVEN 304.

EVEN 466 Sustainability and Life Cycle Analysis  
Credits 3. 3 Lecture Hours.  
Definitions of sustainability and sustainable development from social, economic, political, and technical perspectives; life-cycle analysis and quantitative assessment of sustainability; industrial ecology; valuation of environmental goods and externalities; sustainable infrastructure design and management.  
Prerequisites: Junior or senior classification or approval of instructor.

Environmental Engineering