

Civil Engineering

Department of Civil, Structural, and Environmental Engineering

Civil Engineering
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Overview

Civil engineers build societies, from the landmarks that define who we are to the hidden infrastructure essential for our survival. Civil engineering projects such as the Hoover Dam, the Golden Gate Bridge, Boston's 'Big Dig,' the interstate highway system, and New York City's water supply system illustrate the diversity, scale, grandeur, and functionality that is civil engineering. Because they often work in the public arena, civil engineers require broad technical training as well as strong communication skills, and usually must be licensed as professional engineers.

Program educational objectives for the civil engineering BS degree are:

- Employment and promotion as civil engineers in consulting, industry, government, academia, and related professions;
- Maintain state-of-the-art knowledge through lifelong learning, such as graduate study and continuing education;
- Respond to the changing impact of civil engineering solutions in a global and social context, and;
- Advance and support the engineering profession through participation in professional societies, civic groups, and educational institutions.

About our Degrees

The civil engineering B.S. degree is accredited by the Accreditation Board of Engineering and Technology (ABET) and prepares students for graduate study and/or professional practice.

Acceptance Criteria

Please see the School of Engineering and Applied Sciences entry in the Undergraduate Catalog, <http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml>.

Acceptance Information

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Degree Requirements

Please see [Degrees and Policies](#).

About our Courses

The BS curriculum includes math, science, and basic engineering courses in the freshman and sophomore years, required civil engineering courses in the junior and senior years, and technical elective courses in the senior year. Laboratories in civil engineering are included in two lab classes in the junior year. Students have considerable flexibility in the selection of technical elective courses, allowing them to specialize in one of the civil engineering sub-disciplines. Also available to interested students are several work-experience courses (internship, engineering co-op).

The typical class size for:

Freshman/introductory courses is: 100+
Sophomore/intermediate courses is: 50-100+
Upper level required courses is: 100-120
Upper level electives is: 25-100

In the Department of Civil, Structural, and Environmental Engineering, what do teaching assistants (TAs) do?

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TAs hold office hours to answer students' questions about homework and exam preparation, grade homework (exams are usually graded by instructors), and manage lab assignments.

For course descriptions, please see [Courses](#).

About our Faculty

We have 24 full-time faculty (all with PhD degrees) and approximately 10 adjunct faculty. The faculty is actively engaged in teaching, research, and service and has won many honors and awards, including:

- Three SUNY Chancellor's Awards for Excellence in Teaching
- Four National Science Foundation Presidential Young Investigator awards
- One Office of Naval Research Young Investigator Awards/Career Awards
- One SUNY Chancellor's Award for Excellence in Scholarship and Creative Activity
- One SUNY Distinguished Professor
- Two ASCE Newmark Medals

See a list of our [Undergraduate Faculty](#).

Transfer Policy

For the transfer policy, please see the School of Engineering and Applied Sciences entry in the Undergraduate Catalog, <http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml>.

Extracurricular Activities

Our undergraduate students are engaged in many campus-wide activities and organizations. These, as well as other nationwide student organizations specific to engineering, include the following:

- [Air and Waste Management Association \(AWMA\)](#)
- [American Society of Civil Engineers \(ASCE\)](#)
- [Associated General Contractors of America \(AGC\)](#)
- [Chi Epsilon \(Civil Engineering Honor Society\)](#)
- [Earthquake Engineering Research Institute \(EERI\)](#)
- [Engineers for a Sustainable World \(ESW\)](#)
- [National Society of Professional Engineers \(NSPE\)](#)
- [Society of Women Engineers \(SWE\)](#)
- [Tau Beta Pi \(Engineering Honor Society\)](#)
- [UB Environmental Engineering and Science Club \(UBEESC\)](#)
- [Water Environment Federation \(WEF\)](#)

See the [UB Student Association](#).

Practical Experience and Special Academic Opportunities

Internships/Co-ops

Summer internships are available as technical electives in the junior and senior years through the Engineering Career Institute. Please see <http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml> for more information.

Career Information and Further Study

Career Choices

Civil engineers can choose from a broad spectrum of opportunities in industry, governmental agencies, private consulting firms (in which civil engineers often participate as owners or partners), and construction companies as well as in research and development. Many graduates return immediately or within a few years to graduate school for advanced studies. BS (Civil) graduates have the skills and most prerequisites to pursue

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further education in law, medicine, management, or other professional fields.

The civil engineering profession is unique because of two features that set it apart from other engineering professions:

1. First, each civil engineering project is constructed as an entity (unlike mass-produced manufactured items, such as cars and computers). Each civil engineering project receives individual planning, investigation, design, and performance monitoring.
2. Second, civil engineering projects involve interplay between technical, governmental, legal, financial, and social elements. Thus, civil engineering requires strong communication skills along with broad technical training.

Alumni in Civil Engineering Have Found Employment in the Following Fields:

- Computational engineering
- Computer-aided design
- Construction engineering and management
- Environmental engineering
- Geotechnical engineering and foundation design
- Highway design and construction
- Hydraulic and water resources engineering
- Structural engineering and design
- Transportation engineering

Examples of companies who actively recruit UB civil engineering candidates for internships and/or full time positions are:

Ciminelli Construction Companies, Inc.; Clark Patterson Assoc.; Clough Harbour & Assoc.; Cannon Design; Erdman Anthony & Associates, Inc.; NYS Dept of Transportation; Parsons Brinkerhoff; Turner Construction; TVGA Engineering Surveying; URS Corporation; and Watts Engineers

Degree Level Required

A growing number of employers are now requiring the ME or MS degree for entry-level civil engineering jobs. Thus, some students continue their studies at the graduate level.

Salary Information

Average starting salary: \$53,500

Factors influencing salary: Educational level, experience, specialization, GPA, location, computer skills, and many other factors. The best way to ensure a good starting salary is to intern with a civil-related firm before graduation, earn a competitive GPA, and do undergraduate research with a faculty member.

What percentage of graduates goes to graduate school?

Every year, about 20 to 25% of our BS (Civil) graduates go to graduate school, either in our own MS and ME programs or graduate programs at other universities.

Additional Resources

- iCivilEngineer.com
- [American Society of Civil Engineers \(ASCE\)](http://www.asce.org)
- [Civil Engineering News Online](http://www.civil-engineering.com)
- [Associated General Contractors of America](http://www.agc.org)
- [First Source](http://www.firstsource.com)
- [US Army Corps of Engineers](http://www.usarmy.com)
- [National Society of Professional Engineers](http://www.nspe.org)
- [Institute of Transportation Engineers](http://www.itpe.org)
- [American Public Works Association](http://www.apwa.org)
- [Resources of Scholarly Societies - Civil Engineering](http://www.scholarly-societies.org)

Degree Options

The Department of Civil, Structural, and Environmental Engineering offers a BS degree in civil engineering, a BS degree in environmental engineering (described separately), and a five-year BS (Civil)/MBA combined-degree program, or a five-year BS (Civil)/ME (Civil) combined-degree program.

The Department of Civil, Structural, and Environmental Engineering also offers programs leading to the master of engineering (ME), master of

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science (MS), and doctor of philosophy (PhD) degree.

Degrees Offered

Undergraduate: BS

Combined: BS (Civil)/MBA

Graduate: MS, ME, PhD

Concentrations: Construction management engineering, environmental engineering, geotechnical engineering, and structural engineering.

Links to Further Information About this Program

- [Undergraduate Catalog](#)
- [Undergraduate Admissions](#)
- [Graduate Admissions](#)
- [Department of Civil, Structural, and Environmental Engineering](#)
- [School of Engineering and Applied Sciences](#)

Civil Engineering - B.S.

Acceptance Criteria

Please see the School of Engineering and Applied Sciences entry in the Undergraduate Catalog, <http://undergrad-catalog.buffalo.edu/academicprograms/eas.shtml>.

Required Courses

[CHE 107](#) General Chemistry for Engineers
[CHE 108](#) General Chemistry for Engineers
[CIE 303](#) Geodesy, GPS, and GIS
[CIE 308](#) Engineering Statistics
[CIE 323](#) Structural Engineering I
[CIE 324](#) Structural Engineering II
[CIE 327](#) Civil Engineering Materials
[CIE 334](#) Soil Mechanics
[CIE 340](#) Environmental Engineering
[CIE 343](#) Hydraulic Engineering
[CIE 354](#) Fluid Mechanics
[CIE 361](#) Civil Engineering Laboratory I
[CIE 362](#) Civil Engineering Laboratory II
[CIE 415](#) Professional Practice Issues
[CIE 416](#) Civil Engineering Capstone Design
[CIE 435](#) Foundation Engineering
[CIE 439](#) Transportation System Analysis
[EAS 140](#) Engineering Principles
[EAS 202](#) Engineering Impact on Society
[EAS 207](#) Statics
[EAS 208](#) Dynamics
[EAS 209](#) Mechanics of Solids
[EAS 230](#) Engineering Computations or [CSE 113](#) Introduction to Computer Science I
[MAE 177](#) Introduction to Engineering Drawing/CAD
[MTH 141](#) College Calculus I
[MTH 142](#) College Calculus II
[MTH 241](#) College Calculus III
[MTH 306](#) Introduction to Differential Equations
[PHY 107](#) General Physics I
[PHY 108/PHY 158](#) General Physics II/Lab
One applied math elective
One engineering elective
Four civil engineering technical electives (one with design)

Summary

Total required credit hours for the major: 113

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See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [CHE 107](#), [EAS 140](#), [MTH 141](#)

Spring [EAS 202](#), [CHE 108](#), [MAE 177](#), [MTH 142](#), [PHY 107](#)

SECOND YEAR

Fall [EAS 207](#); [EAS 230](#) or [CSE 113](#); [MTH 241](#), [PHY 108/PHY 158](#)

Spring [EAS 208](#), [EAS 209](#), [MTH 306](#), one engineering elective

THIRD YEAR

Fall [CIE 303](#), [CIE 323](#), [CIE 327](#), [CIE 354](#), [CIE 361](#), [CIE 308](#)

Spring [CIE 324](#), [CIE 334](#), [CIE 340](#), [CIE 343](#), [CIE 362](#), one applied math elective

FOURTH YEAR

Fall [CIE 415](#), [CIE 435](#), [CIE 439](#), two civil engineering technical electives (one with design),

Spring [CIE 416](#), two civil engineering technical electives

Electives and Course Groupings

CIVIL ENGINEERING TECHNICAL ELECTIVES

Four technical electives are required (see list below).

At least one of the technical electives must be [CIE 428](#), [CIE 429](#), [CIE 430](#), [CIE 438](#), or [CIE 442](#).

Senior-level courses outside civil engineering may also be taken as technical electives with prior approval from the Director of Undergraduate Studies.

Only three credits of the informal courses ([CIE 498](#), [CIE 499](#), [EAS 396](#), and [EAS 496](#)) can be counted as a technical elective toward fulfillment of degree requirements.

[CIE 423](#) Structural Engineering III
[CIE 424](#) Computer-Aided Design in Civil Engineering
[CIE 426](#) Finite Element Structural Analysis
[CIE 428](#) Steel Design
[CIE 429](#) Reinforced Concrete Design
[CIE 430](#) Design of Wood Structures
[CIE 437](#) Pavement Design
[CIE 438](#) Advanced Foundation Design and Construction
[CIE 441](#) Ecological Engineering
[CIE 442](#) Treatment Process Engineering
[CIE 444](#) Hydrologic Engineering
[CIE 445](#) Groundwater Engineering
[CIE 447](#) Sustainability Practicum
[CIE 448](#) Chemical Principles in Environmental Engineering
[CIE 449](#) Environmental Engineering Design
[CIE 458](#) Geoenvironmental Engineering
[CIE 461](#) Air Pollution
[CIE 469](#) Hazardous Waste Management
[CIE 476](#) Design and Construction of Earth Structures
[CIE 491](#) Construction Estimating
[CIE 493](#) Project Management
[CIE 498](#) Research and Creative Activities
[CIE 499](#) Independent Study
[EAS 480](#) Technical Communication
[EAS 396](#) Engineering Career Institute (1 credit)
[EAS 496](#) Co-op (2-3 credits)

APPLIED MATH ELECTIVES

[MAE 376](#) Numerical Methods in Mechanical Engineering
[MTH 309](#) Introduction to Linear Algebra
[MTH 417](#) Multivariable Calculus
[MTH 418](#) Analytical Methods or [MAE 428](#) Analytical Methods

ENGINEERING ELECTIVES

[EE 200](#) EE Concepts/Nonmajors
[MAE 204](#) Thermodynamics
[EE 202](#) Circuit Analysis I
[IE 320](#) Engineering Economy

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Emphasis Areas

Construction Management Engineering
 Environmental Engineering
 Geotechnical Engineering
 Structural Engineering

Civil Engineering/Business Administration - B.S / M.B.A

Acceptance Criteria

Same as BS in Civil Engineering, but students must also apply to MBA program. MBA applications are due by May 1 of the third year.

Required Courses

Same as Civil Engineering except two technical electives are required instead of four, and the applied math elective is not required. In addition, the following MBA courses are required:

[MGA 603](#) Financial Accounting for Managers
[MGA 605](#) Accounting for Management Decision Making
[MGB 610](#) Organizational Behavior
[MGB 611](#) Team Skills
[MGE 604](#) Business Economics
[MGF 611](#) Financial Analysis for Managers
[MGG 601](#) Corporate Social Responsibility/Sustainability
[MGG 635](#) Management Communication
[MGM 615](#) Marketing for Managers
[MGO 620](#) Operations Management
[MGO 640](#) Business Strategy
[MGO 642](#) Integration of Business Functions
[MGO 644](#) Business Practice
[MGQ 608](#) Statistical Analysis for Managers
[MGQ 609](#) Analytics for Managers
[MGS 605](#) IT Management
 Seven MGT electives (may include internship)

Summary

Total required credit hours for the undergraduate portion...103

Total required credit hours for the BS/MBA...151

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

Refer to the School of Management's MBA handbook for requirements for MBA candidates.

Recommended Sequence of Program Requirements

FIRST YEAR

Fall [CHE 107](#), [EAS 140](#), [MTH 141](#)

Spring [EAS 202](#), [CHE 108](#), [MAE 177](#), [MTH 142](#), [PHY 107](#)

SECOND YEAR

Fall [EAS 207](#); [EAS 230](#) or [CSE 113](#); [MTH 241](#), [PHY 108/PHY 158](#)

Spring [EAS 208](#), [EAS 209](#), [MTH 306](#), one engineering elective,

THIRD YEAR

Fall [CIE 303](#), [CIE 323](#), [CIE 327](#), [CIE 354](#), [CIE 361](#), [EAS 308](#)

Spring [CIE 324](#), [CIE 334](#), [CIE 340](#), [CIE 343](#), [CIE 362](#)

FOURTH YEAR

Fall [CIE 435](#), [MGA 603](#), [MGB 610](#), [MGB 611](#), [MGF 611](#), [MGG 601](#), [MGG 635](#), [MGM 615](#), [MGQ 608](#), [MGQ 609](#)

Spring [MGA 605](#), [MGE 604](#), [MGO 620](#), [MGO 640](#), [MGS 605](#), one CIE technical elective, one MGT elective

FIFTH YEAR

Fall [CIE 415](#), [CIE 439](#), one CIE technical elective (with design), two MGT electives

Spring [CIE 416](#), [MGO 642](#), [MGO 644](#), four MGT electives

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Contact School of Management for elective options. Additional program details may be found at <http://www.eng.buffalo.edu/undergrad/academics/combined-degrees>.

Electives and Course Groupings

CIVIL ENGINEERING TECHNICAL ELECTIVES

Same as BS in Civil Engineering

CIE 101: Introduction to Civil Engineering

Credits: 1

Semester(s): Fall

Pre-requisites: Civil, Structural & Environmental Engineering

Majors Only

Type: LEC

Develops an understanding of what Civil Engineers do through presentations by invited speakers on selected contemporary topics. Serves as a beginning point of contact between freshmen and faculty in Civil Engineering and between freshmen and alumni professional engineers. Students who join civil engineering program as sophomores, junior or seniors are exempt from taking [CIE 101](#).

CIE 303: Geodesy, Gps, and GIS

Credits: 3

Semester(s): Fall, Spring

Pre-requisites: [MAE 177](#); Civil, Structural & Environmental Engineering Majors Only

Type: LEC/LAB

Introduces students to spatial concepts that are important in the planning, construction, and operation of civil engineering projects and activities. Introduces the expression of these concepts in graphical language, which is central to civil and architectural communication by first developing some basic skills in CAD. Studies concepts and principles of location and layout of points on the surface of the 3-D earth from both a historical and a modern technology perspective. Also covers the problem of converting the curved surface of the earth onto a plane map or computer screen. Reviews the use of plane concepts for local layouts, along with the circumstances under which 2-D plane concepts can be utilized. Discusses and demonstrates the technological basis for modern measurement and positioning systems, such as DME and GPS. Covers techniques used to identify and lay out land areas in the United States. Introduces GIS.

CIE 308: Engineering Statistics

Credits: 3

Pre-requisites: [MTH 241](#); Civil, Structural & Environmental Engineering Majors Only

Type: LEC/REC

Introduces statistical inference, methods of data analysis, point and interval estimation, tests of hypotheses, correlation and regression, and experiment design. Students may not receive credit for this course and [EAS 305](#).

CIE 323: Structural Engineering I

Credits: 3

Semester(s): Fall

Pre-requisites: [EAS 209](#)

Civil, Structural & Environmental Engineering Majors Only

Type: LEC/REC

First of a two-course sequence required of all civil engineering students. Basic aspects of structural analysis and design. Introduces structural engineering by an approach that unifies structural behavior, analysis, and design. Emphasizes analysis and design of determinate structures. Topics include analysis of determinate structures, determination of loadings, design criteria, and design of steel members in tension, bending, and compression.

CIE 324: Structural Engineering II

Credits: 3

Semester(s): Spring

Pre-requisites: [CIE 323](#); Civil Engineering Majors Only

Type: LEC/REC

Second of a two-course sequence on structural analysis required of all civil engineering students. Concentrates on the calculation of deflections and the analysis of statically indeterminate structures. Various methods will be presented to compute displacements, with the use of virtual work emphasized. For analysis of statically indeterminate structures, the force method of analysis (also called flexibility method) will be emphasized. Displacement-based methods will also be introduced including slope deflection method and moment distribution. Structures examined in this course will be modeled as planar trusses, beams and/or frame structures. Students will use a general purpose structural analysis program to analyze more complicated structures.

CIE 327: Civil Engineering Materials

Credits: 3

Semester(s): Fall

Pre-requisites: [EAS 209](#); Civil, Structural & Environmental Engineering Majors Only

Type: LEC/REC

Mechanical properties of materials. Crystal structure, phase equilibria, deformation behavior under various states of stress. Failure theories, composite materials, prediction of composite material properties based on properties of constituent materials, and concrete mix design. Applications of materials technology to building products and design of structural components.

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CIE 334: Soil Mechanics

Credits: 3
Semester(s): Spring
Pre-requisites: [EAS 209](#)
 Civil, Structural & Environmental Engineering Majors Only
Type: LEC/REC

Soil formation and identification. The physical and mechanical properties of granular and cohesive soils. The nature and flow of water in soils, stress distribution, consolidation, analysis of deformation and strength of soils, stress path dependent behavior and slope stability.

CIE 340: Environmental Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: Civil, Structural & Environmental Engineering and Environmental Geosciences Majors Only
Type: LEC/REC

Introduces environmental engineering systems and infrastructure. Covers fundamentals including the application of mass and energy balances and equilibrium chemistry to environmental systems. Applies these concepts to a number of important environmental topics including risk assessment, modeling of water quality systems, water and wastewater treatment facilities, air quality modeling, and municipal and hazardous solid waste management.

CIE 343: Hydraulic Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 354](#) and Civil, Structural & Environmental Engineering Majors Only
Type: LEC/REC

Application of fundamentals of fluid mechanics to design systems, including pipe/pump systems, analysis of flow in rivers, and hydrodynamic and aerodynamic forces on structures. Topics include friction losses in pipes, flow measurement, hydraulic machinery, boundary layer characteristics, drag and lift forces, energy and momentum principle in open channel, resistance in open channels, uniform flow, nonuniform flow, surface profile computation, and design of channel controls and transitions.

CIE 354: Fluid Mechanics

Credits: 3
Semester(s): Fall
Type: LEC/REC

Provides an introductory treatment of the dynamics of fluids, emphasizing incompressible fluids. Develops and applies hydrostatics, thermodynamics, fluid characteristics, kinematics, and dynamics; methods of analysis including the infinitesimal and finite control volume; stress rate-of-strain relations; and basic equations for continuity, energy, motion, and force-momentum. Measurement methods.

CIE 360: Environmental Engineering Laboratory

Credits: 2
Semester(s): Fall

Type: LAB

Laboratory testing to enhance and extend the student's understanding of the fundamental principles of fluid mechanics and environmental engineering, including modern methods of pollutant analysis. Data are collected and analyzed using statistical and numerical tools. Individual and group reports serve as vehicles for the development of technical communication skills. One 3-hour lab per week or equivalent.

CIE 361: Civil Engineering Laboratory I

Credits: 2
Semester(s): Fall
Type: LEC/LAB

Laboratory testing to enhance and extend the student's understanding of the fundamental principles of structural analysis, civil engineering materials, and fluid mechanics. One 3-hour lab per week or equivalent.

CIE 362: Civil Engineering Laboratory II

Credits: 2
Semester(s): Spring
Type: LEC/LAB

Laboratory testing to enhance and extend the student's understanding of the fundamental principles of soil mechanics, hydraulic engineering, and environmental engineering. Continuation of [CIE 361](#). One 3-hour lab per week or equivalent.

CIE 415: Professional Practice Issues

Credits: 3
Semester(s): Spring
Type: LEC

Ethical issues in civil engineering practice, the professional licensure process, the project life cycle, engineering economics fundamentals, construction contracts and delivery methods, cost estimating fundamentals, project scheduling fundamentals, project control fundamentals.

CIE 416: Civil Engineering Capstone Design

Credits: 3
Pre-requisites: [CIE 415](#)
Type: LEC

Second course of a two-course sequence. Students work in teams of four to six on a design problem that is drawn from industry. The project is introduced in [CIE 415](#). Teams compete against each other and are required to complete a preliminary design report and project presentation. Teams meet weekly in smaller groups with faculty and practicing engineers to discuss progress.

CIE 423: Structural Engineering III

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 324](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC

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Emphasizes the matrix formulation of the equations that describe the response of statically indeterminate systems, and it also provides an introduction to plastic analysis, approximate methods of analysis, and structural dynamics for seismic applications. Implements a modern approach which integrates theory and computational analysis to solve a wide-range of civil engineering structures for vertical and lateral loads.

CIE 424: Computer-Aided Design in Civil Engineering

Credits: 3
Semester(s): Spring
Type: LEC/REC

Basic principles of interactive computer graphics, computer-aided drafting, 3-D modeling, and visualization in modern CAD systems. The use of modern CAD software as a design tool in civil engineering applications. Overview of trends and futures in computer-aided design. Lecture and hands-on laboratory.

CIE 426: Finite Element Structural Analysis

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 423](#) and Civil, Structural & Environmental Engineering Majors Only
Co-requisites: Math Elective
Type: LEC

Comprehensively introduces the finite element method as applied primarily to structural analysis. Presents the foundations of finite elements by addressing the theory of elasticity, calculus of variations, and variational principles of solid mechanics. Subsequently, applies the finite element methodology to trusses, beams, membrane elements, plates, torsion, and axisymmetry. Introduces students to computer programming aspects of the finite element method. Additional topics (time permitting) are dynamics, stability, fluid flow, heat transfer, Galerkin and Ritz methods.

CIE 428: Steel Design

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 324](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC/REC

Emphasizes a theoretical understanding of fundamental concepts in analysis and design of steel structures. Focuses on building structures; topics addressed in the class include materials, probabilistic underpinnings of structural steel design, tension members, compression members, beams and beam-columns, welded and bolted connections and analysis and design of steel structures for gravity, wind, and seismic loads.

CIE 429: Reinforced Concrete Design

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 324](#) and Civil Engineering Majors Only
Type: LEC

The design of reinforced concrete members for flexure, shear and combined flexure, and axial load; anchorage and development of

reinforcement; design of connections for monolithic construction; 2-D reinforced concrete elements in shear and bending. Considers the calculation of long- and short-term deformations, as well as the problem of shrinkage; introduces the design of prestressed concrete members.

CIE 430: Design of Wood Structures

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 324](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Introduces the properties of wood and its grading process. Presents design principles for members under axial tension, column members, beams under flexure, mechanical connections, and shear walls under lateral loads.

CIE 435: Foundation Engineering

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 334](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Applies soil mechanics to engineering problems. Soil exploration and sampling. States of plastic equilibrium, bearing capacity, and settlement of foundations. Foundation design, spread footing, mat, piles, and drilled shafts. Lateral earth pressures, retaining walls, and braced excavations.

CIE 437: Pavement Design and Materials

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 334](#) and Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Design principles of flexible and rigid pavements. Includes a study of soils and paving materials, their interaction, their behavior under various loading conditions, and their ability to perform under all ambient loading conditions. Topics include surface, base, subbase and base courses: bituminous materials, quality control, and flexible and rigid pavement design methods. Laboratory sessions on asphaltic concrete mix design.

CIE 438: Advanced Foundation Design and Construction

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 435](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Site investigation, evaluation of soil parameters, and design of earth systems, retaining walls, sheet piles, tie backs, anchors, shallow foundations, including settlement and bearing capacity of shallow spread footings, mats, and deep foundations supplemented with case studies. Design of ground improvement. Geotechnical and structural design of shallow foundations, pile foundations, drilled shafts for a variety of structures. Group project involving site investigation, preliminary design, and final design report for one or

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two large-size real-world project(s).

CIE 439: Transportation System Analysis

Credits: 3
Semester(s): Fall
Type: LEC

Introduces engineering and planning principles applicable to all types of transportation systems; concept and methods of transportation network analysis; operation and management of transportation systems; traffic engineering elements; traffic flow theory; highway capacity analysis; design and application of traffic control devices.

CIE 441: Ecological Engineering

Credits: 3
Semester(s): Fall
Pre-requisites: [MTH 306](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Focuses on the physical, chemical, and hydrodynamic processes governing pollutant fate in natural systems. Topics include mass and energy balances, mixing processes, partitioning processes (exchange with solids and air), and particle removal. Examples from natural systems address lake, river, and atmospheric pollution.

CIE 442: Treatment Process Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 340](#)
Co-requisites: [CIE 343](#)
Civil, Structural & Environmental Engineering Majors Only
Type: LEC/REC

Overview of environmental engineering treatment systems analysis and design. Topics include water distribution, water treatment, wastewater collection, wastewater treatment, sludge processing, and industrial waste management.

CIE 444: Hydrologic Engineering

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 343](#)
Co-requisites: [CIE 308](#)
Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Studies the physical processes associated with the components of the hydrologic cycle. Discusses measurement and collection of data. Explores model conceptualization and data analysis for quantification of water flow for design purposes. Emphasizes analysis procedures for surface and ground water hydrology useful for design of urban facilities. Discusses and applies hydrologic design methods to engineering projects. Emphasizes watershed management concepts.

CIE 445: Groundwater Engineering

Credits: 3

Semester(s): Spring
Pre-requisites: [CIE 354](#) and Civil, Structural & Environmental Engineering and Geology Majors Only
Type: LEC

Fundamentals of fluid flow and mass transport in porous media. Derives the governing mass and energy balance equations and develops several commonly applied solutions. Particular topics include groundwater flow under saturated and unsaturated conditions, well hydraulics, introduction to multiphase flow, fundamentals of solute transport, geostatistics, and remediation of contaminated aquifers.

CIE 446: Water Resources Engineering

Credits: 3
Semester(s): Spring
Type: LEC

Studies and applies modeling, computational analysis, and design procedures for the design of water resources projects. Design projects include stream quality and stream flow, including bridge openings and floodway determination, wastewater collection, and wastewater treatment. Relates the treatment design projects to wastewater stabilization ponds and wastewater treatment plants. Emphasizes watershed management concepts.

CIE 447: Sustainability Practicum

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 340](#) and [CIE 343](#); Civil, Structural & Environmental Engineering Majors Only
Type: LAB

Engineering policy dimensions of sustainability. Topics include: (1) definitions and concepts of "sustainability," (2) introduction to climate change science and policy, and (3) relevant analytical tools such as life cycle assessment and carbon footprint analysis. Student teams will conduct studies that integrate environmental, economic, and social concerns in an engineering context, with a strong emphasis on oral and written communications.

CIE 448: Chemical Principles in Environmental Engineering

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 340](#) and [CIE 343](#); Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Presents fundamentals in aquatic chemistry as applied to natural waters, water treatment, and wastewater treatment. Topics include equilibrium concepts, chemical thermodynamics, acid-base reactions, precipitation and dissolution, oxidation and reduction, carbonate system chemistry, and complexation.

CIE 449: Environmental Engineering Design

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 444](#) and [CIE 415](#)
Co-requisites: [CIE 442](#)
Civil, Structural & Environmental Engineering Majors Only
Type: LEC

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Design of environmental engineering systems, such as water-distribution networks; storm and wastewater collection systems; treatment systems for air, water, and wastewater; and hazardous waste site remediation. This is a professional practice-oriented course and includes process engineering principles, system analysis and design, regulations, economics, guest lectures, and field trips. Students work in design teams and produce written and oral reports for a major design project.

CIE 458: Introduction to Geoenvironmental Engineering

Credits: 3
Semester(s): Fall
Pre-requisites: [CIE 334](#)
Type: LEC

Soil-water-contaminant interaction processes, conduction phenomena, hydraulic conductivity and contaminant transport phenomena, effects of contaminants on soil properties, design aspects of landfills, waste-disposal systems, barriers and cutoff walls, site characterization, and soil remediation.

CIE 460: Special Topics

Credits: 1-4
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Offered irregularly. The subject matter of the course is announced when offered.

CIE 461: Air Pollution

Credits: 3
Semester(s): Spring
Type: LEC/LAB

Introduces the fundamental aspects of the science and technologies associated with air pollution. Topics include: atmospheric chemistry and basic chemical kinetics; photochemical reactions in the atmosphere; aerosol physics and chemistry; sources of outdoor and indoor air pollution; climatic effects; pollution reduction technologies; gas phase and aerosol measurement and analytical techniques; health effects; atmospheric meteorology; and plume dispersion and transport models.

CIE 462: Special Topics in Structural Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 324](#)
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Develops experience and expertise in the application of structural engineering fundamentals to design of civil engineering projects. Specific technique/problem areas are announced when offered. Requires students to complete homework assignments and hour tests, and they are graded on both. May require an in-depth design exercise.

CIE 463: Special Topics in Water Resources Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 343](#)
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Develops experience and expertise in the application of fundamentals of water resources engineering to design civil engineering projects. Specific technique/problem areas are announced when offered. Requires students to complete homework assignments and hour tests, and they are graded on both. May require an in-depth design exercise.

CIE 464: Special Topics in Environmental Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 340](#) and [CIE 343](#)
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Develops experience and expertise in the application of fundamentals of environmental engineering to design of civil engineering projects. Specific technique/problem areas are announced when offered. Requires students to complete homework assignments and hour tests, and they are graded on both. May require an in-depth design exercise.

CIE 465: Special Topics in Geotechnical Engineering

Credits: 3
Semester(s): Spring
Pre-requisites: [CIE 435](#)
Type: LEC

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Develops experience and expertise in the application of fundamentals of geotechnical engineering to design of civil engineering projects. Specific technique/problem areas are announced when offered. Requires students to complete homework assignments and hour tests, and they are graded on both. May require an in-depth design exercise.

CIE 469: Hazardous Waste Management

Credits: 3
Semester(s): Fall
Type: LEC

Waste management continues to be a major global challenge for environmental engineers and other stakeholders. Technical, regulatory and societal aspects of Hazardous and Solid Waste Management are addressed. Topics related to Hazardous Waste include: (1) evolution of current laws dealing with hazardous waste disposal and cleanup; (2) investigation and remediation contaminated sites; and (3) environmental fate and transport of

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hazardous chemicals. Solid Waste topics include (1) social, economic and political forces that influence the waste management industry; (2) current laws governing solid waste management; and (3) emerging concepts, including Integrated Solid Waste Management, Materials Management, and Life Cycle Analysis. For both focus areas, a strong emphasis is placed on communication of technical issues to the public.

CIE 476: Design and Construction of Earth Structures

Credits: 3
Semester(s): Spring
Type: LEC

Selection, engineering design, construction, monitoring, and performance evaluation of earth structures. Densification: soft ground consolidation, deep dynamic compaction; reinforcement: earth-retaining systems, soil nailing, reinforced earth, micropiles; ground improvement by admixtures: grouting, soil mixing techniques.

CIE 491: Construction Estimating

Credits: 3
Semester(s): Fall
Pre-requisites: Senior Standing
Civil, Structural & Environmental Engineering Majors Only
Type: LEC

Estimation of construction costs. Topics include project life cycle, financial considerations, order-of-magnitude estimates, the project acquisition decision, material/labor and equipment costs, overhead and profit consideration, building systems estimates, uncertainty, the bidding process, value engineering, and cost control.

CIE 493: Project Management

Credits: 3
Semester(s): Spring
Type: LEC

Life cycle planning of construction projects; contract types, project delivery strategies; bid packaging, bid evaluation, and selection of contractors; preconstruction planning; contract administration procedures; project quality control; value engineering and management; project site layout; and materials management.

CIE 498: Undergraduate Research and Creative Activity

Credits: 1-3
Semester(s): Fall, Spring
Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Students collaborate with faculty research mentors on an ongoing project in a faculty member's laboratory or conduct independent research under the guidance of a faculty member. This experience provides students with an inquiry based learning opportunity and engages them as active learners in a research setting.

CIE 499: Independent Study

Credits: 1-12
Type: TUT

The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.

Students electing this course should be accepted for work on a special topic by a member of the teaching staff. Special forms are available in the department office.