

CIVIL ENGINEERING AND CONSTRUCTION ENGINEERING MANAGEMENT

College of Engineering

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Students desiring detailed information about Civil Engineering or Construction Management programs should contact the department office for referral to one of the faculty advisors.

Career Possibilities

Civil Engineer • Traffic Engineer • Sanitary Engineer • Structural Engineer • Hydraulic Engineer • Highway Administration Engineer • Harbor Engineer • Airport Engineer • Environmental Engineer • Transportation Engineer • Drainage Design Coordinator • Technical Sales and Consulting • Field Engineer • Facilities Engineer • Plant Engineer • Project Engineer • Safety Engineer • Sales Representative • Estimator • Construction Coordinator • Procurement Construction Coordinator • Construction Inspector • Cost Analysis Coordinator • Contract Coordinator • Consultant (Some of these, and other careers, require additional education or experience. For more information, see www.careers.csulb.edu.)

Advisory and Development Councils

The Civil Engineering Advisory and Development Council

This council consists of outstanding engineers and executives from industry and government in Southern California. Its function is to form a liaison between the University and industry and to keep the administration and faculty informed of modern engineering practices. This ensures that the curricula are kept up-to-date. It also advises on placement opportunities before and after graduation.

Construction Management Advisory and Development Council

This council provides current information and guidance about industrial developments in methods, materials and techniques. Members make recommendations in course content, methods and/or facilities. Present membership in the council is made up of representatives from the different sectors of the construction industry.

ABET Accreditation

The Bachelor of Science in Civil Engineering is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

ACCE Accreditation

The Bachelor of Science in Construction Management is accredited by the American Council for Construction Education (ACCE), website: <http://www.acce-hq.org/>.

Undergraduate Programs

Bachelor of Science in Civil Engineering (120 units)

Mission

The mission of the Civil Engineering Program is to prepare students to succeed in the civil engineering profession by providing them with essential technical tools and skills and to promote the need for lifelong learning.

Educational Objectives

The Civil Engineering Program Educational Objectives are to produce graduates, who after entering the civil engineering practice will:

1. Apply knowledge of fundamental science and engineering principles and design to the solution of complex engineering projects.
2. Pursue lifelong learning through continuing education and/or advanced degrees in civil engineering or other related fields.
3. Progress to professional registration and continue to develop professionally.
4. Progress to leadership or management in engineering.

Major Declaration

Freshmen admission to engineering majors is to a 'pre-major' status (i.e., Pre-Civil Engineering). Continuation in the major will be subject to meeting specific lower division course and GPA requirements at CSULB that indicate the student's ability to succeed and complete the major. Transfer applicants and CSULB students seeking admission into Civil Engineering must also meet similar major specific requirements. To become fully admitted into the Civil Engineering major, all prospective students (i.e., pre-majors, undeclared, major changes) must have a minimum cumulative 2.5 GPA and complete the following lower-division courses with a minimum grade of "C" prior to earning 60 units:

Core Lower Division Major Requirements:

MATH 122 (Calculus I), MATH 123 (Calculus II), PHYS 151 (Mechanics and Heat)

General Education Foundations Courses:

Written and Oral Communication

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 122 within one calendar year.

Transfer Students: A grade of "C" or better must be achieved in MATH 123 and PHYS 151 within one calendar year.

Requirements

Lower Division:

Take all of the following:

CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination.

Corequisite: MATH 109 or higher.

CE 101 Introduction to Civil Engineering and Construction Engineering Management (1)

Prerequisites: None.

CE 130 Surveying and Mapping (1)

Corequisites: CE 130L and MAE 172 or CEM 121.

CE 130L Surveying and Mapping Laboratory (1)

Corequisite: CE 130.

CE 200 Materials for Civil Engineering (1)

Prerequisites: CHEM 111A and PHYS 151 all with a grade of "C" or better; consent of department undergraduate advisor.

Corequisite: CE 200L

CE 200L Materials for Civil Engineering Lab (1)

Prerequisites: CHEM 111A and PHYS 151 all with a grade of "C" or better and consent of department undergraduate advisor.

Co-requisite: CE 200.

CE 205 Analytical Mechanics I (Statics) (3)

Prerequisite: PHYS 151 with a grade of "C" or better.

Prerequisite/Corequisite: MATH 123.

CE 206 Computer Programming and CE

Applications I (1)

Prerequisites: MATH 122, PHYS 151 all with a grade of "C" or better.

Corequisite: CE 206L

CE 206L Computer Programming and CE Applications I Lab (1)

Prerequisites: MATH 122, PHYS 151

Corequisite: CE 206

ENGR 101 Intro to the Engineering Profession (1)

Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)

Prerequisite: ENGR 101 with a grade of "C" or better.

MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

MATH 123 Calculus II (4)

Prerequisite: A grade of "C" or better in MATH 122.

MATH 224 Calculus III (4)

Prerequisite: A grade of "C" or better in MATH 123 or MATH 222.

MAE 172 Engineering Design Graphics (2)

Prerequisites: None.

PHYS 151 Mechanics and Heat (4)

Prerequisite/Corequisite: MATH 122.

Take one of the following:

BIOL 200 General Biology (4)

Prerequisite: GE Foundation requirements.

BIOL 201 Microbiology for Health Professionals (4)

Prerequisites: CHEM 111A or CHEM 140 with a grade of "C" or better and GE Foundation requirements.

Take 4 units of the following:

EE 210 Electro-Magnetic Foundations in EE (3)

Prerequisite: PHYS 151 with a grade of "C" or better.

Corequisites: MATH 123, EE 210L.

EE 210L Electro-Magnetic Foundations in EE Lab (1)

Corequisite: EE 210.

PHYS 152 Electricity and Magnetism (4)

Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:

Take all of the following:

CE 307 Probability & Statistics in Civil Engineering (2)

Prerequisites: CE 206

CE 325 Transportation Safety and Sustainability (3)

Prerequisites: GE Foundation requirements.

CE 335 Fluid Mechanics (3)

Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.

CE 345 Geotechnical Engineering I (3)

Prerequisite: Consent of Department Undergraduate Advisor.

Corequisites: MAE 373; GEOL 370.

CE 346 Geotechnical Engineering Laboratory (1)

Prerequisite: ENGL 100 or GE Composition (Area A1) with a grade of "C" or better.

Corequisite: CE 345.

CE 359 Structural Analysis I (3)

Prerequisite: MAE 373 with a grade of "C" or better.

CE 364 Environmental Engineering (3)

Prerequisites: CHEM 111A, BIOL 200/BIOL 201 or MICR 200 with a grade of "C" or better.

Prerequisite/Corequisite: CE 335.

CE 406 Project Cost-Benefit Analysis (3)

Prerequisite: GE Foundation requirements.

CE 426 Transportation Engineering (3)

Prerequisite: CE 345 with a grade of "C" or better.

Corequisite: CE 406.

CE 437 Engineering Hydraulics (3)

Prerequisites: C E 335, MATH 370A all with a grade of "C" or better.

CE 459 Reinforced Concrete Design I (3)

Prerequisites: C E 200 and 359 all with a grade of "C" or better.

CE 481 Professional Practice in Civil Engineering (1)

Prerequisite: Senior standing.

CE 490 Senior Design Project (3)

Prerequisite(s): CE 459; completion of all 300-level engineering courses for the civil engineering major all with a grade of "C" or better and consent of department undergraduate advisor.

Prerequisite(s)/Corequisite(s): CE 426, CE 437.

GEOL 370 Geology for Engineers (2)

Prerequisites: CE 200.

MATH 370A Applied Mathematics I (3)

Prerequisites: A grade of "C" or better in MATH 123. Not open to Freshmen.

MAE 330 Engineering Thermodynamics I (3)

Prerequisites: MATH 224, PHYS 151 or equivalent, and CHEM 111A all with a grade of "C" or better or consent of instructor.

MAE 371 Analytical Mechanics II (Dynamics) (3)

Prerequisites: CE 205, MAE 205, or CE 206 and 206L all with a grade of "C" or better.

MAE 373 Mechanics of Deformable Bodies (3)

Prerequisite: CE 205 with a grade of "C" or better.

Take six units of elective courses from:

CE 427/427L, CE 428/428L, CE 429/429L, CE 435, CE 438/438L, CE 439, CE 445, CE 446, CE 455, CE 456, CE 458, CE 464, CE 466, CE 495

Take two laboratories from:

CE 326, CE 336, CE 365, CE 454, MAE 374

A grade of "C" or better must be achieved in the required courses below:

CHEM 111A, MATH 122, MATH 123, MATH 224, MATH 370A, BIOL 200, BIOL 201, PHYS 151, MAE 172, MAE 373, CE 130, CE 130L, CE 200, CE 205, CE 206, CE 325, CE 335, CE 345, CE 359, CE 406, CE 459 and CE 490.

Bachelor of Science in Construction Management (120 units)

Mission

The Mission of the Construction Management program is to educate and prepare students to succeed in the construction management profession by providing them with essential technical, managerial and communication skills and tools which will enable them to perform current and future construction management tasks and to promote the need for life-long learning.

Educational Objectives

The Construction Management program educational objectives are to produce graduates, who after entering the construction management practice with a knowledge of fundamental construction management principles and current technologies, communication skills and practical construction experience, will:

1. Provide substantial contributions to the construction industry.
2. Pursue life-long learning through continuing education and/or advanced degrees in construction management or other related fields.
3. Continue to develop professionally through participation in professional organizations and/or participation in professional development activities in the industry.
4. Progress towards professional certifications.

Major Declaration

Freshmen admission to engineering majors is to a 'pre-major' status (i.e., Pre-Construction Management). Continuation in the major will be subject to meeting specific lower division course and GPA requirements at CSULB that indicate the student's ability to succeed and complete the major. Transfer applicants and CSULB students seeking admission into Construction Management must also meet similar major specific requirements. To become fully admitted into the Construction Management major, all prospective students (i.e., pre-majors, undeclared, major changes) must

have a minimum cumulative 2.5 GPA and complete the following lower-division courses with a minimum grade of "C" prior to earning 60 units:

Core Lower-Division Major Requirements:

MATH 122 (Calculus I), PHYS 100A (General Physics)

General Education Foundations Courses:

Written and Oral Communication

Degree Progress

Students must complete the following requirements within one calendar year of declaring the major. Some students may need to take courses during Summer Session to meet these requirements. At the end of the year, students who have not met the requirements must either declare another major or meet with an Academic Advisor to determine if the student's performance in the courses merits an additional semester to complete.

First-Time Freshmen: A grade of "C" or better must be achieved in MATH 111 and MATH 113, and PHYS 100A within one calendar year.

Transfer Students: A grade "C" or better must be achieved in MATH 122 and PHYS 100A & B within one calendar year.

Requirements

Lower Division:

Take all of the following:

CE 101 Introduction to Civil Engineering and Construction Engineering Management (1)

Prerequisites: None.

CE 130 Surveying and Mapping (1)

Corequisites: CE 130L and MAE 172 or CEM 121.

CE 130L Surveying and Mapping Laboratory (1)

Corequisite: CE 130.

ENGR 101 Intro to the Engineering Profession (1)

Prerequisite/Corequisite: MATH 111 or MATH 113 or MATH 122.

ENGR 102 Academic Success Skills (1)

Prerequisite: ENGR 101 with a grade of "C" or better.

MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and MATH 113.

PHYS 100A General Physics (4)

Prerequisite: MATH 109 or MATH 113 or MATH 119A or MATH 120 or MATH 122.

PHYS 100B General Physics (4)

Prerequisite: PHYS 100A.

CEM 121 Construction Drawing I (2)

Prerequisites: None.

CEM 125 Fundamentals of Construction (3)

Prerequisites: None.

CEM 200 Concrete Construction (1)

Prerequisite: CEM 125 with a grade of "C" or better.
Corequisite: CEM 200L.

CEM 200L Concrete Construction Laboratory (1)

Corequisite: CEM 200.

CEM 202 Probability and Statistics for CEM (2)

Prerequisite: High School Algebra.

CEM 204 Applied Mechanics-Statics (3)

Prerequisites: MATH 122 and PHYS 100A all with a grade of "C" or better.

CEM 225 Residential and Light Commercial Construction Practices and Estimating (3)

Prerequisites: CEM 121, CEM 125 all with a grade of "C" or better. Corequisites: CEM 200, CEM 200L.

Take one of the following:

BLAW 220 Introduction of Law and Business

Transactions (3)

Prerequisites: None

BLAW 320 Legal and Regulatory Environment of Business (3)

Prerequisites: None

Take one of the following:

CEM 201 Cost Accounting for Construction

Engineering (3)

Prerequisites: None.

ACCT 201 Elementary Financial Accounting (3)

Prerequisites: None.

Upper Division:

Take all of the following:

CE 406 Project Cost-Benefit Analysis (3)

Prerequisite: GE Foundation requirements.

CEM 304 Applied Mechanics Strength of Materials (2)

Prerequisite: CEM 204 with a grade of "C" or better.

CEM 315 Construction Safety (2)

Prerequisite: CEM 225 or CE 200 with a grade of "C" or better.

CEM 324 Commercial, Institutional, and Industrial Construction Practices and Estimating (3)

Prerequisites: CEM 315 with a grade of "C" or better.

CEM 335 Soil Mechanics Technology (2)

Prerequisite: CEM 304 with a grade of "C" or better. Corequisite: CEM 335L.

CEM 335L Soil Mechanics Technology Laboratory (1)

Prerequisite: CEM 304 with a grade of "C" or better. Corequisite: CEM 335.

CEM 365 Mechanical Equipment for Buildings (2)

Prerequisite: PHYS 100B with a grade of "C" or better. Corequisite: CEM 324.

CEM 375 Electrical Equipment Buildings (2)

Prerequisites: CEM 324, PHYS 100B all with a grade of "C" or better.

CEM 404 Structural Design I (2)

Prerequisite: CEM 304 with a grade of "C" or better.

CEM 421 Construction Planning and Scheduling (3)

Prerequisite: CEM 324 with a grade of "C" or better.

CEM 425 Earthwork and Civil Works Construction Practices (2)

Prerequisite: CEM 324, CE 406 with a grade of "C" or better.

CEM 426 Business and Construction Law (3)

Prerequisites: CEM 324; BLAW 220 with a grade of "C" or better.

CEM 429 Advanced Estimating and Bidding (3)

Prerequisite: CEM 315 with a grade of "C" or better. Corequisite: CEM 425.

CEM 431 Construction Cost Control (3)

Prerequisites: CE 406 and CEM 421 with a grade of "C" or better.

CEM 438 Structural Design II (2)

Prerequisite: CEM 304 with a grade of "C" or better.

CEM 490 Construction Project Management (3)

Prerequisites: CEM 426, CEM 429 and CEM 431 with a grade of "C" or better.

ECON 300 Fundamentals of Economics (3)

Prerequisites: GE Foundation requirements.

MGMT 300 Principles of Management & Operations

(3)

Recommended: IS 310.

CBA 300 International Business (3)

Prerequisites: None

Take one of the following:

MGMT 413 Managing Quality for Productivity (3)

Prerequisites: MGMT 300, IS 301.

Recommended: IS 310.

HRM 361 The Human Resource Function (3)

Prerequisites: None.

Upper Division Electives:

Take six units of electives in consultation with an advisor:

1. Design-build Emphasis: CEM 373, CEM 409, CEM 443, CEM 485

2. Facility Management Emphasis: CEM 409, CEM 432, CEM 433, CEM 434, CEM 436, CEM 485

3. Heavy Construction Emphasis: CEM 409, CEM 476, CEM 485, CEM 486.

A grade of "C" or better must be achieved in all required courses listed below:

PHYS 100A and B, MATH 122, CEM 121, CEM 125, CEM 200, CEM 200L, CEM 204, CEM 225, CEM 304, CEM 315, CEM 324, CEM 421, CEM 429, CEM 431, CEM 490; CE 130, CE 130L, CE 406, MGMT 300; ACCT 201; BLAW 220 or BLAW 320.

Fieldwork Requirements

Fieldwork experience is required for the BS in Construction Management, consisting of no less than three months full-time (or equivalent part-time) of employment in an approved industry or governmental agency. The student must hold a position equivalent to a technician or higher which affords the opportunity to exercise responsibility usually given to those who have completed two years of college. The fieldwork must be completed prior to graduation, be certified and approved by the faculty of the department.

GRADUATE PROGRAMS

Master of Science in Civil Engineering

Mission

The mission of the civil engineering graduate program at CSULB is to provide a high-quality educational experience and the technical specialization required to become successful leaders in industry and the society, to engage students in innovative practical research and encourage them to pursue advanced degrees and lifelong learning.

Program Objectives

Graduates of the MSCE program will:

1. have technical competency in an area of specialization.
2. have technical knowledge and skills needed to conduct independent and/or innovative research.
3. keep current with state of the art technologies and advancements in a specialized technical area.

Prerequisites

1. A bachelor's degree in an ABET accredited curriculum in civil engineering or a closely related engineering degree with a minimum GPA of 2.8, with the requirement that essential undergraduate prerequisites in civil engineering are satisfied;
2. The general Graduate Record Examination (GRE) is required and appropriate level of competency will be determined by the Department.
3. Graduate students must consult with the graduate advisor for information concerning procedures and requirements for appropriate approval of their courses of study prior to enrolling in their graduate programs.
4. The Graduation Writing Assessment Requirement (GWAR) must be met during the first semester in residence. Failure to attempt to fulfill the GWAR during the first semester will prevent registration in engineering courses in subsequent semesters.

Advancement to Candidacy

1. Removal of all undergraduate deficiencies as determined by the Department Graduate Studies Committee;
2. Completion of at least 12 graduate units at CSULB; minimum GPA of 3.0; currently enrolled;
3. Fulfillment of the Graduation Writing Assessment Requirement (GWAR).

Requirements

1. Completion of 30 units of graduate coursework as follows:
 - a. Twelve units of courses in one of the following areas of specialization: construction management, structural engineering, environmental/water resources engineering and geotechnical/transportation engineering.
 - b. Six units of department approved courses with mathematical content;
 - c. Twelve units of elective courses from the following options:
 - Thesis Option: Complete CE 698 and two elective courses from the approved graduate courses in Civil Engineering.
 - Comprehensive Exam Option: Complete CE 697 and three elective courses from the approved graduate courses in Civil Engineering, and successfully complete the Comprehensive Exam on coursework in the student's program.

Civil Engineering Courses (C E)

LOWER DIVISION

101. Introduction to Civil Engineering and Construction Engineering Management (1)

Civil engineering and construction management as a profession. Current trends and challenges, ethical, social and environmental issues in professional practice. Professional organizations and licensure. Communication and lifelong learning skills for professional practice.

Letter grade only (A-F). (Lecture-problems 1 hour)

130. Surveying and Mapping (1)

Corequisites: CE 130L and MAE 172 or CEM 121.

Theory and practice of plane surveying, including the use of instruments for measuring distances, angles, and elevations. Plotting of surveying data and topographic mapping. Fundamentals of construction layout. Integration of data with surveying software.

Letter grade only (A-F). (Lecture-Problems 1 hour)

130L. Surveying and Mapping Laboratory (1)

Corequisite: CE 130.

Fundamentals of surveying methods as applied to construction layout. Use of level and total station for location and control of structures, vertical and horizontal control, and area determination.

Letter grade only (A-F). Not open for credit to students with credit in CE 131. (Laboratory 3 hours)

200. Materials for Civil Engineering (1)

Prerequisites: CHEM 111A and PHYS 151 all with a grade of "C" or better and consent of department undergraduate advisor.

Corequisite: CE 200L

Basic properties of materials in civil engineering, including concrete, masonry, steel, wood, asphalt and composites.

Letter grade only (A-F). (Lecture 1 hour)

200L. Materials for Civil Engineering Laboratory (1)

Prerequisites: CHEM 111A and PHYS 151 all with a grade of "C" or better and consent of department undergraduate advisor.

Co-requisite: CE 200.

Laboratory testing of basic properties of materials in civil engineering, including concrete, masonry, steel, wood, asphalt and composites.

Letter grade only (A-F). (Laboratory 3 hours)

205. Analytical Mechanics I (Statics) (3)

Prerequisite: PHYS 151 with a grade of "C" or better.

Prerequisite/Corequisite: MATH 123.

Application of the mechanics of equilibrium to force systems using analytical and graphical solutions of problems involving structures and machines.

Letter grade only (A-F). (Lecture 2 hours, Activity 2 hours). Same course as CE 205H. Not open for credit to students with credit in CE 205H.

205H. Analytical Mechanics I (Statics) (3)

Prerequisite: PHYS 151 with a grade of "C" or better.

Prerequisite/Corequisite: MATH 123.

Application of the mechanics of equilibrium to force systems using analytical and graphical solutions of problems involving structures and machines.

Letter grade only (A-F). CE 205H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 205. (Lecture 2 hours, Activity 2 hours)

206. Computer Programming and Civil Engineering Applications I (1)

Prerequisites: MATH 122, PHYS 151 all with a grade of "C" or better.

Corequisite: CE 206L

Introduction to programming and application of computers to elementary civil engineering problems.

Letter grade only (A-F). (Lecture-Problems 1 hour)

206L. Computer Programming and Civil Engineering Applications Laboratory (1)

Prerequisites: MATH 122, PHYS 151 all with a grade of "C" or better.

Corequisite: CE 206

Hands-on application of computers and programming to elementary civil engineering problems.

Letter grade only (A-F). (Laboratory 3 hours)

UPPER DIVISION

307. Probability and Statistics in Civil Engineering (2)

Prerequisites: CE 206

Analysis of uncertainties, and applications of the basic theories of probability and statistics in civil engineering areas of geotechnical, environmental, water resources, structural and transportation engineering.

Letter grade only (A-F). (Lecture-problems 1 hour, Lab 3 hrs)

325. Transportation Safety and Sustainability (3)

Prerequisites: Completion of GE Foundation Requirements

Introduction to transportation systems and various modes of transportation: land, air, and water; legislations affecting transportation practices; transportation safety; impacts of transportation on the environment; sustainable transportation: transit, bicycles, and pedestrians. (Lecture-Problems 3 hours).

Letter grade only (A-F).

326. GIS Laboratory for Civil Engineers (1)

Prerequisites: CE 130, CE 130L, CE 206 all with a grade of "C" or better.

Fundamentals of geographic information systems (GIS); spatial and network analyses. Hands-on application of GIS software to solve civil engineering problems.

(Laboratory 3 hours) Letter grade only (A-F).

335. Fluid Mechanics (3)

Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.

Properties of fluids, fluid statics, fluid dynamics, dynamic similitude, flow of compressible and incompressible fluids in closed conduits.

Letter grade only (A-F). (Lecture-Problems 3 hours). Same course as CE 335H. Not open for credit to students with credit in CE 335H.

335H. Fluid Mechanics (3)

Prerequisites: MATH 224 and C E 205 all with a grade of "C" or better.

Properties of fluids, fluid statics, fluid dynamics, dynamic similitude, flow of compressible and incompressible fluids in closed conduits.

Letter grade only (A-F). CE 335H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 335. (Lecture-problems 3 hours)

336. Fluid Mechanics Laboratory (1)

Prerequisite: ENGL 100 or GE Composition (Area A1) all with a grade of "C" or better.

Prerequisite/Corequisite: CE 335.

Experiments in and study of the phenomena of fluid flow.

Letter grade only (A-F). (Laboratory 3 hours)

345. Geotechnical Engineering I (3)

Corequisites: MAE 373; GEOL 370.

Prerequisite: Consent of Department Undergraduate Advisor.

Soil mechanics applied to engineering structures. Soil exploration, identification, classification, drainage, stability and bearing capacity.

Letter grade only (A-F). (Lecture-Problems 3 hours). Same course as CE 359H. Not open for credit to students with credit in CE 359H.

345H. Geotechnical Engineering I (3)

Corequisites: MAE 373; GEOL 370.

Prerequisite: Consent of Department Undergraduate Advisor.

Soil mechanics applied to engineering structures. Soil exploration, identification, classification, drainage, stability and bearing capacity.

Letter grade only (A-F). CE 345H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 345. (Lecture-problems 3 hours)

346. Geotechnical Engineering Laboratory (1)

Prerequisite: ENGL 100 or GE Composition (Area A1) all with a grade of "C" or better.

Corequisite: CE 345.

Laboratory investigation and experiments in the phenomena of soil mechanics.

Letter grade only (A-F). (Laboratory 3 hours)

359. Structural Analysis I (3)

Prerequisite: MAE 373 with a grade of "C" or better.

Analysis of structures including trusses, beams, and frames, conjugate beam, virtual work, energy methods, approximate methods, and influence lines. Use of code based finite element computer programs in analysis of frame and truss type structures.

Letter grade only (A-F). (Lecture-Problems 3 hours). Same course as CE 359H. Not open for credit to students with credit in CE 359H.

359H. Structural Analysis I (3)

Prerequisite: MAE 373 with a grade of "C" or better.

Analysis of structures including trusses, beams, and frames, conjugate beam, virtual work, energy methods, approximate methods, and influence lines. Use of code based finite element computer programs in analysis of frame and truss type structures.

Letter grade only (A-F). CE 359H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 359. (Lecture-problems 3 hours)

364. Environmental Engineering I: Fundamentals (3)

Prerequisites: CHEM 111A, BIOL 200/BIOL 201 or MICR 200 all with a grade of "C" or better.

Prerequisite/Corequisite: CE 335.

Introduction to the fundamental physical, chemical and biological processes affecting air and water quality. Models of transport and transformation of impurities. Emphasis on theory underlying the design of water quality control technologies.

Letter grade only (A-F). (Lecture-Problems 3 hours). Same course as CE 364H. Not open for credit to students with credit in CE 364H.

364H. Environmental Engineering I: Fundamentals (3)

Prerequisites: CHEM 111A, BIOL 200/MICR 200 all with a grade of "C" or better.

Prerequisite/Corequisite: CE 335.

Introduction to the fundamental physical, chemical and biological processes affecting air and water quality. Models of transport and transformation of impurities. Emphasis on theory underlying the design of water quality control technologies.

Letter grade only (A-F). CE 364H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 364. (Lecture-problems 3 hours)

365. Environmental Engineering Laboratory (1)

Prerequisite/Corequisite: CE 364.

Experiments in routine water quality analysis and environmental engineering applications.

Letter grade only (A-F). (Laboratory 3 hours)

370. Analytical Mechanics (3)

Prerequisites: PHYS 151 with a grade of "C" or better.

Prerequisite/Corequisite: MATH 123.

Fundamental principles of statics, kinematics and kinetics, with application to idealized structures and systems.

Intended for Electrical Engineering majors. Not open for credit to Civil or Mechanical Engineering majors. Letter grade only (A-F). (Lecture-Problems 3 hours)

404. Laboratory Techniques (1)

Prerequisites: ENGL 100 or GE Composition (Area A1) with a grade of "C" or better., senior standing in Civil Engineering and consent of instructor.

Study in the techniques of organizing and directing of the civil engineering laboratory.

May be repeated to maximum of 3 units. Letter grade only (A-F). (Conference 1 hour, Laboratory 3 hours)

405. Selected Topics in Civil Engineering (3)

Prerequisites: Senior standing in civil engineering and consent of instructor.

Selected topics from recent advances in civil engineering. Course content will vary from year to year.

Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in *Schedule of Classes*. (Lecture-Problems 3 hours)

406. Project Cost-Benefit Analysis (3)

Prerequisite: GE Foundation requirements.

Systematic evaluation of the economic and social benefits and costs of projects. Decision-making in an environment of limited resources, environmental and economic constraints, and uncertainty. The economy of multi-year projects, selection among competing independent alternatives, before and after tax analyses, replacement economy and inflation.

Letter grade only (A-F). (Lecture-Problems 3 hours). Same course as CE 406H. Not open for credit to students with credit in CE 406H.

406H. Project Cost-Benefit Analysis (3)

Prerequisite: GE Foundation requirements.

Systematic evaluation of the economic and social benefits and costs of projects. Decision-making in an environment of limited resources, environmental and economic constraints, and uncertainty. The economy of multi-year projects, selection among competing independent alternatives, before and after tax analyses, replacement economy and inflation.

Letter grade only (A-F). CE 406H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 406. (Lecture-Problems 3 hours)

408. Special Problems (1-3)

Prerequisite: Senior standing in civil engineering.

Assigned topics in technical literature or laboratory projects and report on same.

Letter grade only (A-F).

426. Transportation Engineering (3)

Prerequisite: CE 345 with a grade of "C" or better.

Corequisite: CE 406.

Integrative learning course on transportation engineering.

Characteristics of driver, pedestrian, vehicle, and road; traffic flow; intersection design and control, planning, and geometric design;

safety issues. Team project, oral presentations, and written reports required.

Letter grade only (A-F). (Lecture-Discussion 3 hours). Same course as CE 426H. Not open for credit to students with credit in CE 426H.

426H. Transportation Engineering (3)

Prerequisite: CE 345 with a grade of "C" or better.

Corequisite: CE 406.

Integrative learning course on transportation engineering.

Characteristics of driver, pedestrian, vehicle, and road; traffic flow; intersection design and control, planning, and geometric design; safety issues. Team project, oral presentations, and written reports required.

Letter grade only (A-F). CE 426H is open only to students in the Engineering Honors Program. Additional assignments/projects adding depth to the course materials required for Engineering Honors students. Not open for credit to students with credit in CE 426. (Lecture-Discussion 3 hours)

427. Highway Design (2)

Prerequisite: CE 345 with a grade of "C" or better.

Corequisite: CE 427L

Geometric design of highways and streets. Route location and earthwork computation. Introduction to roadside and pavement design. Design problems in highway engineering.

Letter grade only (A-F). (Lecture-Problems 3 hours)

427L. Highway Design Laboratory (1)

Co-requisite: CE 427.

Geometric highway design project, horizontal alignment, vertical alignment, cross section, earthwork calculation, environmental impact, use of software application.

Letter grade only (A-F). (Laboratory 3 hours)

428. Highway Engineering Materials (2)

Prerequisites: CE 200 and CE 345 all with a grade of "C" or better.

Corequisite: CE 428L

Design and properties of highway materials, including aggregates, asphalt binder, and mixtures. Hot Mix Asphalt (HMA) aggregate gradation, blending procedure, volumetrics, design, plant operation, and lay down. Superpave binder testing and specifications.

(Lecture 2 hours) Letter grade only (A-F).

428L. Highway Engineering Materials Laboratory (1)

Co-requisite: CE 428.

Laboratory testing for aggregate, asphalt binder, and asphalt concrete mixture.

Letter grade only (A-F). (Laboratory 3 hours)

429. Traffic Engineering (2)

Corequisite: CE 426, CE 429L.

Capacity and level of service analyses of highway facilities.

Intersection signal timing design. Introduction to traffic control devices. Volume, speed and delay studies. Use of traffic data for design, planning and operational levels of analyses.

Letter grade only (A-F). Graduate students required to do extra projects. (Lecture-Problems 3 hours)

429L. Traffic Engineering Laboratory (1)

Corequisites: CE 426, CE 429

Laboratory activities on traffic flow theory, capacity and level of service analyses, signal timing, parking lot design, and travel demand forecasting; traffic volume, speed and delay studies. Use of traffic engineering software.

(Laboratory 3 hours) Letter grade only (A-F). Not open for credit to student with credit in CE 430.

435. Hydrology and Water Resources Engineering (3)

Prerequisite: C E 335 with a grade of "C" or better.

Fundamental surface and ground water hydrology concepts and quantitative methods. Selected topics and procedures of the hydrological cycle. Planning, development and management of water resource surface systems.

Letter grade only (A-F). (Lecture-Problems 3 hours)

437. Engineering Hydraulics (3)

Prerequisites: C E 335, MATH 370A all with a grade of "C" or better.

Analysis of steady flow in pipe and pipeline networks, and centrifugal pump systems. Theory and analysis of uniform and non-uniform flow in open conduits. Design of lined and unlined channels, computations of critical, gradually, and rapidly varied flows.

Letter grade only (A-F). (Lecture-Problems 3 hours)

438. Hydraulic Engineering Design I (2)

Corequisites: CE 437, CE 438L

Application of hydraulic principles to the design of dams, water courses, water systems and their related structures and devices.

Letter grade only (A-F). (Lecture 2 hours)

438L. Hydraulic Design I Laboratory (1)

Corequisite: CE 437 and CE 438

Computer laboratory applications to the design of water courses, water systems and their related structures and devices

Letter grade only (A-F). (Laboratory 3 hours)

439. Fundamentals of Groundwater Flow and Contaminant Transport (3)

Corequisite: CE 437

Introduction to principles of groundwater flow and contaminant transport. Groundwater remediation methods. Mathematical description of flow and transport in the subsurface with software applications.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

445. Geotechnical Engineering II (3)

Prerequisites: CE 345, CE 346 all with a grade of "C" or better.

Methods of design and construction of various geotechnical engineering projects utilizing theory of soil mechanics.

Letter grade only (A-F). (Lecture-Problems 3 hours)

446./542. Geotechnical Projects (3)

Prerequisite: CE 345 with a grade of "C" or better.

Design and problem solving oriented geotechnical projects utilizing soil mechanics theory and experimental methods according to the state-of-the-art practice.

Letter grade only (A-F). Graduate students required to do additional readings and write a research term paper to deal with current topics in geotechnical engineering. (Lecture-Problems 3 hours).

454. Structures Laboratory (1)

Prerequisite: CE 359 with a grade of "C" or better.

Corequisite: CE 459.

Laboratory examination of structural concepts. Utilize computer simulation modeling techniques in combination with structural tests.

Letter grade only (A-F). (Lecture 3 hours) Not open for credit to students with credit in CE 491.

455. Structural Steel Design (3)

Prerequisite: CE 359 with a grade of "C" or better.

Detailed design of components with typical codes and specifications.

Letter grade only (A-F). (Lecture-Problems 3 hours)

456. Timber Design (3)

Prerequisite: CE 359 with a grade of "C" or better.

Design of various structural elements made of wood material subjected to both vertical and lateral loads. Application of current building codes and specifications in timber design.

Letter grade only (A-F). (Lecture-Problems 3 hours)

458. Structural Analysis II (3)

Prerequisite: CE 359 with a grade of "C" or better.

Solution of indeterminate truss and frame structures using moment distribution and slope deflection methods. Introduction to matrix methods. Energy theorems and virtual work principles. Use of code based finite element computer programs in the analysis of indeterminate structural systems.

Letter grade only (A-F). (Lecture-Problems 3 hours)

459. Reinforced Concrete Design I (2)

Prerequisites: C E 200 and CE 359 all with a grade of "C" or better.

Theory and design of structural elements of reinforced concrete, analysis by working stress and ultimate strength design theories.

Letter grade only (A-F). (Lecture-Problems 3 hours)

464. Environmental Engineering II: Unit Processes (3)

Prerequisites: CE 335 and CE 364 all with a grade of "C" or better.

Civil engineering applications of the fundamentals of chemical reactions, kinetics of biochemical systems, gas transfer systems, liquid/solid separations, solubility equilibria, adsorption, ion exchange and membrane processes.

Letter grade only (A-F). (Lecture-Problems 3 hours)

466. Environmental Systems Design (3)

Prerequisite: CE 335 and CE 364 with a grade of "C" or better.

Principles of water treatment plant design, including intake stations, rapid and mixing tanks, clarifiers, filters and disinfection basins as well as wastewater treatment plant design, including primary, secondary and tertiary treatment with hydraulic profiles, equipment lists and control systems.

Letter grade only (A-F). (Lecture-Problems 3 hours)

481. Professional Practice In Civil Engineering (1)

Prerequisite: Senior standing.

Topics related to practice of civil engineering profession.

Professional society meetings and readings.

Letter grade only (A-F). (Lecture-Problems 1 hour)

490. Senior Design Project (3)

Prerequisite(s): CE 459; completion of all 300-level engineering courses for the civil engineering major all with a grade of "C" or better and consent of department undergraduate advisor.

Prerequisite(s)/Corequisite(s): CE 426, CE 437.

Capstone design that fulfills integrative capstone design course.

A supervised design team project, incorporating all aspects from concept to completed design. Technical aspects, social, environmental, and economic issues considered. Ethical concepts discussed. Oral presentations and written reports are required.

Letter grade only (A-F). (Lecture-Problems 2 hrs, Design lab 3 hrs)

495. Seismic Design I (3)

Prerequisites: CE 459 with a grade of "C" or better.

Elements of lateral-force design in steel, concrete, masonry, and timber structures. Application of current building codes.

Letter grade only (A-F). (Lecture 3 hours)

497. Senior Problem Directed Studies (2)

Prerequisites/Corequisites: CE 406, CE 481, CE 490.

Directed study on assigned topics or lab/field studies practicum and report on same.

Letter grade only (A-F).

GRADUATE LEVEL

500. Engineering Analysis I (3)

Prerequisites: MATH 370A with a grade of "C" or better.

Application of analytical methods to engineering problems. Differential equations and series solutions, Bessel functions and Legendre polynomials, boundary value and eigenvalue problems, Fourier series, partial differential equations, vector analysis.

Letter grade only (A-F). (Lecture-Problems 3 hours)

501. Engineering Analysis II (3)

Prerequisite: MATH 370A with a grade of "C" or better.

Analysis of engineering mechanics by matrix theory and complex variables; introduction to numerical techniques.

Letter grade only (A-F). (Lecture-Problems 3 hours)

502. Finite Element Method and Applications (3)

Prerequisite: CE 458 with a grade of "C" or better or consent of instructor

Introduction of the theory of finite element method and its application to mechanics of structures and solids. Variational calculus, discretization of continuum, discrete element stiffness matrices, displacement and force vector, direct stiffness formulation, and solution methods for linear equations.

(Lecture-Problems 3 hours) Letter grading only (A-F).

503. Selected Topics in Civil Engineering (3)

Prerequisites: Graduate standing and consent of instructor.

Selected topics, with laboratory work required, from the most recent developments in civil engineering.

Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in the *Schedule of Classes*. No more than 6 units of CE 503 or CE 504 may be counted for the Master's Degree. (Lecture-Problems 2 hours, Laboratory 3 hrs)

504. Selected Topics in Civil Engineering (3)

Prerequisite: Graduate standing or consent of instructor.

Selected topics from recent developments in civil engineering.

Letter grade only (A-F). May be repeated to a maximum of 6 units. Topics announced in the *Schedule of Classes*. No more than 6 units of CE 503 and/or CE 504 may be counted for the master's degree. (Lecture-Problems 3 hrs)

508. Probabilistic and Statistical Methods in Engineering Applications (3)

Prerequisite: Graduate standing or consent of instructor.

Civil Engineering applications of nondeterministic models and decision theory. Applications of proven statistical computer programs.

Letter grade only (A-F). (Lecture-Problems 3 hours)

509. Computational Methods in Civil Engineering (3)

Prerequisite: Graduate standing or consent of instructor.

Numerical analysis and computer methods applied to various areas of civil engineering. Application of proven computer methods, including special problem-oriented languages.

Letter grade only (A-F). (Seminar 3 hrs)

516. Timber Design II (3)

Prerequisite: CE 359 and CE 456 all with a grade of "C" or better.

Structural behavior of timber buildings/wood structures under seismic load. Analysis/design of nonrectangular buildings, horizontal diaphragms and shearwalls. Analysis/design of member under biaxial bending and axial force. Load/resistance factor design (LRFD) for wood construction. Current building codes/specifications in advanced timber design.

Letter grade only (A-F). (Lecture-Problems 3 hours)

517. Reinforced Masonry Design (3)

Prerequisite: CE 359 with a grade of "C" or better.

Theory, design and application of reinforced masonry (brick and block) in compliance with latest Building Code. Earthquake provisions. Construction and specifications. Design of high rise buildings, industrial buildings and retaining walls.

Letter grade only (A-F). Graduate students required to do a design project and assigned readings from journals and research papers. (Lecture-Problems 3 hours)

520. Seaport Planning and Design (3)

Prerequisite: CE 426 with a grade of "C" or better or consent of instructor.

Planning and design of seaports and facilities as access systems. Support transportation, use analysis and ocean transport crafts. Site selection and comprehensive planning.

Letter grade only (A-F). (Lecture-Problems 3 hours)

522. Transportation Planning (3)

Prerequisite: C E 426 with a grade of "C" or better or consent of instructor.

Planning of transportation facilities in urban setting; application of travel forecasting and analytical models in the planning process; evaluation of transportation alternatives and impacts; transportation system and demand management techniques.

Letter grade only (A-F). (Lecture-Problems 3 hours)

526. Pavement Engineering (3)

Corequisite: C E 427 or consent of instructor.

Aggregate, binder systems. Theory and design of pavement structures.

Letter grade only (A-F). (Lecture-Problems 3 hours)

528. Advanced Highway Materials (3)

Prerequisite: CE 428 with a grade of "C" or better or consent of instructor.

Hot mix asphalt design methods and lay down methods. Distress identification and rehabilitation procedures of highway materials.

(Lecture-Discussion 3 hours) Letter grade only (A-F)

529. Advanced Traffic Engineering (3)

Prerequisite/Corequisite: CE 426 or consent of instructor.

Analysis of arterial streets traffic operations. Queuing Analysis; Signal timing coordination and optimization; Use of traffic optimization and simulation computer models to solve problems.

Letter grade only (A-F). (Lecture-Problems 3 hours)

530. Groundwater Flow: Principles and Modeling (3)

Prerequisite: CE 437 with a grade of "C" or better or consent of instructor.

Principles of water flow in the saturated and unsaturated zone. Well hydraulics. Numerical modeling of groundwater flow in the subsurface with computer applications. Groundwater artificial recharge and saline water intrusion.

(Lecture 3 hrs). Letter grade only (A-F).

532. Sediment Transportation (3)

Prerequisite: C E 437 with a grade of "C" or better.

Phenomena of sediment transportation related to streams and marine environments.

Letter grade only (A-F). (Lecture-Problems 3 hours)

533. Groundwater Contaminant Transport: Principles and Modeling (3)

Prerequisites: CE 437, CE 530 all with a grade of "C" or better or consent of instructor.

Mechanisms of contaminant transport in groundwater. Analysis of groundwater remediation methods and alternatives. Numerical modeling of flow and transport in the subsurface. Software applications.

(Lecture 3 hrs). Letter grade only (A-F).

535. Advanced Hydrology (3)

Prerequisite: Graduate standing or consent of instructor.

Theory and application of surface hydrology. Hydrologic statistics, dynamic wave routing, frequency analysis and risk analysis. Simulation of design flows, flood forecasting, flood plain analysis and hydrologic design. Mathematical models, numerical methods in analysis and evaluation.

Letter grade only (A-F). (Lecture-Problems 3 hours)

536. Urban Surface Water Management (3)

Prerequisite: CE 437 with a grade of "C" or better or consent of instructor.

Planning and design of facilities to control flooding, erosion, sedimentation, and non-point source pollution for urban storm water runoff management. Presentation of analysis and design methodologies, structural and non-structural measures for management, and master planning principles.

Letter grade only (A-F). Lecture-Problems 3 hours)

538. Hydraulic Engineering Design II (3)

Prerequisites: C E 437, CE 438 all with a grade of "C" or better or consent of instructor.

Design of water supply networks, hydraulic transitions, controls and structures. Hydraulic power conversion. River engineering. Water resources systems.

Letter grade only (A-F). (Lecture-Problems 3 hours)

542./446. Geotechnical Projects (3)

Prerequisite: CE 345 with a grade of "C" or better.

Design and problem solving oriented geotechnical projects utilizing soil mechanics theory and experimental methods according to the state-of-the-art practice.

Letter grade only (A-F). Graduate students required to do additional readings and write a research term paper to deal with current topics in geotechnical engineering. (Lecture-Problems 3 hours).

543. Waste Management and Landfill Engineering (3)

Prerequisite: Graduate standing or consent of instructor.

Advanced principles and practices of landfill engineering for waste management and subsurface flow problems. Presentation of research and case studies in geotechnical aspects of waste management and landfill engineering.

Letter grade only (A-F). (Lecture-Problems 3 hours)

546. Foundation Engineering (3)

Prerequisite: CE 345 with a grade of "C" or better or consent of instructor.

Foundation, explorations, stress and deformation relationships and design of various footings, piles, piers and caissons. Analysis of lateral loads and design of retaining structures, machinery foundations and foundation dewatering.

Letter grade only (A-F). (Lecture-Problems 3 hours)

547. Geotechnical Earthquake Engineering (3)

Prerequisite: CE 345 with a grade of "C" or better or consent of instructor.

Theory and behavior of dynamically loaded soil. Analysis, design and mitigation of geotechnical projects subjected to earthquake loading. Topics include: soil liquefaction, slope stability, retaining structures, and site response analysis.

Letter grade only (A-F). (Lecture-Problems 3 hours)

548. Advanced Soil Mechanics (3)

Prerequisite: C E 345 with a grade of "C" or better or consent of instructor.

Stress-strain time relationship of soils. Theory and methods of analysis with special emphasis on the applications and limitations in soil engineering.

Letter grade only (A-F). (Lecture-Problems 3 hours)

549. Retaining Structure and Slope Stability (3)

Prerequisite(s): CE 345 or equivalent.

Theory of earth pressures, retaining structures, design of retaining walls, sheet piles, mechanically stabilized earth, soil nails, anchored and braced excavation. Theory of slope stability, including shear strength, design charts, limit equilibrium analysis, seepage analysis, staged construction, and rapid drawdown.

Letter grade only (A-F). (Lecture-Problems 3 hours)

551. Prestressed Concrete (3)

Prerequisite: C E 459 with a grade of "C" or better.

Principles of prestressed concrete. materials used, applications to structural design, review of existing specifications.

Letter grade only (A-F). (Lecture-Problems 3 hours)

552. Theory of Plates and Shells (3)

Prerequisite: Completion of C E Graduate MATH Requirement.

Review of theory of elasticity; formulation of general equation of bending of thin elastic plates; methods of obtaining exact and approximate solutions; membrane and bending theories of shells with emphasis on cylindrical shells and shells of revolution.

Letter grade only (A-F). (Lecture-Problems 3 hours)

553. Behavior and Design of Steel Structures (3)

Prerequisite: C E 455 with a grade of "C" or better.

Study of torsion, unsymmetrical bending, stability. Plastic design, code provisions and commentary. Design of complete structural systems in steel.

Letter grade only (A-F). (Lecture-Problems 3 hours)

554. Analysis and Design with Composite Materials (3)

Prerequisite: Graduate standing or consent of instructor.

Mechanics of composite materials with design applications in aerospace, civil engineering and construction. Lab experiments on composite samples. Project required with canned computer programs.

(Lecture-Problems 3 hrs) Letter grade only (A-F).

555. Earthquake Analysis and Design (3)

Prerequisite/Corequisite: CE 495 or consent of instructor.

Advanced computational methods to evaluate responses of structural systems subjected to earthquake ground motions. Time-history and response spectrum analysis for various structural systems. Innovative earthquake design of buildings and other structures.

Letter grading only (A-F). (Lecture-Problems 3 hours)

557. Advanced Structural Analysis (3)

Prerequisite: C E 458 with a grade of "C" or better or consent of instructor.

Virtual forces and displacements, strain energy and complementary energy. Force and displacement matrix methods. Computer applications to planar and space frames, trusses, floor beams and shear wall systems.

(Lecture-Problems 3 hours) Letter grade only (A-F).

558. Dynamics of Structures (3)

Prerequisite: CE 458 with a grade of "C" or better or consent of instructor.

Response of structures and structural components having one or more degrees of freedom. Damping and inelastic action; earthquake and nuclear blasts, dynamic resistance of structural elements and structures, elastic and inelastic response of structures.

(Lecture-Problems 3 hours) Letter grade only (A-F).

562. Water Treatment System Design (3)

Prerequisite: C E 364 with a grade of "C" or better or consent of instructor.

Design of physical and chemical processes for water treatment plants, intake stations, predisinfection units, rapid mixing tanks, slow mixing tanks, clarifiers, granular filtration tanks and post disinfection basins, hydraulics profiles, equipment lists and control systems.

(Lecture-Problems 3 hours) Letter grade only (A-F).

563. Wastewater Treatment System Design (3)

Prerequisite: C E 562 with a grade of "C" or better or consent of instructor.

Design of physical and chemical biological processes for wastewater treatment, including primary, secondary and tertiary treatment combined with hydraulics profiles, equipment lists and control systems at the plants.

(Lecture-Problems 3 hours) Letter grade only (A-F).

564. Environmental Health Engineering (3)

Prerequisite: CE 364 with a grade of "C" or better or consent of instructor.

Health and safety aspects of environmental quality and related engineering systems. Regulatory aspects. Projects and case studies.

(Lecture-Problems 3 hours) Letter grade only (A-F).

567. Liquid and Solid Waste Project Planning and Management (3)

Prerequisite: CE 364 with a grade of "C" or better or consent of instructor.

The presentation of research and case studies of liquid and solid waste project planning and management.

Letter grade only (A-F). (Lecture-Problems 3 hours)

570. Engineering Management Principles and Practices (3)

Prerequisites: CE 406 with a grade of "C" or better, graduate standing or consent of instructor.

Transition of engineers into management. Analysis of technical manager's functions at lower and middle levels as support to corporate management. Principles of engineering management and applications to private and public sector organizations. Case studies of practices in different technical organizations.

Letter grade only (A-F). (Lecture 3 hours)

571. Construction Planning and Cost Control (3)

Prerequisite: Graduate standing or consent of instructor.

Planning, scheduling and resource allocation for a complex construction project. Topics include traditional critical path method, advanced computer expert systems and optimization techniques for construction planning and cost control.

Letter grade only (A-F). (Lecture-Problems 3 hours)

573. Engineering Specifications, Law and Contracts (3)

Prerequisite: Graduate standing or consent of instructor.

Application of law of contracts to construction contracts. Legal matters of concern to engineers.

(Lecture-Problems 3 hours) Letter grade only (A-F).

574. Methods, Analysis and Design of Construction Operations (3)

Prerequisite: CE 571 with a grade of "C" or better or consent of instructor.

Equipment, methods, analysis and design of a construction operation, from site work improvement and data acquisition to modeling and design. Particular attention will be paid to interfacing between design and construction activities and work method development, productivity and safety.

(Lecture-Problems 3 hours) Letter grade only (A-F).

576. Construction Organization and Management (3)

Prerequisite: Graduate standing or consent of instructor.

An introduction to construction organization, control concepts and labor, emphasizing the business aspects of construction management. Topics include legal framework, finance in construction management, labor, accounting and other decision making in the construction business.

(Lecture-Problems 3 hours) Letter grade only (A-F).

577. Accounting and Finance in Construction Management (3)

Prerequisite: CE 406 with a grade of "C" or better or consent of instructor.

Economics and business aspects in construction, financing structure, methodology, and project financial evaluation. Emphasis is on financial aspects in property acquisition, development, construction, and project management.

(Lecture-Problems 3 hours) Letter grade only (A-F).

578. Management of Advanced Technologies in Construction (3)

Prerequisite: Consent of instructor.

New development of advanced technology as applied to construction industry. Productivity and competitiveness in construction on the basis of new technology. Comparison of construction innovation in the U.S., Japan, and other countries.

(Lecture-problems 3 hours) Letter grade only (A-F).

581. Sustainability and Green Construction (3)

Prerequisite: Graduate standing or consent of instructor.

Comprehensive coverage of the green building design and construction practices through high-performance, market-leading design, construction, and operation practices. Presents the green operations and management of new construction and major renovation projects, with emphasis on green building rating systems.

(Lecture 3 hours) Letter grade only (A-F).

582. Management of Productivity and Quality (3)

Prerequisite: CE 570 with a grade of "C" or better or consent of instructor.

System approaches to quality and productivity in construction. Total Quality Management (TQM) in construction and management. Investigation of methods and strategies for improving competitiveness at the company level. Domestic and international competitiveness in the construction business.

(Lecture-Problems 3 hours) Letter grade only (A-F).

585. Utility Rehabilitation and Construction (3)

State of infrastructure systems with a focus on underground facilities, diagnostic and evaluation techniques of underground utility pipes, planning, equipment, materials and methods for rehabilitation and construction of sewer and water mains using Trenchless (i.e. NO-DIG) Technology.

(Lecture-Problems 3 hours). Letter grade only (A-F).

602. Seminar in Civil Engineering (3)

Prerequisite: Graduate Standing or consent of instructor.

Presentation of research in special fields of structures, transportation, environmental, urban, geotechnical, water resources, or construction management. May be repeated once for credit. No more than six units of CE 602.

(Lecture-Problems 3 hours) Letter grade only (A-F).

629. Traffic Operations (3)

Prerequisite: CE 429 or CE 529 all with a grade of "C" or better, or consent of instructor.

Principles of traffic flow. Highway traffic operations. Evaluation of quality of traffic operations including long-range impact on efficient use of the systems and on safety. Identification and evaluation of measures of effectiveness. Travel demand management strategies and intelligent transportation system applications.

(Lecture-Problems 3 hours) Letter grade only (A-F).

630. Mathematical Modeling in Hydraulic Engineering (3)

Prerequisite: CE 437 with a grade of "C" or better or consent of instructor.

Numerical techniques for solving hydraulic problems in water supply, waste water disposal and storm drainage systems. Prediction of important parameters by mathematical modeling on problems encountered in artificial channels, rivers, estuaries and marine environments.

(Lecture-Problems 3 hours) Letter grade only (A-F).

640./740. Mathematical Modeling in Geotechnical Engineering (3)

Prerequisite: Graduate standing or consent of instructor.

Mathematical modeling techniques used in geotechnical engineering. Application of proven computer programs.

M.S. students register in CE 640; Ph.D. students register in CE 740. Ph.D. students will be required to complete a more rigorous computer project. (Lecture-Problems 3 hours) Letter grade only (A-F).

696. Research Methods (1)

Prerequisite: Candidacy or consent of instructor.

Bibliographical and library techniques and resources. Preparation and presentation of theses and directed studies technical papers. Letter grade only (A-F).

697. Directed Studies (3)

Prerequisites: Advancement to candidacy for degree of Master of Science in Civil Engineering, and CE 696 or consent of directed studies faculty advisor.

MSCE and MSE degree candidates in Civil Engineering and Interdisciplinary Areas need to have either CE 697 or CE 698 as their program requirement. Theoretical and experimental problems in civil engineering requiring intensive analysis.

Letter grade only (A-F).

698. Thesis (2-6)

Prerequisites: Advancement to candidacy for degree of Master of Science in Civil Engineering, and CE 696 or consent of directed studies faculty advisor.

Planning, preparation and completion of a thesis and/or project in the field of civil engineering.

Letter grade only (A-F). May be repeated to a maximum of 6 units.

699. Thesis (3-9)

Prerequisite: Admission to candidacy for degree of Civil Engineer. Corequisite: C E 696 or written consent of faculty advisor.

Planning, preparation and completion of a thesis in the field of civil engineering practice.

Letter grade only (A-F). May be repeated to a maximum of 9 units.

740./640. Mathematical Modeling in Geotechnical Engineering (3)

Prerequisite: Graduate standing or consent of instructor.

Mathematical modeling techniques used in geotechnical engineering. Application of proven computer programs.

M.S. students register in CE 640; Ph.D. students register in CE 740. Ph.D. students will be required to complete a more rigorous computer project. (Lecture-Problems 3 hours) Letter grade only (A-F).

Construction Management Courses (CEM)

LOWER DIVISION

121. Construction Drawing I (2) F

An introduction to conventional and computer aided drafting techniques in the relation of drawings for construction. Interpretation of details in construction drawings/blueprints and reference materials. Laboratory: Drafting plans for a residential building using the techniques introduced in the course.

(Lecture 1 hr, laboratory 3 hrs) Letter grade only (A-F).

125. Fundamentals of Construction (3)

Survey of the professional activities and environments of Construction Education. Overview of residential, commercial, institutional, industrial, and heavy civil construction and associated codes, standards, and ethical boundaries. Areas of focus to include type of foundations, materials, contract documents, working drawings and vocabulary.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

200. Concrete Construction (1)

Prerequisite: CEM 125 with a grade of "C" or better. Corequisite: CEM 200L.

Concrete composition, Concrete mix design technology, physical properties of concrete, use of admixtures, concrete batching, curing, testing. Includes physical testing of designed mixes. Modern concepts as fundamental solution to concrete construction challenges. New developments in concrete chemistry and strength theory.

Letter grade only (A-F). Not open for credit to students with credit in CEM 235. (Lecture-Discussion 1 hour)

200L. Concrete Construction Laboratory (1)

Corequisite: CEM 200.

Laboratory exercises in support of CEM 200, Concrete Construction. Develop concrete mix designs and prepare concrete samples for testing, such as compressive strength, slump and air entrainment, and aggregate testing.

(Laboratory 3 hours) Letter grade only (A-F). Not open for credit to students with credit in CEM 235L.

201. Cost Accounting for Construction Engineering (3)

Theoretical Practical and concepts of cost accounting. Variable and fixed costs, break-even point, interrelationships of cost, volume and profits; job-order accounting, general and flexible budgeting, standard costs; product costing methods; cost allocation; inventory planning; control and valuation; joint product.

(Lecture-Problems 3 hours) Letter grade only (A-F).

202. Probability and Statistics for Construction Engineering Management (2)

Prerequisite: High School Algebra.

Statistics and probability theories, sampling, correlation, regression applied to Construction Management. Projects on simulation using statistical packages

(1 hour lecture, 2 hours activity.) Letter grade only (A-F).

204. Applied Mechanics–Statics (3)

Prerequisites: MATH 122 and PHYS 100A all with a grade of "C" or better.

Provides an overview of the principles of statics as it relates to building structures and machines. Equilibrium of forces. Free body diagrams. Force components. Bending moments. U.S. and S.I. units of measurements.

(Lecture 2 hours, Activity 2 hours) Letter grade only (A-F).

206. Trends in Construction Engineering Management (2)

Prerequisites: CEM 121 and CEM 125 all with a grade of "C" or better.

Introduction to current trends including emerging technologies and practices in Construction Management (CEM). Applications of the emerging technologies and practices in CEM problem solving.

(Lecture 1 hr, laboratory 3 hrs) Letter grade only (A-F).

225. Residential and Light Commercial Construction Practices and Estimating (3)

Prerequisites: CEM 121, CEM 125 with a grade of "C" or better. Corequisites: CEM 200, CEM 200L.

Introductory course in planning, design, and construction of residential and light commercial buildings including materials, equipment, construction/assembly methods, quantity take-off, and building codes/standards. Field trips or visual presentation is required.

(Seminar 2 hours and Activity 2 hours) Letter grade only (A-F).

UPPER DIVISION

304. Applied Mechanics Strength of Materials (2)

Prerequisite: CEM 204 with a grade of "C" or better.

Strength of structural materials and applications in building structures and machines. Mechanical properties of materials, structural behaviors of load resisting components associated with construction processes.

(Lecture-Discussion 1 hr, Activity 2 hrs) Letter grade only (A-F).

310. Communication in Engineering Profession (3)

Prerequisites: ENGL 100 or GE Composition (Area A1), COMM 110 all with a grade of "C" or better and Senior standing.

Basic concepts for understanding/practice of communication in world of business for managers and professionals. Language/ conversations in business and role in coordinating actions, resolving breakdowns in work and customer satisfaction. Business writing formats, formal report, business conversation. International, technical, and linguistic developments in business communication.

(Lecture - Discussion 3 hours) Letter grade only (A-F).

315. Construction Safety (2)

Prerequisite: CEM 225 or CE 200 all with a grade of "C" or better.

Terminology, safety functions, accident costs, workman's compensation and liability laws, O.S.H.A., governmental and non-governmental codes, regulations and field safety methods pertinent to the construction industry. Field trips.

Not open for credit to students with credit in CEM 328. (Lecture 1 hour , Activity 2 hours) Letter grade only (A-F).

320. Operations Management in Contemporary Organizations (3)

Prerequisites: MGMT 300, ENGR 310 all with a grade of "C" or better.

Overview of Managerial and organizational theories and practices - introduction to concepts, methods to analyze and improve operations performance in construction and in service organizations. Decision-making and problem-solving processes for organizations. management Effectiveness and efficiency at the organizational, process level, and performer level.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

324. Commercial, Institutional and Industrial Construction Practices and Estimating (3)

Prerequisites: CEM 315 with a grade of "C" or better.

Fundamental of commercial construction, including building layout, shallow and deep foundations, introduction to formwork systems, high strength, heavy and light weigh concrete, framing, flooring and roofing systems, construction and expansion joints, masonry and steel construction. Quantity takeoff.

(Lecture-Discussion 2 hours, Activity 2 hours). Letter grade only (A-F).

335. Soil Mechanics Technology (2)

Prerequisite: CEM 304 with a grade of "C" or better.

Corequisite: CEM 335L.

Soil Composition, description, and classification; soil compaction; determination of physical properties of soils.

(Lecture-Problems 2 hours) Letter grade only (A-F).

335L. Soil Mechanics Technology Laboratory (1)

Prerequisite: CEM 304 with a grade of "C" or better.

Corequisite: CEM 335.

Laboratory investigations and experiments in the phenomena of soil mechanics. Field trips.

(Laboratory 3 hours) Letter grade only (A-F).

365. Mechanical Equipment for Buildings (2)

Prerequisite: PHYS 100B with a grade of "C" or better.

Corequisite: CEM 324.

Principles and current practices in water supply, waste disposal, heating, ventilating, air conditioning and fire protection.

(Lecture 1 hour and Activity 2 hours) Letter grade only (A-F).

373. Fundamentals of Integrated Project Delivery (3)

Prerequisite: Junior standing.

General overview of the attributes of all major project delivery systems, procurement methodologies and contracting approaches.

(2 hrs lecture, 2 hrs activities) Letter grade only (A-F).

375. Electrical Equipment for Buildings (2)

Prerequisites: CEM 324, PHYS 100B all with a grade of "C" or better.

Principles and current practices in the application of electrical equipment and material utilization, sound and signal systems.

(Lecture 1 hour, Activity 2 hours) Letter grade only (A-F).

404. Structural Design I (2)

Prerequisite: CEM 304 with a grade of "C" or better.

Fundamentals of design for structural concrete and masonry buildings in compliance with current building codes.

(Lecture 1 hour, Activity 2 hours) Letter grade only (A-F).

409. Directed Studies in Construction Engineering Management (3)

Prerequisites: Senior standing in CEM or consent of instructor.

Advanced work of a technical nature within area of specialization on an experimental or research basis.

Letter grade only (A-F). Not open to students who have previously obtained 1-2 units of this course.

421. Construction Planning and Scheduling (3)

Prerequisite: CEM 324 with a grade of "C" or better.

Planning and scheduling of construction projects by graphic charts and Critical Path Method (CPM) networks utilizing manual and computer methods.

Letter grade only (A-F). Field trips. (Lecture-Discussion 2 hrs, Activities 2 hrs)

425. Earthwork and Civil Works Construction Practices (2)

Prerequisite: CEM 324, CE 406 all with a grade of "C" or better.

Fundamentals of earthmoving operations, including volume calculation and mass diagrams, soil protection and dewatering systems, volume change characteristics and fundamentals of moving earth, equipment selection, management and economics.

(Seminar 1 hour and Activity 2 hours) Letter grade only (A-F).

426. Business and Construction Law (3)

Prerequisites: CEM 324; BLAW 220 all with a grade of "C" or better.

Contractors license, mechanics lien, subdivision laws; public works projects, bid and bid requirements. Litigation and legal trends in affirmative action, design professional's liability. Administrative procedures of contractors. Study documentation, claims, waivers, arbitration, bonding, insurance, and indemnification. Discuss ethical practices.

(Lecture-Discussion 3 hrs.) Letter grade only (A-F).

429. Advanced Estimating and Bidding (3)

Prerequisite: CEM 315 with a grade of "C" or better.
Corequisite: CEM 425.

Concept and practices involved in the total estimate bidding process in construction, from initial project selection for submission of final bids. A complete project estimate and bid is prepared by each study.

(Lecture 2 hours, Activity 2 hours) Letter grade only (A-F).

431. Construction Cost Control (3)

Prerequisites: CE 406 and CEM 421 all with a grade of "C" or better.

Establishing and controlling construction projects cost through utilization of procedures, techniques and systems commonly used to control resources allocated and to be expended on construction projects.

(2 hrs lecture, 2 hrs activities) Letter grade only (A-F).

432. Facility Administration (3)

Prerequisite: CEM 421 with a grade of "C" or better.

Management skills for facility management. Emphasis is placed on the management functions of planning, organizing, directing and controlling. topics include: negotiation; communication; performance measurement; job enrichment; motivation; contracting services and interpersonal relationships.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

433. Facility Finance Management (3)

Corequisite: CEM 432.

Analysis of financial management strategies associated with facility management. Topics include: buy-lease considerations; building efficiency; leasing considerations; cost control and record keeping; facility capitalization; facility budgeting; cost benefit analysis and financial reports.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

434. Facility and Property Management (3)

Prerequisite: CEM 433 with a grade of "C" or better.

Principles of facility and property management. Topics include: property development; cost benefit analysis; site selection; architectural design; layout plans; building engineering; specifications; stacking and blocking plans; aesthetic standards;

renovation and contracting standards.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

436. Facility Operations Management (3)

Prerequisite: CEM 432 with a grade of "C" or better.

Analysis of the functions of facility operations management. Topics include: building systems; mechanical systems; energy management; electrical systems; trades operations; grounds maintenance; custodial; furniture and equipment; waste removal contracting services; furniture standards; security systems and planned maintenance.

(Lecture-Discussion 3 hours) Letter grade only (A-F).

438. Structural Design II (2)

Prerequisite: CEM 304 with a grade of "C" or better.

Simplified designs for steel and wood structures in accordance with current building codes. Selection of structural steel and wood systems with structural characteristics of members and connections.

(Lecture 1 hour, Activity 2 hours) Letter grade only (A-F).

443. Principles of Design-Build Project Delivery (3)

Prerequisite: CEM 373 with a grade of "C" or better.

General overview and unique distinguish essential elements of design-build project delivery and how to make the mental-shift needed to transition from traditional Design-Bid-Build to design-build project delivery.

(2 hrs lecture, 2 hrs activities) Letter grade only (A-F).

476. Construction and Maintenance of Infrastructure Facilities (2)

Prerequisites: CEM 425 with a grade of "C" or better.

Comprehensive coverage of the construction principles and technologies embraced by the heavy civil industry. The course presents the construction methods and maintenance practices of heavy civil projects, with emphasis on utility pipes, bridges and roads.

(Lecture 1 hour - Activity 2 hours) Letter grade only (A-F).

485. CEM Senior Seminar (3)

Prerequisites: CEM 429 and CEM 431 all with a grade of "C" or better or consent of instructor.

Advanced work of a technical nature within the construction industry. All students will be required to participate into the Bid Competitions.

(Lecture 2 hours, Activity 2 hours). Letter grade only (A-F).

486. Infrastructure Management (2)

Prerequisites: CEM 476 and CE 406 all with a grade of "C" or better.

Integrated approach to infrastructure management theories and practices including: tools, models and applied systems. The course presents the principles required to manage, preserve and improve the performance of infrastructure systems, with emphasis on utility pipes, bridges and roads.

(1 hr lecture, 2 hrs activities) Letter grade only (A-F).

490. Construction Project Management (3)

Prerequisites: CEM 426, CEM 429 and CEM 431 all with a grade of "C" or better.

Integrative learning capstone design course. A supervised design team project, incorporating all aspects of project management of design-build projects. Technical aspects, social, environmental, and economic issues considered. Ethical concepts discussed. Oral presentations and written reports are required

(2 hrs lecture, 2 hrs activities) Letter grade only (A-F).