ENGINEERING - CIVIL

College of Engineering and Computer Science

Program Description

Civil Engineering involves the application of scientific principles and knowledge of mathematics and computers to the planning, analysis, design, and construction of all types of private and public works. Reduction of air and water pollution, disposal of hazardous wastes, renewal of our old cities, planning and building of new communities, providing water, power, and high-speed ground transportation systems are the responsibilities of the civil engineer. It is a continual challenge to the civil engineer to provide these services efficiently by the construction of dams, buildings, bridges, tunnels, highways, airports, waterways, and waste handling facilities in harmony with the natural environment.

Because of the broad range of demands on the civil engineer's services, the undergraduate program is devoted to fundamental principles in mathematics; basic and engineering sciences; the spectrum of Civil Engineering practice in both analysis and design; and required courses in the humanities and the social sciences, so that engineers may better relate to the world and society they serve. The upper division program permits students to select 9 units (3 courses) of electives. Students may increase the breadth or depth of their knowledge in Civil Engineering by selecting these electives in several areas: environmental and water quality engineering, geotechnical engineering, structural engineering, transportation, and water resources engineering.

- **MS:** Environmental-Water Quality Engineering / Geotechnical Engineering / Structural Engineering / Transportation Engineering / Water Resources Engineering

Special Features

- The BSCE degree is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, Inc. (EAC/ABET).
- A notable strength of the program is that most faculty are licensed professional engineers in California and have practical experience in industry. Thus, faculty bring an ability to relate theory to practice, and the program prepares the student for the profession as well as for advanced study.
- Emphasis is placed on design which is the definition and solution of engineering problems in a practical manner. Lower division and first semester junior year coursework provides the preparation for design in courses such as mathematics, physics, descriptive geometry, CAD, surveying, computer applications, and engineering economics. Design courses are available to students in their last three semesters including a senior design project course in the final semester.
- Class sizes are small providing for close interaction between students and faculty. This interaction is enhanced in laboratory courses which are an integral part of the curriculum.
- Computers are used in many courses and students have free access to computer laboratories.
- Communication skills and social and ethical responsibilities of professional practice are emphasized.
- Students are encouraged to participate in the Student Chapter of American Society of Civil Engineers and other student organizations, to develop organizational skills, and to interact with practicing civil engineers.
- Sacramento, the State Capital and the seat of county government, provides proximity to city, county, state and federal agencies, and many consulting firms with Civil Engineering departments. Thus, students have a unique environment to draw upon for semester projects, part-time or summer employment, and career opportunities.

Program Educational Objectives

The objectives of the civil engineering are to prepare graduates to:

- ethically apply their hands-on, practice-oriented civil engineering education to succeed professionally;
- engage in lifelong learning through graduate education, professional development, and/or active involvement in professional organizations; and
- communicate effectively on multi-disciplinary teams to address diverse challenges, creating solutions that serve the general public.

Academic Policies and Procedures

The following is a summary of policies and procedures specific to the Department of Civil Engineering. Other University policies and procedures in this catalog also apply to Civil Engineering majors. The Department will not hear petitions for deviation from articulated policies made by students who disregard catalog policy.

- **Course Repeat Policy:** Undergraduate engineering and Civil Engineering courses that are used to meet the Bachelor of Science in Civil Engineering degree requirements may be repeated only twice (for a total of three attempts). Grades of the second and third attempt will be averaged in grade point calculations.
- **Reinstatement Policy:** Students seeking reinstatement to the Civil Engineering major must complete a Reinstatement Petition (obtained at Admissions and Records). That petition will be reviewed by the Department Chair for approval or rejection.
  Note: The only basis for reinstatement is the expectation (supported by evidence provided by the student) that the student is now likely to progress towards the satisfactory completion of the Department's degree requirements in a timely manner.
- **Minimum Grade Requirements:** The purpose of this requirement is to assure that all Civil Engineering majors attain the minimum level of competency in all their coursework required for a Bachelor of Science Civil Engineering Degree.
  All required courses in the major, all electives in the major, ENGL 5, and ENGL 20 must be completed with a grade of "C-" or better.
  A minimum grade point average of 2.0 ("C") is required in the major courses applied to the degree.
- **Incomplete Grades:** Incomplete grades are issued only in accordance with University policy. The student must be passing the course at the time an “Incomplete” is requested. An Incomplete Petition (obtained in the Department Office) must be submitted to the Department with the student’s and the course instructor’s signature. The Incomplete Petition must specify the work to be completed, the basis by which the student’s final grade will be determined, and the last date for completion of the incomplete work. An incomplete grade that is not cleared by the set date will lapse to an F grade.

Career Possibilities

Bridge Engineer · Civil Engineer · Construction Engineer · Design Engineer · Environmental Engineer · Foundation Engineer · Geotechnical Engineer · Highway Engineer · Hydraulic Engineer · Hydrologic Engineer · Project Engineer · Public Works Engineer · Research Engineer · Sanitary Engineer

· Soils Engineer · Structural Engineer · Traffic Engineer · Transportation Engineer · Urban Planner · Water Resources Engineer

Contact Information

Benjamin Fell, Department Chair
Ashley Mihok, Administrative Support Coordinator
Riverside Hall 4024
(916) 278-6982
www.ecs.csus.edu/ce (http://www.ecs.csus.edu/ce)

Faculty

ARMSTRONG, RICHARD

ARYANI, CYRUS

DAMMEL, EUGENE E.

FELL, BENJAMIN

FOGARTY, JULIE

JOHNSTON, JOHN

KHAN, GHAZAN

MAHMOOD, RAMZI J.

MATSUMOTO, ERIC E.

MERAYYAN, SAAD

POINDEXTER, CRISTINA

SCOTT-HALLET, KIMBERLY

Undergraduate Program

Students must satisfy the requirements of the Accreditation Board for Engineering and Technology (EAC/ABET). Consult the Civil Engineering Department Chair for specific General Education requirements.

Courses may be interchanged between semesters to accommodate the student's schedule, as long as prerequisites are observed. Civil engineering is a demanding major, but with devoted study it can be completed in four years. Students who are working half-time or more often find it difficult to successfully pass a full load of classes each semester. Such students should plan to take fewer units per semester and a longer time to finish their degree.

BS Degree in Civil Engineering

Units required for Major: 94 plus GE courses
Minimum total units for the BS: 124

NOTE: Students graduating with a BS in Civil Engineering will not be subject to the University's Foreign Language Graduation Requirement. Students who change major may be subject to the University's Foreign Language Graduation Requirement.

Required Lower Division Courses (65 Units)

First Semester Freshman Year		
CE 1A	Civil Engineering Seminar	1
CE 4	Engineering Graphics and CAD	2
CHEM 1E	General Chemistry for Engineering [1]	4
MATH 30	Calculus I [1]	4
Select two General Education courses		6
Second Semester Freshman Year		
CE 9	Plane and Topographic Surveying	3
MATH 31	Calculus II [1]	4
PHYS 11A	General Physics: Mechanics [1]	4
Select two General Education courses		6
First Semester Sophomore Year		
ENGR 45	Engineering Materials	3
MATH 45	Differential Equations for Science and Engineering	3
PHYS 11C	General Physics: Electricity and Magnetism [1]	4
Select two General Education courses		6
Second Semester Sophomore Year		
ENGL 20	College Composition II	3
ENGR 30	Analytic Mechanics: Statics	3
MATH 35	Introduction to Linear Algebra	3
or MATH 100	Applied Linear Algebra	
Select two General Education courses		6

Required Upper Division Courses (59 Units) [2]

First Semester Junior Year		
CE 100	Engineering Geology	2
CE 101	Computer Applications in Civil Engineering	3
ENGR 110	Analytic Mechanics - Dynamics	3
ENGR 112	Mechanics Of Materials	3
ENGR 115	Statistics For Engineers	2
ENGR 140	Engineering Economics	2
Second Semester Junior Year		
CE 113	Structural Laboratory	1
CE 146	Civil Engineering Professional Practice	3
CE 161	Introduction to Structural Analysis	3
CE 171A	Soil Mechanics	4
ENGR 132	Fluid Mechanics	3
First Semester Senior Year		
CE 137	Water Resources Engineering	3
CE 147	Transportation Engineering	4
CE 170	Principles of Environmental Engineering	4
Select Civil Engineering elective		3
Select General Education course		3
Second Semester Senior Year		
CE 135	Hydraulics Laboratory	1
CE 190	Senior Project	3
ENGR 124	Thermodynamics	3
Select two CE electives [3]		6

Civil Engineering Electives

Select from the following: [4]

CE 138	Hydrology
CE 139	Open Channel Hydraulics [5]
CE 148	Transportation Systems
CE 149	Traffic Analysis and Design [5]
CE 151	Introduction to GIS in Civil Engineering
CE 162	Advanced Structural Analysis
CE 163	Structural Design in Steel I [5]

CE 164	Reinforced Concrete Design [5]	
CE 165	Structural Design in Steel II [5]	
CE 166	Seismic Behavior of Structures	
CE 168	Pre-stressed Concrete Design [5]	
CE 169A	Timber Design [5]	
CE 169B	Reinforced Masonry Design [5]	
CE 171B	Soil Mechanics and Foundation Engineering [5]	
CE 172	Design of Urban Water and Sewer Systems [5]	
CE 173	Design of Water Quality Control Processes [5]	
CE 181	Geoenvironmental Engineering	
CE 184	Geotechnical Earthquake Engineering [5]	
Total Units		124

1 Indicates course which can also be used to meet University General Education requirements.

2 Students must normally complete all lower division preparation before enrolling in upper division Engineering or Civil Engineering courses.

3 At least two CE electives must be design courses (indicated by [5]).

4 Electives are to be chosen from these courses in consultation with a faculty advisor and must include at least two design electives (indicated by [5]).
Note: Other electives, such as a CE 196 series course or CE 199E may be chosen with the approval of a faculty advisor and Department Chair.

5 Indicates a design elective.

Certificate Program

Certificate - Wastewater Treatment Plant Operation Specialist

Operating and maintaining the infrastructure system and consistently meeting those public health and environmental objectives are the operators of wastewater treatment plants and wastewater collection systems. The Wastewater Treatment Plant Operator Certificate program is designed to provide students with the technical, scientific, and application background to obtain licensure and the knowledge, skills, and abilities to completely work in the wastewater treatment industry. The Certificate is offered by the College of Business Administration and is administered by the Sacramento State College of Continuing Education.

Cooperative Education Program (Work Experience)

The Department of Civil Engineering encourages eligible students to participate in the Cooperative Education Program (Co-op). Eligibility requirements are completion of the pre-major and the first semester junior year with a minimum GPA of 2.5. The program provides alternate periods of University study and major-related, paid, off-campus work experience in private industry or government. The experience will enhance the student's employment prospects upon graduation. Participants in this program will complete the equivalent of one or two six-month work periods in their junior year and/or their senior year. Students must enroll in the appropriate Professional Practice course (CE 195A) and are awarded a Certificate on satisfactory completion of the Co-op. However, the credits for this course do not replace the curricular requirements of the BSCE degree. Students interested in the Cooperative Education Program should apply in the satellite office in Riverside Hall 2004 or the main office in Lassen Hall 2008. For information call (916) 278-7234.

Graduate Programs

Civil Engineering encompasses a broad range of professional activities. The four years of undergraduate preparation for the Bachelor of Science degree are devoted to fundamental analytical principles and basic design applications. For technical competence in specialized areas and continued effectiveness on the job, graduate study is becoming increasingly necessary.

The Civil Engineering Department offers a graduate program of study leading to a Master of Science degree in Civil Engineering in the following areas of concentration:

- **Environmental/Water Quality Engineering** - water quality analysis and management, water, and waste treatment;
- **Geotechnical Engineering -** properties and behavior of soil and their application to design of foundation, retaining structures, earth dams and slopes, soil improvement and ground stabilization, geosynthetics inclusions, and soil dynamics, and earthquake engineering;
- **Structural Engineering -** earthquake resistant steel and concrete design applied to buildings and bridges, structural dynamics, structural mechanics, and finite element methods;
- **Transportation Engineering** - Transportation engineering and planning, traffic flow theory, and system management applicable to all modes with emphasis on highway and multi modal transportation; interdisciplinary study with other areas of Civil Engineering as well as with non-engineering areas (e.g., Environmental Studies, Geography, Public Policy & Administration, and Business Administration) may also be arranged; and
- **Water Resources Engineering** - advanced hydraulics and modern hydrologic techniques, flood forecasting, groundwater flow modeling, water resources management, and policy formulation.

Each area of concentration consists of a set of core courses, a choice of electives, and culminating requirements; all selected by the student and approved by an advisor. Practicing engineers who do not have a degree objective may choose to enroll in selected courses as part of a continuing education program.

Graduate students can also elect an emphasis in **Engineering Management** by taking elective courses in the College of Business Administration. Graduate students who are interested in this option can select up to 9 units of foundation courses and/or graduate business classes (refer to College of Business Administration catalog for listing of courses). Individual programs can be tailored with a faculty advisor.

Graduate brochures specifically describing the program in each area are available in the Department Office. Some graduate assistantships are available to qualified students. Application forms for these can be obtained from the Department or from the Office of Graduate Studies, River Front Center 206, (916) 278-6470.

Admission Requirements

Admission as a classified graduate student in Civil Engineering requires:

- an undergraduate degree in Civil Engineering; and
- a minimum 2.8 GPA both overall and in upper division engineering courses.

In addition, the merit of past academic endeavor, potential for future study, and professional goals may also be considered for granting admission.

Applicants who have deficiencies in admission requirements that can be removed by specified additional preparation may be admitted with conditionally classified graduate status. Any deficiencies will be noted on a written response to the student's admission application.

Students with a baccalaureate degree in engineering majors other than Civil Engineering (e.g., Electrical and Electronic, Industrial, Mechanical, or Surveying) or in other non-engineering scientific disciplines (e.g., Mathematics, Physics, or Geology) who wish to pursue the graduate program in Civil Engineering may be considered on an individual basis. Such students may be admitted as conditionally classified students and will be required to complete a specifically designed list of undergraduate prerequisite courses in engineering and/or mathematics, physics, and chemistry to correct undergraduate deficiencies. Such a student must have an approved study program on file with the Department while undertaking this qualifying work. Upon completion of these courses with a GPA of 2.8 or better, the student may apply for classified graduate status in Civil Engineering.

Admission Procedures

All prospective graduate students, including Sacramento State graduates, must file the following with the Office of Graduate Studies:

- an online application for admission; and
- two sets of official transcripts from all colleges and universities attended, *other than Sacramento State*.

For more admissions information and application deadlines, please visit http://csus.edu/gradstudies/.

Approximately six weeks after receipt of all items listed above, a decision regarding admission will be mailed to the applicant. After being admitted, students must meet with an advisor and complete a Graduate Student Advising Form (obtainable in the Civil Engineering Department). This advising form must be kept current and on file in the Department Office.

Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the graduate student has:

- removed any deficiencies in admission requirements;
- obtained classified graduate status;
- completed at least 12 units in the graduate program with a minimum 3.0 GPA, including at least three courses at the 200-level;
- taken the Writing Placement for Graduate Students (WPG) or taken a Graduate Writing Intensive (GWI) course in their discipline within the first two semesters of coursework at California State University, Sacramento or secured approval for a WPG waiver; and
- selected and obtained approval for a culminating requirement (Plan A, B, or C).

Advancement to Candidacy forms are available in the Department and in the Office of Graduate Studies. The student fills out the form after planning a degree program in consultation with his or her faculty advisor. The completed form is then approved by the Graduate Coordinator of the Department and submitted to the Office of Graduate Studies.

All graduate degree programs are subject to general University requirements for graduate degrees, explained in the *Graduate Studies* section of this catalog.

MS Degree in Civil Engineering

Units required for the MS: 30 - Includes research or independent study and units required in area of concentration (see below)
Minimum GPA: 3.0
Minimum Grades: No course in the program of study may have a grade below "C+".

Required coursework (18 Units)		
Core Courses		
15 units are required as outlined in the Core Courses section below		15
Mathematics/Statistics		
Select one of the following: [1]		3
ENGR 201	Engineering Analysis I	
ENGR 202	Engineering Analysis II	
ENGR 203	Engineering Statistics	
Elective Courses		6 - 9
Select 6-9 units of electives [2]		
Culminating Requirement (3-6 Units)		
Select one of the following CE 500 requirements:		3 - 6

Plan A

Master's Thesis (3-6 units) Approval by the faculty thesis advisor and by a second faculty or an expert in the area of study is required. The thesis must comply with University standards for format and is filed in the University Library. The Master's Thesis should be the written product of a systematic study of a significant problem. It identifies the problem, states the major assumptions, explains the significance of the undertaking, sets forth the sources for and methods of gathering information, analyze the data, and offers a conclusion or recommendation. The finished product evidences originality, critical and independent thinking, appropriate organization and format, and thorough documentation. The work should be associated with engineering research or innovation. No more than 3 units may be awarded for a topic directly related to a topic studied of CE 299. A public presentation is required.

Plan B

Master's Project (3-6 units) Approval by the faculty thesis advisor and by a second faculty or an expert in the area of study is required. A Master's Project should be a significant undertaking appropriate to the engineering profession. It evidences originality and independent thinking, appropriate form and organization, and rationale. It is described and summarized in a written report that includes a discussion of the project's significance, objectives, methodology and a conclusion or recommendation. The work should be associated with practical engineering applications. The report must comply with University standards for format and will be filed in the University Library. No more than 3 units may be awarded for a topic directly related to a topic studied for CE 299. A public presentation is required.

Plan C

Directed Study (3 units) and Comprehensive Examination (0 units). Approval of one faculty member is required for Directed Study. The comprehensive examination is administered by a committee of three faculty members.	
Total Units	30-33

1 With advisor approval. Students pursuing an emphasis in Environmental Engineering, Water Resource Engineering or Transportation Engineering must take ENGR 203. Students pursuing an emphasis in Structural Engineering must take ENGR 201 or ENGR 202.

2 Elective courses (including CE 299) selected with prior approval of the student's faculty advisor in the area of interest. In addition to 200-level courses, these may also include the technical electives (but not the required courses) from the undergraduate curriculum. Not more than 3 units of CE 299 may be taken without prior approval of the Graduate Coordinator.
Students who are interested in emphasizing **Engineering Management** may select 9 units of elective courses from the College of Business Administration (refer to foundation courses and/or graduate courses offered by the College of Business Administration). Under this option students should work with a faculty advisor to develop a plan for the management elective courses.

Core Courses

Units required: 15 -- a minimum of 12 units must be taken from one of the following five areas of specialization. Up to 3 units can be satisfied by 200 level coursework (not including CE 299) outside the chosen area of specialization.

Environmental/Water Quality Engineering (21 Units)		
CE 250	Systems Analysis of Resources Development	3
CE 252A	Environmental Quality Processes I	3
CE 252B	Environmental Quality Processes II	3
CE 252C	Environmental Quality Processes III	3
CE 254	Water Quality Management	3
CE 255	Transport of Chemicals in Soil Systems	3
CE 276	Groundwater Hydrology	3
Geotechnical Engineering (21 Units)		
CE 280A	Advanced Soil Mechanics and Foundation Engineering I	3
CE 280B	Advanced Soil Mechanics and Foundation Engineering II	3
CE 280C	Geotechnical Modeling	3
CE 283	Ground Modification Engineering	3
CE 284	Soil Dynamics and Earthquake Engineering	3
CE 285	Geosynthetics I	3
CE 286	Geosynthetics II	3
Structural Engineering (18 Units)		
CE 231A	Computer Methods of Structural Analysis I	3
CE 231B	Computer Methods of Structural Analysis II	3
CE 232	Nonlinear Structural Analysis	3
CE 234	Dynamics and Earthquake Response of Structures	3
CE 266	Advanced Design in Reinforced Concrete	3
CE 267	Structural Systems for Buildings	3
Transportation Engineering (15 Units)		
CE 261	Transportation Planning	3
CE 262	Advanced Transportation Facility Design	3
CE 263	Traffic Flow Theory	3
CE 265	Analysis and Control of Traffic Systems	3
CE 285	Geosynthetics I	3
Water Resources Engineering (18 Units)		
CE 250	Systems Analysis of Resources Development	3
CE 251	Water Resources Planning	3
CE 271	Modern Hydrologic Techniques	3
CE 272	Advanced Engineering Hydraulics	3
CE 274	Hydrologic Modeling	3
CE 276	Groundwater Hydrology	3

Certificates

The graduate certificate program in Civil Engineering is designed to recognize students who have completed core graduate courses in a specialty area in Civil Engineering. This program meets the need of professional engineers that are interested in sharpening their skills in their specialty area. The certificate program is available to matriculated students in the Civil Engineering Graduate Program. A grade point average of 3.0 must be attained for all courses taken in the program. Certificates in the following areas are offered:

Environmental Engineering

Certificate - Geo-Environmental

CE 181	Geoenvironmental Engineering	3
CE 252A	Environmental Quality Processes I	3
CE 255	Transport of Chemicals in Soil Systems	3
ENGR 203	Engineering Statistics	3
Total Units		12

Certificate - Treatment Systems

CE 252A	Environmental Quality Processes I	3
CE 252B	Environmental Quality Processes II	3
CE 252C	Environmental Quality Processes III	3
ENGR 203	Engineering Statistics	3
Total Units		12

Certificate - Water Quality

CE 250	Systems Analysis of Resources Development	3
CE 252A	Environmental Quality Processes I	3
CE 254	Water Quality Management	3
ENGR 203	Engineering Statistics	3
Total Units		12

Geotechnical Engineering

Certificate - Foundation Engineering

CE 280A	Advanced Soil Mechanics and Foundation Engineering I	3
CE 280B	Advanced Soil Mechanics and Foundation Engineering II	3
CE 280C	Geotechnical Modeling	3

CE 284	Soil Dynamics and Earthquake Engineering	3
Total Units		12

Certificate - Ground Modification

CE 283	Ground Modification Engineering	3
CE 285	Geosynthetics I	3
CE 286	Geosynthetics II	3
ENGR 203	Engineering Statistics	3
Total Units		12

Structural Engineering

Certificate - Structural Engineering

CE 231A	Computer Methods of Structural Analysis I	3
CE 232	Nonlinear Structural Analysis	3
CE 234	Dynamics and Earthquake Response of Structures	3
CE 266	Advanced Design in Reinforced Concrete	3
Total Units		12

Transportation Engineering

Certificate - Transportation Planning

CE 250	Systems Analysis of Resources Development	3
CE 261	Transportation Planning	3
CE 262	Advanced Transportation Facility Design	3
ENGR 203	Engineering Statistics	3
Total Units		12

Certificate - Transportation/Traffic Engineering

CE 250	Systems Analysis of Resources Development	3
CE 263	Traffic Flow Theory	3
CE 265	Analysis and Control of Traffic Systems	3
ENGR 203	Engineering Statistics	3
Total Units		12

Water Resources Engineering

Certificate - Engineering Hydraulics

CE 272	Advanced Engineering Hydraulics	3
CE 274	Hydrologic Modeling	3
CE 276	Groundwater Hydrology	3
ENGR 203	Engineering Statistics	3
Total Units		12

CE 250	Systems Analysis of Resources Development	3
CE 251	Water Resources Planning	3
CE 271	Modern Hydrologic Techniques	3
ENGR 203	Engineering Statistics	3
Total Units		12

CE 1A. Civil Engineering Seminar. 1 Unit
Introduces students to civil engineering as a profession. Topics include the technical disciplines (environmental, geotechnical, structural, transportation, and water resources), the role of civil engineers in planning, constructing and operating infrastructure, and professional responsibilities such as licensure and ethics. Case studies are used to explore both technical and nontechnical aspects of civil engineering projects such as design and environmental constraints, constructability, and social and political issues.

CE 4. Engineering Graphics and CAD. 2 Units
In-depth graphic analysis and solution of typical three dimensional space problems by applying the principles of orthogonal projection. Fundamentals of interactive computer aided design and drafting. Lecture one hour; laboratory three hours.

CE 9. Plane and Topographic Surveying. 3 Units
Prerequisite(s): MATH 26A or MATH 30; may be taken concurrently.
Instruments, methods and theories necessary for the measurement of distance, direction, angles and elevations. Application of data to traverse computations, estimation of earthwork volumes, transportation facility design and construction layout. Introduction to legal aspects of surveying, geodetic surveys, maps, boundary surveys and new technologies used in surveying. Lecture two hours; laboratory three hours.

CE 100. Engineering Geology. 2 Units
Prerequisite(s): ENGR 112; may be taken concurrently.
Soil and rock mechanics and their relations to geological features influencing design, construction and maintenance of engineering projects. Lectures and field problems.

CE 101. Computer Applications in Civil Engineering. 3 Units
Prerequisite(s): ENGR 30 and CE 4 (CE 4 may be taken concurrently).
Develops a computer-based concept for problem solving and graphical presentation of results with applications in five areas of civil engineering: environmental, geotechnical, structural, transportation and water resources. Uses word processing, spreadsheets, structure programming (Visual BASIC with spreadsheets), and special purpose software packages. Lecture two hours; laboratory three hours.

CE 113. Structural Laboratory. 1 Unit
Prerequisite(s): CE 101 and ENGR 112; WPJ score of 70+, or at least a "C-" in ENGL 109M or ENGL 109W.
Introduction to the principles of structural analysis and design by testing of structural elements. Experimental verification of the assumptions of strength of materials. Introduction to laboratory techniques. Laboratory three hours.

CE 135. Hydraulics Laboratory. 1 Unit
Prerequisite(s): CE 101, CE 137 and CE 146; CE 137 and CE 146 may be taken concurrently
Laboratory experiments relating the principles of fluid mechanics to real fluid flow. Laboratory three hours.

CE 137. Water Resources Engineering. 3 Units
Prerequisite(s): CE 1A, CE 101, CE 146, ENGR 115, ENGR 132, and ENGR 140; CE 146 may be taken concurrently.
Hydrologic and hydraulic fundamentals which are common to water resources projects; introduction to reservoirs, dams, pipelines, channels, hydraulic machinery, ground water, water rights, statistical analysis, engineering economy applications, and water resources planning.

CE 138. Hydrology. 3 Units
Prerequisite(s): CE 137.
Introduction to hydrologic engineering design. Precipitation analysis, hydrograph and flood routing applications for civil engineering. Groundwater hydrology including quality problems in development of subsurface water resources. Statistical applications in hydrology.

CE 139. Open Channel Hydraulics. 3 Units
Prerequisite(s): CE 137.
Civil engineering design problems in open channel flow. Model design, pressure problems, design application of hydraulic analysis in structures, transitions, culverts, weirs and spillways. Channel design including roughness for subcritical and supercritical flow. Analyzes and design problems in steady, uniform, gradually and rapidly varied flow.

CE 146. Civil Engineering Professional Practice. 3 Units
Prerequisite(s): CE 1A and ENGR 30; GWAR; CE 1A may be taken concurrently.
Corequisite(s): CE 1A.
Introduction to the legal and business environment of professional engineering practice, including legal responsibilities of professionals, ethics, risk and liability, types and use of contracts, specifications, the construction bid process, and environmental responsibilities. Elements of engineering organizations such as business economics, human resources, and project management.

CE 147. Transportation Engineering. 4 Units
Prerequisite(s): CE 1A, CE 9, CE 101, CE 146, ENGR 115; CE 146 may be taken concurrently
Introduction to the fundamental topics in Transportation Engineering. Focus on roadway geometric design, layout considerations, pavement materials and design, traffic operations and analysis. Lecture three hours; laboratory three hours.

CE 148. Transportation Systems. 3 Units
Prerequisite(s): CE 147, ENGR 140 or instructor permission, and (GWAR certification before Fall 09, or WPJ score of 70+, or at least a C- in ENGL 109M or ENGL 109W).
Transportation systems evaluation and management. Focus on transportation planning methods, including data analysis, estimation of future demand, evaluation of travel demand impacts on existing systems, and transportation system decision-making.

CE 149. Traffic Analysis and Design. 3 Units
Prerequisite(s): CE 147
Introduction to the fundamental principles of traffic operations, traffic data collection methods, intersection control, signal design and analysis techniques. Methods and software for designing and optimizing signalized and unsignalized intersection operation. This course may be paired with CE 265.

CE 151. Introduction to GIS in Civil Engineering. 3 Units
Prerequisite(s): ENGR 115, CE 9, and either CE 137, CE 147, CE 170, or CE 171A.
Fundamental geographic information system (GIS) concepts; GIS data acquisition and analysis; GIS analytical methods. Lab exercises with GIS software used to introduce students to typical uses of GIS in civil engineering. This course may be paired with CE 296H. Lecture two hours; lab three hours.

CE 161. Introduction to Structural Analysis. 3 Units
Prerequisite(s): CE 1A, CE 101, CE 146, ENGR 112, and MATH 35 or MATH 100. CE 146 may be taken concurrently.
Analysis of statically determinate and indeterminate beams, frames, and trusses. Includes energy principles, flexibility and stiffness analyses, and influence lines. Computers are used to aid in the solution of complex structural problems.

CE 162. Advanced Structural Analysis. 3 Units
Prerequisite(s): CE 161.
Analyzes continuous beams and plane frames by moment distribution and direct stiffness methods. Use of symmetry in structures. Temperature, support displacement, misfit effects, and non-prismatic members. Extensive use of computer programs. Introduction to applications of matrix condensation and finite element analysis.

CE 163. Structural Design in Steel I. 3 Units
Prerequisite(s): CE 161.
Theory and practice in design of structural steel members and connections using current design specifications. Design of tension and compression members, laterally supported and unsupported beams, beam-columns, and bolted and welded connections. Use of microcomputers in design.

CE 164. Reinforced Concrete Design. 3 Units
Prerequisite(s): CE 113, CE 161; CE 113 may be taken concurrently.
Theory and practice in design of reinforced concrete beams, slabs, columns, footings and retaining walls. Includes study of design, preparation and testing of cements, aggregates and concrete mixtures.

CE 165. Structural Design in Steel II. 3 Units
Prerequisite(s): CE 163.
Continuation of CE 163. Torsion analysis and design of wide-flange beams. Analyzes and design of heavy industrial structures such as plate girders and crane girders, braced and unbraced frames. Composite floors.

CE 166. Seismic Behavior of Structures. 3 Units
Prerequisite(s): CE 101, CE 161, ENGR 110.
Analyzes simple structures' response to dynamic loads with emphasis on response to earthquake ground motion. Introduction to multi-story buildings dynamics. Modal and approximate analyses of earthquake response. Dynamic analysis and building code procedures.

CE 168. Pre-stressed Concrete Design. 3 Units
Prerequisite(s): CE 161, CE 164; CE 164 may be taken concurrently.
Analyzes and design of pre-stressed concrete structures using ultimate strength and working stress methods. Detailed study of stress-strain behavior of P.C. members. Study of bond and shear. An introduction to least-weight design.

CE 169A. Timber Design. 3 Units
Prerequisite(s): CE 161.
Wood as a structural material. Design of sawn and glulam beams, concentrically and eccentrically loaded columns, shear walls, flexible diaphragms and connections for vertical and lateral loading including effects of wind and seismic forces.

CE 169B. Reinforced Masonry Design. 3 Units
Prerequisite(s): CE 161.
Reinforced masonry as a structural material. Design of reinforced masonry beams, concentrically and eccentrically loaded columns, walls for vertical and lateral loading including effects of wind and seismic forces. Design of a small building for wind and seismic loading including torsional effects.

CE 170. Principles of Environmental Engineering. 4 Units
Prerequisite(s): CHEM 1E or CHEM 1A, CE 1A, CE 101, CE 146, ENGR 115; CE 146 may be taken concurrently
Introduction to the principles and practices of environmental quality management. Physical and chemical principles affecting environmental quality. Water and air quality parameters, their importance, and natural processes that affect them. Introduction to treatment processes and waste management. Environmental ethics. Lecture three hours. Laboratory three hours.

CE 171A. Soil Mechanics. 4 Units
Prerequisite(s): CE 1A, CE 100, CE 101, CE 146, and ENGR 112. CE 146 may be taken concurrently.
Composition and properties of soils; soil classification; soil compaction; soil-water interaction, including permeability and seepage analyses; soil stresses; soil compressibility, consolidation, and settlement analysis; soil shear strength. Lecture three hours; laboratory three hours.

CE 171B. Soil Mechanics and Foundation Engineering. 3 Units
Prerequisite(s): CE 171A.
Lateral earth pressures and principles of retaining wall design; slope stability analysis and principles of slope stabilization design; ultimate bearing capacity of soils, allowable bearing pressures and settlement of structures; principles of foundation design including shallow foundations and deep foundations.

CE 172. Design of Urban Water and Sewer Systems. 3 Units
Prerequisite(s): CE 137.
Hydraulic design of water distribution and sewerage systems. Computer-assisted pipe network analysis. Analysis of pump systems. Pump station design. Other selected topics.

CE 173. Design of Water Quality Control Processes. 3 Units
Prerequisite(s): CE 170, ENGR 132.
Analysis and design of selected physical, chemical, and biological facilities for water purification and wastewater treatment. Emphasis is on design based on loading factors and integration of unit processes into treatment systems.

CE 181. Geoenvironmental Engineering. 3 Units
Prerequisite(s): CE 170 and CE 171A; CE 170 may be taken concurrently
Equilibrium distribution of contaminants among air, water and solid phases of soil systems; analysis and modeling of soil vapor extraction (SVE), pump and treat, and soil washing systems; movement of gasses in landfills; infiltration through landfill cover; geosynthetic liner systems; hazardous waste containment systems.

CE 184. Geotechnical Earthquake Engineering. 3 Units
Prerequisite(s): CE 171A.
Introduction to seismology and seismic hazard analysis; determination of building code design loads; prediction of soil-site effects; evaluation of liquefaction triggering, cyclic softening and associated consequences; introduction to mitigation techniques for liquefaction and ground failure hazards.

CE 190. Senior Project. 3 Units
Prerequisite(s): To be taken in final semester or instructor permission.
Culminating degree requirement. Completion of a conceptual design and evaluation of alternatives under realistic constraints for proposed infrastructure projects. Students work in teams with practicing professionals providing mentoring. Draws upon full educational experience to date. Lecture two hours. Laboratory three hours.

CE 194. Career Development in Civil Engineering. 1 Unit
Prerequisite(s): Instructor permission.
Designed for Civil Engineering students making career decisions. Instruction will include effective career planning strategies and techniques including skill assessments, employment search strategy, goal setting, time management, interview techniques and resume writing. Lecture one hour.
Note: Units earned cannot be used to satisfy major requirements. Cross Listed: ENGR 194, EEE194

Credit/No Credit

CE 195. Fieldwork in Civil Engineering. 1 - 3 Units
Prerequisite(s): Petition approval by supervising faculty member and Department chair.
Supervised work experience in civil engineering with public agencies or firms in the industry.
Note: May be repeated for credit.

Credit/No Credit

CE 195A. Professional Practice. 1 - 12 Units
Prerequisite(s): Instructor permission.
Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science.
Note: Requires satisfactory completion of the work assignment and a written report.

Credit/No Credit

CE 199. Special Problems. 1 - 3 Units
Individual projects or directed reading.
Note: Open to students judged capable of carrying out individual work. Admission requires departmental approval and sponsorship of a supervising faculty member. Cannot be used as a technical elective in the major. Consult the CE Department for admission procedures and other requirements. May be repeated.

CE 199E. Independent Study Technical Elective. 3 Units
Prerequisite(s): GPA of 2.5 or greater in the upper division courses of the major; grade of "B" or better in the required major course associated with the proposed area of study (CE 137 or CE 146 or CE 147 or CE 161 or CE 170 or CE 171A).
Individual project, research, or directed reading on an advanced topic.
Note: Open to only those students prepared and capable of carrying out independent work. Admission requires departmental approval and sponsorship of a supervising faculty member. Can be used as a technical elective in the major. Consult the CE Department for admission procedures and other requirements. May not be repeated for credit.

CE 231A. Computer Methods of Structural Analysis I. 3 Units
Prerequisite(s): CE 161.
Flexibility and stiffness methods of structural analysis are applied to two- and three-dimensional framed structures. Use of computer software to perform analysis is discussed in detail. Techniques of computer modeling are discussed.

CE 231B. Computer Methods of Structural Analysis II. 3 Units
Prerequisite(s): CE 231A or instructor permission.
Continuation of CE 231A with extension of theory to allow for the analysis of a wider variety of structures. Structural analysis software is used for the analysis of three-dimensional structures. Fundamentals of the finite element method and computer modeling with applications to structural problems.

CE 232. Nonlinear Structural Analysis. 3 Units
Prerequisite(s): CE 231A or instructor permission.
Theory and applications of nonlinear structural analysis including geometric and material nonlinear effects. Stability issues and second-order analysis methods in the context of moment amplification effects, member buckling, and the behavior of structural elements and frames undergoing large deformations. Inelastic material behavior and stress resultant plasticity concepts within a line-type element framework. Computer implementation of geometric nonlinear behavior.

CE 234. Dynamics and Earthquake Response of Structures. 3 Units
Prerequisite(s): Knowledge of the stiffness method of structural analysis.
Response of structures modeled as single-degree systems to harmonic, periodic, and arbitrary excitation and earthquake ground motion; effects of damping and material nonlinearity; numerical methods using spreadsheets; response spectra. Response of structures modeled as multi-degree systems: modeling of structure mass, damping and elastic stiffness; solution by modal superposition; time-history and response spectrum analysis; implications for codes for earthquake-resistant design. Microcomputer software is extensively used.

CE 235. Advanced Steel Design. 3 Units
Prerequisite(s): CE 163
Advanced design methodology of steel structures using Load and Resistance Factor Design (LRFD). System level behavior, especially from a seismic loading perspective, is integrated into the design of steel components and connections. Other topics include plate girder design, plastic design of indeterminate systems, design of moment frame systems, and design of braced-frame systems.

CE 250. Systems Analysis of Resources Development. 3 Units
Prerequisite(s): Graduate status or instructor permission.
Investigation of resource planning using the "systems approach". Objectives of resource development; basic economic and technologic concepts, and economic factors affecting system design. Consideration of evaluation, institutional constraints, and uncertainty in water resources systems. Familiarization with modern computer techniques. Applications of concepts to air and land resources.

CE 251. Water Resources Planning. 3 Units
Prerequisite(s): CE 250 or instructor permission.
Application of single and multi-objective planning to the design and operation of water resources projects. Objectives and constraints for water projects, criteria and procedures for evaluation, planning under uncertainty. Application in water development and water quality planning, with case studies.

CE 252A. Environmental Quality Processes I. 3 Units
Prerequisite(s): CE 170 or equivalent.
Theory and practice of chemical processes affecting water quality. Chemical equilibrium, stoichiometry and kinetics of aqueous chemistry. Acid-base, precipitation-dissolution, oxidation-reduction, and coordination chemistry. Adsorption.

CE 252B. Environmental Quality Processes II. 3 Units
Prerequisite(s): CE 170 or equivalent, CE 252A recommended, or instructor permission.
Theory and practice of biological processes for controlling water. Stoichiometry and kinetics of microbial growth. Aerobic and anaerobic metabolism. Engineered suspended and attached growth systems. Introduction to sludge treatment.

CE 252C. Environmental Quality Processes III. 3 Units
Prerequisite(s): CE 170 or equivalent, CE 252A recommended, or instructor permission.
Theory and practice of physical and chemical processes used in engineered water and wastewater systems. Adsorption, ion exchange, gas transfer, membrane processes, coagulation, flocculation, sedimentation, filtration, precipitation, disinfection, and stripping. Physical/chemical reactors.

CE 254. Water Quality Management. 3 Units
Prerequisite(s): CE 170 or equivalent, CE 252A recommended, or instructor permission.
Examination of pollution sources and effects on water bodies, and the management issues and tools used to protect environmental quality. Topics include point and nonpoint pollution sources, interactions in the environment, Federal and State laws, water quality objectives, beneficial uses, and regulatory mechanisms such as basin plans and total maximum daily loads (TMDLs). Emphasis is on surface water.

CE 255. Transport of Chemicals in Soil Systems. 3 Units
Prerequisite(s): MATH 45. Graduate status.
Study of the mechanics of movement of chemicals in soil, including equilibrium and partition models, development of mass transport equations in porous media, analytical solution for one-dimensional transport, lumped parameter transport model (linear reservoir model), transport of reactive and conservative chemicals numerical solutions of transport models, transport in the unsaturated zone and coupled models for saturated and unsaturated zone.

CE 261. Transportation Planning. 3 Units
Prerequisite(s): CE 148 or instructor permission.
Introduction to the complexities of comprehensive intermodal transportation planning. Study of transportation problems, system operating characteristics, alternative modes, and the planning process. Analyzes factors affecting travel behavior and methods of forecasting demand for travel by various modes.

CE 262. Advanced Transportation Facility Design. 3 Units
Prerequisite(s): CE 147 or instructor permission.
Advanced study of current topics in highway and mass transportation facility design including safety, curve design, pavement design and drainage facility design. Focuses on current design practice and recent or impending changes in design practice.

CE 263. Traffic Flow Theory. 3 Units
Prerequisite(s): CE 147 or CE 148; ENGR 203 or instructor permission.
Study of traffic flow characteristics including flow rate, speed, and density, at both the microscopic and macroscopic levels. Traffic flow analysis using the theoretical methods including capacity analysis, traffic stream models, shockwave analysis, and queuing analysis. Emphasis is on theory with demonstration of practical applications.

CE 265. Analysis and Control of Traffic Systems. 3 Units
Prerequisite(s): CE 147 or CE 148; CE 263 or instructor permission.
Traffic data collection and analysis, practical application of theoretical methods of analysis such as capacity, level of service, and queuing theory. Investigation of traffic control techniques such as actuated signals and signal systems, and study of management techniques for traffic congestion.

CE 266. Advanced Design in Reinforced Concrete. 3 Units
Prerequisite(s): CE 161, CE 163, CE 164.
Advanced topics in behavior and design in reinforced concrete. Detailing for seismic response.

CE 267. Structural Systems for Buildings. 3 Units
Prerequisite(s): CE 232 or instructor permission.
Analyzes and design of various structural systems for buildings: frames, tubes, shear walls with or without openings and interaction between these types. Secondary effects such as P^, material and geometrical nonlinearities.

CE 268. Pre-stressed Concrete Bridge Design. 3 Units
Prerequisite(s): CE 164 or instructor approval.
Behavior and design of short and medium-span prestressed concrete bridges using American Association of State Highway and Transportation Officials (AASHTO) Load Resistance Factor Design (LRFD) specifications. Topics include: bridge types, aesthetics; design process; superstructure load types and live load analysis; limit states and load combinations; prestressed concrete materials; flexural analysis and design; shear analysis and design; and introduction to substructure analysis and design, including seismic design criteria. A team project is required.

CE 271. Modern Hydrologic Techniques. 3 Units
Prerequisite(s): CE 137 or CE 138 and ENGR 203 or instructor permission.
Analyses of hydrologic and meteorologic phenomena by mathematical, statistical, and system methods, linear and non linear, stochastic and parametric hydrology, computer applications in hydrology.

CE 272. Advanced Engineering Hydraulics. 3 Units
Prerequisite(s): CE 137 or equivalent.
Steady uniform and non-uniform open channel flows including gradually, rapid and spatially varied flows; analysis of supercritical flow in transition; basic principles of unsteady flows; long wave theory; Saint-Venant Equations and their solutions including method of characteristics, explicit and implicit finite difference numerical methods.

CE 274. Hydrologic Modeling. 3 Units
Prerequisite(s): CE 272 or equivalent; instructor permission.
Theories and structure of hydraulic model components; application of HEC-RAS (River Analysis System) and HEC-HMS (Hydrologic Modeling System) computer programs; emphasis on flood routing methods; dam safety analysis methodology including dam break and dam overtopping cases; application of microcomputers in hydraulics computations.

CE 276. Groundwater Hydrology. 3 Units
Prerequisite(s): CE 137 or instructor permission.
Occurrence and movement of groundwater; physical characteristics of aquifers; analysis of steady-state groundwater flow problems by mathematical, digital computer, electrical analog and graphical methods; analysis of unsteady-state problems in confined and unconfined, aquifers; multiple well systems.

CE 280A. Advanced Soil Mechanics and Foundation Engineering I. 3 Units
Prerequisite(s): CE 171A or equivalent.
Advanced analyses in soil mechanics and their practical applications in foundation engineering; compressibility of soils, settlement analysis, and tolerable settlement; lateral earth pressures and design of earth retaining structures; bearing capacity of shallow foundations; in-situ soil testing for foundation design; design of deep foundations, including driven piles, drilled shaft foundations, and laterally loaded piles.

CE 280B. Advanced Soil Mechanics and Foundation Engineering II. 3 Units
Prerequisite(s): CE 171A or equivalent.
Advanced analyses in shear strength of cohesionless and cohesive soils, including stress-strain characteristics of soils, total and effective stress analyses; slope stability analyses for natural slopes, fill slopes, earth dams, levees, and methods of slope stabilization; analysis and design of anchored bulkheads, cellular cofferdams, soil nail walls, tieback walls, mechanically stabilized earth walls, and segmental retaining walls.

CE 280C. Geotechnical Modeling. 3 Units
Prerequisite(s): CE 171A
Advanced analysis principles and procedures for calculating monotonic and cyclic soil element response effective stress and pore water pressure distributions, dynamic site response, and soil deformations; application to analysis of complex geotechnical engineering systems such as levees, dams, and wharfs. Laboratory time devoted to numerical analysis software and physical element and small scale tests. Lecture two hours. Laboratory three hours.

CE 283. Ground Modification Engineering. 3 Units
Prerequisite(s): CE 171A or equivalent.
Principles of soil stabilization and earth reinforcement; mechanical compaction and treatment of difficult soils, including expansive soils, collapsible soils, oversize materials, and compressible fill; prefabricated vertical drains and preloading; dynamic deep compaction; vibro compaction; vibro-replacement; rammed aggregate pier; compaction grouting; jet grouting; slurry grouting; chemical grouting; deep soil mixing; slurry trench walls.

CE 284. Soil Dynamics and Earthquake Engineering. 3 Units
Prerequisite(s): CE 171A or equivalent.
Introduction to vibration theory; wave propagation in soils and dynamic behavior of soils and foundations; dynamic tests; analysis of dynamically loaded foundations; causes of earthquakes; earthquake magnitude and zones; ground motions induced by earthquakes; earthquake-resistant design of foundations and earth dams.

CE 285. Geosynthetics I. 3 Units
Prerequisite(s): CE 171A or instructor permission.
Overview of geotextiles, geogrids and geonets; geosynthetic properties and test methods; geosynthetic functions and mechanisms as in separation, roadway and soil reinforcement, filtration, and drainage; applications and design methods; construction, fabrication and installation.

CE 286. Geosynthetics II. 3 Units
Prerequisite(s): CE 171A or instructor permission.
Overview of geomembranes, geosynthetic clay liners, and geocomposites. Topics include: geosynthetic properties and test methods; geosynthetic functions and mechanisms as in landfill liners, liquid barriers and carriers, erosion control, drainage, and design and construction methods.

CE 289. Project Management for Civil Engineers. 3 Units
Prerequisite(s): Graduate standing or instructor permission.
Theory and practice of project management in civil engineering. Interrelationship of planning, design, and construction. New technologies and techniques used in both US and international architectural/engineering/construction (A/E/C) markets.Topics: Project initiation, early estimates, project budgeting, work plans, design proposals, scheduling, tracking, design coordination, construction, project close-out, team and personal management skills, and quality control.

CE 296D. Stormwater Management. 3 Units
Prerequisite(s): CE 137 and CE 170
Principles and practices of stormwater management. Physical and chemical principles affecting stormwater quality, environmental effects, and treatment. Regulatory purposes and requirements for managing construction and post-construction runoff. Choosing and designing Best Management Practices. Erosion control. Hydrologic and hydraulic design of small drainage systems. Emphasis on California climatic and regulatory conditions.

CE 296H. GIS Applications in Civil Engineering. 3 Units
Prerequisite(s): ENGR 115, CE 9 and CE 137 or CE 147 or CE 171A.
Introduction to fundamental concepts of geographic information systems (GIS), methods, and applications in civil engineering. Design and develop GIS-based analytical methods and solutions for civil engineering problems. Lab exercises are used to design and practice GIS applications in civil engineering. This course may be paired with CE 196H.

CE 296I. Pavement Design and Evaluation. 3 Units
Fundamental principles of pavement analysis, design, and evaluation. Topics include pavement materials, mechanics, traffic, and environmental loadings, pavement performance, design methods, and economic evaluation.

CE 299. Special Problems. 1 - 3 Units
Special problems in graduate research.
Note: Approval of a petition must be obtained from the faculty supervising the work and the Department Graduate Program Coordinator. Letter grade or Credit/No Credit.

Credit/No Credit

CE 500. Culminating Experience. 3 - 6 Units
Prerequisite(s): Advanced to candidacy and permission of the faculty advisor and Department Chair.
Successful completion of either: A. Thesis (3-6 units), or B. Project (3-6 units) or C. Directed Study and Examination (3 units). Plan A requires a thesis and is primarily research-orientated. Plan B requires a project report that is primarily application oriented. Plan C requires a detailed literature review or experimental data analysis resulting in a written report plus an examination by three faculty. A public presentation is required for all three plans.