Engineering – Civil

College of Engineering and Computer Science

Bachelor of Science
Master of Science • Certificates

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.

Specializations

- **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 course work 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.

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

Faculty

Mikael Anderson, Cyrus Aryani, Keith Bisharat, Francois Cheong-Siat-Moy, Ed Dammel, Karen Hansen, Ralph Hwang, John Johnston, Ramzi Mahmood, Eric Matsumoto, Saad Merayyan, Ali Porbaha, Kevan Shafizadeh

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- 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 this program are to prepare graduates to:

- succeed in professional employment and/or graduate study in civil engineering;
- identify, analyze, and solve practical civil engineering problems;
- apply knowledge of Environmental, Geotechnical, Structural, Transportation, and Water Resources Engineering to design of civil engineering projects;
- communicate effectively with their peers, other professionals, decision makers, and the general public, in the conduct of their work; and
- practice civil engineering in a professionally responsible and ethical manner.

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 course work required for a Bachelor of Science Civil Engineering Degree.

  Courses that are prerequisites to courses taken for the major and CE 9, ENGR 115, ENGR 140, ENGL 1A, 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.

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. **Working students should expect to take more than four years to complete the degree.**

Requirements • Bachelor of Science Degree

Units required for Major: 60 plus GE courses
Units required for Pre-major: 46 plus GE courses
Minimum total units for the BS: 138

Note: Additional units may be required to meet the Sacramento State foreign language requirement.

Courses in parentheses are prerequisites.

A. Required Lower Division Courses (Pre-Major)

First Semester Freshman Year (17 units)

(2)	CE 4	Engineering Graphics and CAD
(5)	CHEM 1A *	General Chemistry I (High school algebra [two years] and high school chemistry; or equivalent)
(4)	MATH 30 *	Calculus I (MATH 29 or four years of high school mathematics which includes two years of algebra, one year of geometry, and one year of mathematical analysis; completion of ELM requirement and Pre-Calculus Diagnostic Test)
(3)	General Education course	
(3)	General Education course	

Second Semester Freshman Year (18 units)

(1)	CE 1A	Civil Engineering Seminar
(3)	CE 9	Plane and Topographic Surveying (MATH 26A or MATH 30; may be taken concurrently)
(4)	MATH 31*	Calculus II (MATH 30 or appropriate high school based AP credit)
(4)	PHYS 11A*	General Physics: Mechanics (MATH 30, MATH 31 or equivalent certificated high school courses. MATH 31 may be taken concurrently)
(3)	General Education course	
(3)	General Education course	

First Semester Sophomore Year (19 units)

(3)	ENGR 45	Engineering Materials (PHYS 11A, CHEM 1A; CHEM 1A may be taken concurrently)
(3)	MATH 45	Differential Equations for Science and Engineering (MATH 31)
(4)	PHYS 11C *	General Physics: Electricity and Magnetism, Modern Physics (MATH 31, PHYS 11A)
(3)	General Education course	
(3)	General Education course	
(3)	General Education course	

Second Semester Sophomore Year (19 units)

(3)	ENGL 20	College Composition II (ENGL 1A with a grade "C-" or better, or equivalent) **OR**
	ENGL 20T	College Composition II – Technical Communications (ENGL 1A with a grade "C-" or better, or equivalent)
(3)	ENGR 17	Introductory Circuit Analysis (PHYS 11C, MATH 45; either the math or physics may be taken concurrently, but not both)
(3)	ENGR 30	Analytic Mechanics: Statics (MATH 31, PHYS 11A or ENGR 6)
(4)	MATH 32	Calculus III (MATH 31)
(3)	General Education course	
(3)	General Education course	

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

B. Required Upper Division Courses (Major)

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

First Semester Junior Year (19 units)

(2)	CE 100	Engineering Geology (ENGR 112; may be taken concurrently)
(3)	CE 101	Computer Applications in Civil Engineering (CE 4, ENGR 30)
(3)	CE 146	Civil Engineering Practice (CE 1A, CE 101; both may be taken concurrently)
(3)	ENGR 110	Analytic Mechanics: Dynamics (ENGR 30, MATH 32, MATH 45)
(3)	ENGR 112	Mechanics of Materials (ENGR 30, ENGR 45, MATH 45)
(2)	ENGR 115	Statistics for Engineers (MATH 31, may be taken concurrently)
(3)	General Education course	

Second Semester Junior Year (17 units)

(1)	CE 113	Structural Laboratory (ENGR 112, CE 101)
(3)	CE 161	Theory of Structures I (ENGR 112, MATH 32, CE 146; CE 146 may be taken concurrently)
(4)	CE 171A	Soil Mechanics (ENGR 112, CE 100, CE 146; CE 146 may be taken concurrently)
(3)	ENGR 132	Fluid Mechanics (ENGR 110)
(3)	ENGR 140	Engineering Economics (ENGR 17, ENGR 30, or MET 30, or instructor permission)
(3)	General Education course	

First Semester Senior Year (17 units)

(3)	CE 137	Water Resources Engineering (ENGR 115, ENGR 132, ENGR 140; CE 146; CE 146 may be taken concurrently.)
(4)	CE 147	Transportation Engineering (ENGR 115, CE 9 and CE 146, passing score on WPE; CE 146 may be taken concurrently)
(3)	CE 164	Reinforced Concrete Design (CE 161, CE 113; CE 113 may be taken concurrently)
(4)	CE 170	Principles of Environmental Engineering (ENGR 115, CE 146; CE 146 may be taken concurrently, passing score on WPE)
(3)	ENGR 124	Thermodynamics (MATH 32, PHYS 11A, CHEM 1A)

Second Semester Senior Year (16 units)

(1)	CE 135	Hydraulics Laboratory (CE 101, CE 137, passing score on WPE, CE 137 may be taken concurrently)
(3)	CE 190	Senior Design Project (To be taken in final semester or with instructor permission)
(3)	CE elective+	
(3)	CE elective+	
(3)	CE elective+	
(3)	General Education course	

+ One CE elective is restricted to a design course.

C. Civil Engineering Electives

Electives are to be chosen from the following courses in consultation with a faculty advisor and must include at least one design elective (indicated by°).

CE 138	Hydrology (CE 137; may be taken concurrently)
CE 139°	Open Channel Hydraulics (CE 137; may be taken concurrently)
CE 148	Transportation Systems (CE 147, ENGR 140, or instructor permission)
CE 162	Theory of Structures II (CE 161)
CE 163	Structural Design in Steel I (CE 161)
CE 165°	Structural Design in Steel II (CE 163)
CE 166	Seismic Behavior of Structures (CE 101, CE 161; ENGR 110)
CE 167°	Bridge Design (CE 163, CE 164; one may be taken concurrently)
CE 168°	Prestressed Concrete Design (CE 161, CE 164; CE 164 may be taken concurrently)
CE 169A°	Timber Design (CE 161)
CE 169B°	Reinforced Masonry Design (CE 161)
CE 171B°	Soil Mechanics and Foundation Engineering (CE 171A)
CE 172°	Design of Urban Water and Sewer Systems (CE 137)
CE 173°	Design of Water Quality Control Processes (CE 170, ENGR 132)
CE 181	Geoenvironmental Engineering (CE 171A or instructor permission)
CE 184	Introduction to Earthquake Engineering (CE 161, CE 171A)

° Indicates a design elective.

Note: Other electives, such as a CE 196 series course or CE 199 may be chosen with the approval of a faculty advisor and Department Chair.

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 195 A, B, C, or D) 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 multimodal transportation; interdisciplinary study with other areas of civil engineering as well as with non-engineering areas (e.g., Environmental Studies, Geography, Public Policy and 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

Applications may be accepted as long as room for new students exists. However, students are strongly urged to apply by April 1 for the following fall or October 1 for the following spring, in order to allow time for registration deadlines. 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*.

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;
- passed the Writing Proficiency Examination (WPE) or secured approval for a WPE 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.

Requirements • Master of Science Degree

Units required for the MS: 30 - Includes research or independent study and units required in area of concentration (see below)

Minimum GPA: 3.0

Courses in parentheses are prerequisites.

A. Required Course Work (18 units)

Core Courses: 15 units are required as outlined in the Core Courses section below.

Mathematics/Statistics: Select one of the following with advisor approval:

	ENGR 201	Engineering Analysis I (MATH 45)
	ENGR 202	Engineering Analysis II (MATH 45)
	ENGR 203	Engineering Statistics (ENGR 115 or equivalent)

B. Elective Courses (6-9 units)

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.

C. Culminating Requirement (3-6 units)

Choose one of the following CE 500 requirements:

Plan A: Master's Thesis (3-6 units) Approval by the faculty thesis/project advisor and by a second faculty or an expert in the area of study is required. A presentation is also required. The thesis or project must comply with University standards for format and is filed in the University Library.

Plan B: Master's Project (3-6 units) See Plan A requirements.

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.

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 course work (not including CE 299) outside the chosen area of specialization.

Environmental/Water Quality Engineering

(3)	CE 250	Systems Analysis of Resources Development (Graduate status or instructor permission)
(3)	CE 252A	Environmental Quality Processes I (CE 170 or equivalent)
(3)	CE 252B	Environmental Quality Processes II (CE 170 or equivalent, CE 252A recommended, or instructor permission)
(3)	CE 252C	Environmental Quality Processes III (CE 170 or equivalent; CE 252A recommended)
(3)	CE 254	Water Quality Management (CE 170 or equivalent; CE 252A recommended, or instructor permission)
(3)	CE 255	Transport of Chemicals in Soil Systems (MATH 45, graduate status)
(3)	CE 276	Groundwater Hydrology (CE 137 or instructor permission)

Geotechnical Engineering

(3)	CE 280A	Advanced Soil Mechanics and Foundation Engineering I (CE 171A or equivalent)
(3)	CE 280B	Advanced Soil Mechanics and Foundation Engineering II (CE 171A or equivalent)
(2)	CE 280C	Advanced Soil Mechanics Laboratory (CE 280A; Corequisite: CE 280B)
(3)	CE 283	Ground Modification Engineering (CE 171A, or equivalent)
(3)	CE 284	Soil Dynamics and Earthquake Engineering (CE 171A or equivalent)
(3)	CE 285	Geosynthetics I (CE 171A or instructor permission)
(3)	CE 286	Geosynthetics II (CE 171A or instructor permission)

Structural Engineering

(3)	CE 231A	Computer Methods of Structural Analysis I (CE 161)
(3)	CE 231B	Computer Methods of Structural Analysis II (CE 231A or instructor permission)
(3)	CE 232	Stability of Structures (CE 163 or CE 164 or instructor permission)

(3) CE 234 Dynamics and Earthquake Response of Structures (Knowledge of the stiffness method of structural analysis)
(3) CE 266 Advanced Design in Reinforced Concrete (CE 161, CE 163, CE 164)
(3) CE 267 Structural Systems for Buildings (CE 232 or instructor permission)

Transportation Engineering
(3) CE 261 Transportation Planning (CE 148 or instructor permission)
(3) CE 262 Advanced Transportation Facility Design (CE 147 or instructor permission)
(3) CE 263 Traffic Flow Theory (CE 147 or CE 148; ENGR 203 or instructor permission)
(3) CE 265 Analysis and Control of Traffic Systems (CE 147 or CE 148; CE 263 or instructor permission)
(3) CE 285 Geosynthetics I (CE 171A or instructor permission)

Water Resources Engineering
(3) CE 250 Systems Analysis of Resources Development (Graduate status or instructor permission)
(3) CE 251 Water Resources Planning (CE 250 or instructor permission)
(3) CE 271 Modern Hydrologic Techniques (CE 137 or CE 138 and ENGR 203, or instructor permission)
(3) CE 272 Advanced Engineering Hydraulics (CE 137 or equivalent)
(3) CE 274 Hydrologic Modeling (CE 272 or equivalent; instructor permission)
(3) CE 276 Groundwater Hydrology (CE 137 or instructor permission)

Requirements • 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:

Geo-Environmental Certificate
(3) CE 181 Geoenvironmental Engineering (CE 171A or instructor permission)
(3) CE 252A Environmental Quality Processes I (CE 170 or equivalent)
(3) CE 255 Transport of Chemicals in Soil Systems (MATH 45, graduate status)
(3) ENGR 203 Engineering Statistics (ENGR 115 or equivalent)

Treatment Systems Certificate
(3) CE 252A Environmental Quality Processes I (CE 170 or equivalent)
(3) CE 252B Environmental Quality Processes II (CE 170 or equivalent; CE 252A recommended, or instructor permission)
(3) CE 252C Environmental Quality Processes III (CE 170 or equivalent; CE 252A recommended, or instructor permission)
(3) ENGR 203 Engineering Statistics (ENGR 115 or equivalent)

Water Quality Certificate
(3) CE 250 Systems Analysis of Resources Development (Graduate status or instructor permission)
(3) CE 252A Environmental Quality Processes I (CE 170 or equivalent)
(3) CE 254 Water Quality Management (CE 170 or equivalent; CE 252A recommended, or instructor permission)
(3) ENGR 203 Engineering Statistics (ENGR 115 or equivalent)

Geotechnical Engineering:

Foundation Engineering Certificate
(3) CE 280A Advanced Soil Mechanics and Foundation Engineering I (CE 171A or equivalent)
(3) CE 280B Advanced Soil Mechanics and Foundation Engineering II (CE 171A or equivalent)
(2) CE 280C Advanced Soil Mechanics Laboratory (CE 280A; Corequisite: CE 280B)
(3) CE 284 Soil Dynamics and Earthquake Engineering (CE 171A or equivalent)

Ground Modification Certificate
(3) CE 283 Ground Modification Engineering (CE 171A or equivalent)
(3) CE 285 Geosynthetics I (CE 171A or instructor permission)
(3) CE 286 Geosynthetics II (CE 171A or instructor permission)
(3) ENGR 203 Engineering Statistics (ENGR 115 or equivalent)

Structural Engineering:

Structural Engineering Certificate
(3) CE 231A Computer Methods of Structural Analysis I (CE 161)
(3) CE 232 Stability of Structures (CE 163 or CE 164 or instructor permission)
(3) CE 234 Dynamics and Earthquake Response of Structures (Knowledge of the stiffness method of structural analysis)
(3) CE 266 Advanced Design in Reinforced Concrete (CE 161, CE 163, CE 164)

Transportation Engineering:

Transportation Planning Certificate
(3) CE 250 Systems Analysis of Resources Development (Graduate status or instructor permission)
(3) CE 261 Transportation Planning (CE 148 or instructor permission)
(3) CE 262 Advanced Transportation Facility Design (CE 147 or instructor permission)
(3) ENGR 203 Engineering Statistics (ENGR 115 or equivalent)

Transportation/Traffic Engineering Certificate

(3)	CE 250	Systems Analysis of Resources Development (Graduate status or instructor permission)
(3)	CE 263	Traffic Flow Theory (CE 147 or CE 148; ENGR 203 or instructor permission)
(3)	CE 265	Analysis and Control of Traffic Systems (CE 147 or CE 148; CE 263 or instructor permission)
(3)	ENGR 203	Engineering Statistics (ENGR 115 or equivalent)

Water Resources Engineering:

Engineering Hydraulics Certificate

(3)	CE 272	Advanced Engineering Hydraulics (CE 137 or equivalent)
(3)	CE 274	Hydrologic Modeling (CE 272 or equivalent; instructor permission)
(3)	CE 276	Groundwater Hydrology (CE 137 or instructor permission)
(3)	ENGR 203	Engineering Statistics (ENGR 115 or equivalent)

Water Resources Planning Certificate

(3)	CE 250	Systems Analysis of Resources Development (Graduate status or instructor permission)
(3)	CE 251	Water Resources Planning (CE 250 or instructor permission)
(3)	CE 271	Modern Hydrologic Techniques (CE 137 or CE 138 and ENGR 203 or instructor permission)
(3)	ENGR 203	Engineering Statistics (ENGR 115 or equivalent)

Lower Division Courses

CE 1A. Civil Engineering Seminar. 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. **Units:** 1.0.

CE 1B. Civil Engineering Seminar. Designed for non-majors or majors who wish to repeat CE 1A with an opportunity for a different set of case studies. **Note:** May not be used to fulfill civil engineering degree requirements. **Graded:** Credit / No Credit. **Units:** 1.0.

CE 4. Engineering Graphics and CAD. 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. **Units:** 2.0.

CE 9. Plane and Topographic Surveying. 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. **Prerequisite:** MATH 26A or MATH 30; may be taken concurrently. **Units:** 3.0.

Upper Division Courses

CE 100. Engineering Geology. Soil and rock mechanics and their relations to geological features influencing design, construction and maintenance of engineering projects. Lectures and field problems. **Prerequisite:** ENGR 112; may be taken concurrently. **Units:** 2.0.

CE 101. Computer Applications in Civil Engineering. 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. **Prerequisite:** ENGR 4, ENGR 30. **Units:** 3.0.

CE 113. Structural Laboratory. 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. **Prerequisite:** ENGR 112, CE 101. **Units:** 1.0.

CE 135. Hydraulics Laboratory. Laboratory experiments relating the principles of fluid mechanics to real fluid flow. Laboratory three hours. **Prerequisite:** ENGR 132, CE 101, passing score on the WPE. **Units:** 1.0.

CE 137. Water Resources Engineering. 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. **Prerequisite:** ENGR 115, ENGR 132, ENGR 140 CE 146; CE 146 may be taken concurrently. **Units:** 3.0.

CE 138. Hydrology. 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. **Prerequisite:** CE 137; may be taken concurrently. **Units:** 3.0.

CE 139. Hydraulic Flow Design. 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. **Prerequisite:** CE 137; may be taken concurrently. **Units:** 3.0.

CE 146. Civil Engineering Practice. 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 will also be addressed. **Prerequisite:** CE 1A and CE 101; both may be taken concurrently. **Units:** 3.0.

CE 147. Transportation Engineering. 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. **Prerequisite:** ENGR 115, CE 9, CE 146, passing score on WPE; CE 146 may be taken concurrently. **Units:** 4.0.

CE 148. Transportation Systems. 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. **Prerequisite:** CE 147, ENGR 140 or instructor permission. **Units:** 3.0.

CE 161. Theory of Structures I. Analyzes statically determinate and indeterminate beams, frames, trusses and grids. Includes energy principles, flexibility analysis, slope deflection method, moment distribution procedure, and stiffness analysis. Computers are used to aid in the solution of complex structural problems. **Prerequisite:** ENGR 112, MATH 32, CE 146; CE 146 may be taken concurrently. **Units:** 3.0.

CE 162. Theory of Structures II. 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. **Prerequisite:** CE 161. **Units:** 3.0.

CE 163. Structural Design in Steel I. 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. **Prerequisite:** CE 161. **Units:** 3.0.

CE 164. Reinforced Concrete Design. 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. **Prerequisite:** CE 161, CE 113; CE 113 may be taken concurrently. **Units:** 3.0.

CE 165. Structural Design in Steel II. 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. **Prerequisite:** CE 163. **Units:** 3.0.

CE 166. Seismic Behavior of Structures. 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. **Prerequisite:** CE 101, CE 161, ENGR 110. **Units:** 3.0.

CE 167. Bridge Design. Fundamental concepts of bridge design including the following aspects: aesthetics, alternative design, environmental mitigation, permits, right-of-way, agreements and route adaptions. Typical design examples of the super-structure (made of reinforced concrete/steel) are given. **Prerequisite:** CE 163, CE 164; one may be taken concurrently. **Units:** 3.0.

CE 168. Prestressed Concrete Design. Analyzes and design of prestressed 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. **Prerequisite:** CE 161, CE 164; CE 164 may be taken concurrently. **Units:** 3.0.

CE 169A. Timber Design. 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. **Prerequisite:** CE 161. **Units:** 3.0.

CE 169B. Reinforced Masonry Design. 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. **Prerequisite:** CE 161. **Units:** 3.0.

CE 170. Principles of Environmental Engineering. 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. **Prerequisite:** ENGR 115, CE 146 and passing score on the WPE; CE 146 may be taken concurrently. **Units:** 4.0.

CE 171A. Soil Mechanics. 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. **Prerequisite:** ENGR 112, CE 100, CE 146; CE 146 may be taken concurrently. **Units:** 4.0.

CE 171B. Soil Mechanics and Foundation Engineering. 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. **Prerequisite:** CE 171A. **Units:** 3.0.

CE 172. Design of Urban Water and Sewer Systems. Hydraulic design of water distribution and sewerage systems. Computer-assisted pipe network analysis. Analysis of pump systems. Pump station design. Other selected topics. **Prerequisite:** CE 137. **Units:** 3.0.

CE 173. Design of Water Quality Control Processes. Analyzes 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. **Prerequisite:** CE 170, ENGR 132. **Units:** 3.0.

CE 181. Geoenvironmental Engineering. 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. **Prerequisite:** CE 171A or instructor permission. **Units:** 3.0.

CE 184. Introduction to Earthquake Engineering. Introduction to causes of and motions associated with earthquakes; definition, measurement and prediction of earthquake parameters; response of soil deposits and structures to earthquakes; liquefaction; principles of earthquake resistant design. **Prerequisite:** CE 161, CE 171A. **Units:** 3.0.

CE 190. Senior Project. 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. **Prerequisite:** To be taken in final semester or instructor permission. **Units:** 3.0.

CE 194. Career Development in Civil Engineering. 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. **Prerequisite:** Instructor permission. **Cross-listed:** ENGR 194, EEE 194 **Graded:** Credit / No Credit. **Units:** 1.0.

CE 195. Fieldwork in Civil Engineering. Supervised work experience in civil engineering with public agencies or firms in the industry. **Note:** May be repeated for credit. **Prerequisite:** Petition approval by supervising faculty member and Department chair. **Graded:** Credit / No Credit. **Units:** 1.0-3.0.

CE 195A. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Com-

puter Science. **Note:** Requires satisfactory completion of the work assignment and a written report. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

CE 195B. Professional Practice. 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. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

CE 195C. Professional Practice. 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. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

CE 195D. Professional Practice. 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. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

CE 196. Experimental Offerings in Civil Engineering. When a sufficient number of qualified students apply, one of the staff will conduct a proseminar in some topic of engineering. **Note:** May be repeated for credit with permission of advisor. **Units:** 1.0-4.0.

CE 199. Special Problems. Individual projects or directed reading. Open only to those students who appear competent to carry on individual work. **Note:** Admission requires approval of a petition from the faculty supervising the work and the Department Chair. May be repeated for credit. Letter grade or Credit/No Credit. **Graded:** Graded (CR/NC Available). **Units:** 1.0-3.0.

Graduate Courses

CE 231A. Computer Methods of Structural Analysis I. 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. **Prerequisite:** CE 161. **Units:** 3.0.

CE 231B. Computer Methods of Structural Analysis II. 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. **Prerequisite:** CE 231A or instructor permission. **Units:** 3.0.

CE 232. Stability of Structures. Critical loads of columns and beams. Introduction to load and resistance factor design. Torsion of thin-walled members. Torsion of building structures. Stability of frames and trusses. Effect of inelastic behavior of materials. **Prerequisite:** CE 163 or CE 164 or instructor permission. **Units:** 3.0.

CE 234. Dynamics and Earthquake Response of Structures. 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. **Prerequisite:** Knowledge of the stiffness method of structural analysis. **Units:** 3.0.

CE 250. Systems Analysis of Resources Development. 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. **Prerequisite:** Graduate status or instructor permission. **Units:** 3.0.

CE 251. Water Resources Planning. 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. **Prerequisite:** CE 250 or instructor permission. **Units:** 3.0.

CE 252A. Environmental Quality Processes I. 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. **Prerequisite:** CE 170 or equivalent. **Units:** 3.0.

CE 252B. Environmental Quality Processes II. 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. **Prerequisite:** CE 170 or equivalent, CE 252A recommended, or instructor permission. **Units:** 3.0.

CE 252C. Environmental Quality Processes III. 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. **Prerequisite:** CE 170 or equivalent, CE 252A recommended, or instructor permission. **Units:** 3.0.

CE 254. Water Quality Management. 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. **Prerequisite:** CE 170 or equivalent, CE 252A recommended, or instructor permission. **Units:** 3.0.

CE 255. Transport of Chemicals in Soil Systems. 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. **Prerequisite:** MATH 45. Graduate status. **Units:** 3.0.

CE 261. Transportation Planning. 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. **Prerequisite:** CE 148 or instructor permission. **Units:** 3.0.

CE 262. Advanced Transportation Facility Design. 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. **Prerequisite:** CE 147 or instructor permission. **Units:** 3.0.

CE 263. Traffic Flow Theory. 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, shock-wave analysis, and queueing analysis. Emphasis is on theory with demonstration of practical applications. **Prerequisite:** CE 147 or CE 148; ENGR 203 or instructor permission. **Units:** 3.0.

CE 265. Analysis and Control of Traffic Systems. Traffic data collection and analysis, practical application of theoretical methods of analysis such as capacity, level of service, and queueing theory. Investigation of traffic control techniques such as actuated signals and signal systems, and study of management techniques for traffic congestion. **Prerequisite:** CE 147 or CE 148; CE 263 or instructor permission. **Units:** 3.0.

CE 266. Advanced Design in Reinforced Concrete. Advanced topics in behavior and design in reinforced concrete. Detailing for seismic response. **Prerequisite:** CE 161, CE 163, CE 164. **Units:** 3.0.

CE 267. Structural Systems for Buildings. 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. **Prerequisite:** CE 232 or instructor permission. **Units:** 3.0.

CE 271. Modern Hydrologic Techniques. Analyses of hydrologic and meteorologic phenomena by mathematical, statistical, and system methods, linear and non linear, stochastic and parametric hydrology, computer applications in hydrology. **Prerequisite:** CE 137 or CE 138 and ENGR 203 or instructor permission. **Units:** 3.0.

CE 272. Advanced Engineering Hydraulics. 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. **Prerequisite:** CE 137 or equivalent. **Units:** 3.0.

CE 274. Hydrologic Modeling. 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. **Prerequisite:** CE 272 or equivalent; instructor permission. **Units:** 3.0.

CE 276. Groundwater Hydrology. 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. **Prerequisite:** CE 137 or instructor permission. **Units:** 3.0.

CE 280A. Advanced Soil Mechanics and Foundation Engineering I. 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. **Prerequisite:** CE 171A or equivalent. **Units:** 3.0.

CE 280B. Advanced Soil Mechanics and Foundation Engineering II. 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. **Prerequisite:** CE 171A or equivalent. **Units:** 3.0.

CE 280C. Advanced Soil Mechanics Laboratory. Lectures and experimental studies dealing with the more advanced aspects of soil properties and their applications in design. Consolidation, strength of soils in triaxial compression testing with measurements of volume changes and pore-water pressures, dynamic soil tests, in-situ measurement techniques of soil properties such as Dutch cone, pressuremeters, and vane shear methods, advanced instrumentations, R-value and CBR tests for pavement designs and student projects. Lecture one hour; Laboratory three hours. **Prerequisite:** CE 280A. **Corequisite:** CE 280B. **Units:** 2.0.

CE 283. Ground Modification Engineering. 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. **Prerequisite:** CE 171A or equivalent. **Units:** 3.0.

CE 284. Soil Dynamics and Earthquake Engineering. 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. **Prerequisite:** CE 171A or equivalent. **Units:** 3.0.

CE 285. Geosynthetics I. 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. **Prerequisite:** CE 171A or instructor permission. **Units:** 3.0.

CE 286. Geosynthetics II. Overview of geomembranes, geosynthetic clay liners, and geocomposities. 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. **Prerequisite:** CE 171A or instructor permission. **Units:** 3.0.

CE 296. Experimental Offerings in Civil Engineering. When a sufficient number of qualified students are interested, one of the staff will conduct a seminar on some topic of civil engineering. **Note:** May be repeated for credit with permission of advisor. Not offered every semester. **Units:** 1.0-4.0.

CE 299. Special Problems. Special problems in graduate research. **Note:** Approval of a petition must be obtained from the faculty supervising the work and the Department Chair. Not more than 3 units may be taken without written approval from the faculty adviser and Department Chair. Letter grade or Credit/No Credit. **Graded:** Graded (CR/NC Available). **Units:** 1.0-3.0.

CE 500. Culminating Experience. Credit given upon successful completion of either: A. Thesis (1-6 units), or B. Project (1-6 units) or C. Directed Study (1-3 units) and Comprehensive Examination. (Comprehensive Examination must be taken after completion of all course work and Directed Study.) **Prerequisite:** Advanced to candidacy and permission of the faculty advisor and Department Chair one full semester prior to registration. **Graded:** Thesis in Progress. **Units:** 1.0-6.0.