289K. Special Topics in Chemical Engineering; Advanced Transport Phenomena (1-5)
Lecture and/or laboratory. Prerequisite: consent of instructor. Special topics in Advanced Transport Phenomena. May be repeated for credit when topic differs. Offered irregularly.—*F, W, S. (F, W, S.)*

289L. Special Topics in Chemical Engineering; Biomolecular Engineering (1-5)
Lecture and/or laboratory. Prerequisite: consent of instructor. Special topics in Biomolecular Engineering. May be repeated for credit when topic differs. Offered irregularly.—*F, W, S. (F, W, S.)*

290. Seminar (1)
Seminar—1 hour. Seminar. (S/U grading only.) Offered irregularly.—*F, W, S. (F, W, S.)*

290C. Graduate Research Group Conference (1)
Discussion—1 hour. Prerequisite: consent of instructor. Research problems, progress and techniques in chemical engineering. May be repeated for credit. (S/U grading only.) Offered irregularly.—*F, W, S. (F, W, S.)*

294. Current Progress in Biotechnology (1)
Seminar—1 hour. Prerequisite: graduate standing. Seminars presented by guest lecturers on subjects of their own research activities. May be repeated for credit. (Same course as Molecular and Cellular Biology 294.) (S/U grading only.) Offered irregularly.—*F, W, S. (F, W, S.)*

298. Group Study (1-5)
Prerequisite: consent of instructor. Group study. (S/U grading only.) Offered irregularly.—*F, W, S. (F, W, S.)*

299. Research (1-12)
Research. (S/U grading only.) Offered irregularly.—*F, W, S. (F, W, S.)*

Professional

390. Teaching of Chemical Engineering (1)
Discussion—1 hour. Prerequisite: qualifications and acceptance as teaching assistant and/or associate-in in chemical engineering. Participation as a teaching assistant or associate-in in a designated engineering course. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports. May be repeated two times for credit. (S/U grading only.)—*F, W, S. (F, W, S.)*

Engineering: Civil and Environmental

(College of Engineering)

Amit M. Kanvinde, Ph.D., Chairperson of the Department 530-752-0586

Department Office. 2001 Ghausi Hall
530-752-0586; *http://cee.engr.ucdavis.edu*

Faculty

John E. Bolander, Ph.D., Professor
Fabian A. Bombardelli, Ph.D., Associate Professor
Ross W. Boulanger, Ph.D., Professor
Colleen E. Bronner, Ph.D., Lecturer
Christopher D. Cappa, Ph.D., Professor
Y. H. (Rob) Chai, Ph.D., Professor
Lijuan Cheng, Ph.D., Associate Professor
Yannis F. Dafalias, Ph.D., Professor
Jeannie L. Darby, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Jason T. DeJong, Ph.D., Professor
Yueyue Fan, Ph.D., Professor
Alexander L. Forrest, Ph.D., Assistant Professor
John T. Harvey, Ph.D., Professor
Jonathan D. Herman, Ph.D., Assistant Professor
Miguel A. Jaller, Ph.D., Assistant Professor
Boris Jeremic, Ph.D., Professor
Amit M. Kanvinde, Ph.D., Professor
M. Levent Kavvas, Ph.D., Professor
Alissa Kendall, Ph.D., Associate Professor
Michael J. Kleeman, Ph.D., Professor
Sashi K. Kunnath, Ph.D., Professor
Bruce L. Kutter, Ph.D., Professor
Frank J. Loge, Ph.D., Professor
Jay R. Lund, Ph.D., Professor
Sabbie A. Miller, Ph.D., Assistant Professor
Mark P. Modera, Ph.D., Professor *(Civil and Environmental Engineering; Mechanical and Aerospace Engineering)*
Debbie A. Niemeier, Ph.D., Professor
Mark M. Rashid, Ph.D., Professor
Academic Senate Distinguished Teaching Award
S. Geoffrey Schladow, Ph.D., Professor
Daniel Sperling, Ph.D., Professor *(Civil and Environmental Engineering; Environmental Science and Policy)*
N. Sukumar, Ph.D., Professor
Anthony S. Wexler, Ph.D., Professor *(Civil and Environmental Engineering; Mechanical and Aerospace Engineering; Land, Air and Water Resources)*
Thomas M. Young, Ph.D., Professor
Bassam A. Younis, Ph.D., Professor
H. Michael Zhang, Ph.D., Professor

Emeriti Faculty

Takashi Asano, Ph.D., Professor Emeritus
Don O. Brush, Ph.D., Professor Emeritus
Daniel P. Y. Chang, Ph.D., Professor Emeritus
James A. Cheney, Ph.D., Professor Emeritus
Leonard R. Herrmann, Ph.D., Professor Emeritus
Academic Senate Distinguished Teaching Award, UC Davis Prize for Teaching and Scholarly Achievement
I.M. Idriss, Ph.D., Professor Emeritus
Timothy R. Ginn, Ph.D., Professor Emeritus
Ian P. King, Ph.D., Professor Emeritus
Bruce E. Larock, Ph.D., Professor Emeritus
Miguel A. Mariño, Ph.D., Professor Emeritus
(Civil and Environmental Engineering; Land, Air and Water Resources)
Patricia L. Moktarian, Ph.D., Professor Emerita
Gerald T. Orlob, Ph.D., Professor Emeritus
Otto G. Raabe, Ph.D., Professor Emeritus
Melvin R. Ramey, Ph.D., Professor Emeritus
Karl M. Romstad, Ph.D., Professor Emeritus
Academic Senate Distinguished Teaching Award
Edward D. Schroeder, Ph.D., Professor Emeritus
Academic Senate Distinguished Teaching Award
Verne H. Scott, Ph.D., Professor Emeritus
Michael A. Taylor, Ph.D., Professor Emeritus
George Tchobanoglous, Ph.D., Professor Emeritus
Stefan Wuertz, Ph.D., Professor Emeritus

Affiliated Faculty

Norman A. Abrahamson, Ph.D., Adjunct Professor
Kenneth J. Loh, Ph.D., Adjunct Associate Professor
Patrick C. Lucia, Ph.D., Adjunct Professor
Brian H. Maroney, D.Engr., Adjunct Assistant Professor

The Civil and Environmental Engineering Programs

Mission. The Department of Civil and Environmental Engineering integrates research, education, and professional service in areas related to civil infrastructure and the environment. We provide the profession and academia with outstanding graduates who advance both engineering practice and fundamental knowledge.

Program Educational Objectives. The objectives of the Civil Engineering undergraduate program at the University of California, Davis are to produce civil and environmental engineers who *(1)* are proficient in the fundamentals of engineering science, analytical and quantitative reasoning, and design in the context of civil and environmental engineering, *(2)* are able to apply these skills in developing safe, sustainable, economical and environmentally sound solutions to civil engineering problems either within the profession or through post-graduate research, *(3)* grow professionally in their careers through continued development of technical and management skills, achievement of professional licensure, and assumption of roles of responsibility in professional service, and *(4)* understand the needs and represent the diversity of the program's constituencies*, thereby serving the needs of society and the profession.

*The constituency of the CEE program includes our students and those organizations or employers that they might join during career paths spanning professional practice, education, and research. Specifically, these constituents may include consulting firms and organizations, state and federal agencies or laboratories, universities, cities and counties, contractors, civil-product manufacturers and suppliers, and environmental organizations.

Study Abroad and Civil Engineering. The department offers courses in locations such as Ireland, Italy, and Japan through the Summer Abroad Program. Students may also complete a portion of the civil engineering program at an international institution, such as the University of Edinburgh, by participating in an Education Abroad Program. The department encourages interested students to participate in both Summer Abroad and Education Abroad Programs. Please consult with the undergraduate staff adviser in the department for more information. Often students are in their junior or senior year of study when they participate in this option.

Civil Engineering Undergraduate Program

The Civil Engineering program is accredited by the Engineering Accreditation Commission of ABET; see *http://www.abet.org*.

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed. Exclusive of General Education units, the minimum number of units required for the Civil Engineering major is 152 (77 units in lower division and 75 units in upper division).

Lower Division Required Courses

	UNITS
Mathematics 21A-21B-21C-21D	16
Mathematics 22A-22B	6
Physics 9A-9B-9C and choice of Physics 9D, Chemistry 2C, Biological Science 2A or Geology 50-50L	19
Chemistry 2A-2B or 2AH-2BH	10
Civil and Environmental Engineering 3, 16	6
(Civil and Environmental Engineering 3 is designed for lower division students and is not open to upper-division students. Students who do not take this course will substitute four units of additional upper-division Civil and Environmental Engineering coursework.)	
One course from: Civil and Environmental Engineering 19, Engineering 6, or Computer Science Engineering 30	4
Engineering 35, 45 or 45Y	8
English 3 or University Writing Program 1, 1V, or 1Y, or Comparative Literature 1, 2, 3, or 4, or Native American Studies 5 (grade of C- or better)	4
Communication 1 or 3	4

Upper Division Requirements:

Environmental Engineering. This area focuses on understanding and management of physical, chemical, and biological processes in natural and engineered systems. Areas of emphasis include improvement of air, land, and water quality in the face of increasing population, expanding industrialization, and global climate change. Examples of environmental engineering include innovative analysis and design of air, water, wastewater, and solid waste treatment systems; mathematical modeling of natural and engineered systems; life cycle analysis; sampling, analysis, transport and transformation of natural and anthropogenic pollutants; and modeling of air pollutant emissions.

Suggested Advisers. C.E. Bronner, C. D. Cappa, J.L. Darby, A. Kendall, M.J. Kleeman, F. J. Loge, J.R. Lund, M.P. Modera, D.A. Niemeier, S.G. Schladow, T.M. Young

Geotechnical Engineering. This area deals with civil infrastructure and environmental problems that require quantifying the behavior of geologic materials (such as soils and rocks). Examples of geotechnical engineering problems include foundations for buildings and bridges, earthwork (such as dams, tunnels, highways), earthquake hazards (such as ground motions, liquefaction, soil-structure interaction), and geo-environmental problems (ground water flow, subsurface contaminant transport and remediation).

Suggested Advisers. R.W. Boulanger, Y.F. Dafalias, J.T. DeJong, J.T. Harvey, B. Jeremic, B.L. Kutter, P.C. Lucia

Structural Engineering and Structural Mechanics. Structural Engineering addresses the conception, sustainable design, analysis, construction, and life-cycle modeling of all types of civil infrastructure, including buildings, bridges, dams, ports, highways, and industrial facilities subject to sources of loadings ranging from gravity, to earthquakes, to extreme environmental events. Structural Mechanics encompasses the theory of solid structures, and the associated methods of analysis and computation used in the practice of Structural Engineering. For both disciplines, materials of particular interest include steel, reinforced concrete, timber, advanced composites and particulate media.

Suggested Advisers. J.E. Bolander, Y.K. Chai, L. Cheng, Y.F. Dafalias, J.T. Harvey, A.M. Kanvinde, S.K. Kunnath, B.H. Maroney, S.A. Miller, M.M. Rashid, N. Sukumar

Transportation Planning and Engineering. This area deals with the movement of people and goods in a manner consistent with society's environmental and socio-economic goals. Transportation engineering applies engineering, physical and mathematical sciences, economics, and behavioral social science principles to plan, analyze, design, and operate resilient and sustainable transportation systems, such as highways, transit, airfields and ports. Transportation planning involves the formulation and analysis of transportation policy, program, and project alternatives in consideration of societal goals, budgetary constraints, socio-economic (such as safety, equity and mobility) and environmental objectives (such as air and water quality, climate change, and clean energy), and technological feasibilities (such as vehicle, infrastructure, and information technologies).

Suggested Advisers. Y. Fan, J.T. Harvey, M.A. Jaller, A. Kendall, M.P. Modera, D.A. Niemeier, D. Sperling, H.M. Zhang

Water Resources Engineering. This area includes hydrology, hydraulics, fluid mechanics, and water resources systems planning and design. Hydrology deals with quantifying and understanding all aspects of the hydrologic cycle, including the relationships between precipitation, runoff, groundwater, and surface water. Water quality and contaminant transport issues are linked to hydrologic conditions. Hydraulics and fluid mechanics deal with flows in pipes, open-channel water-distribution systems, and natural systems, such as lakes and estuaries. Water resources systems planning and design deals with the comprehensive development of water resources to meet the multiple needs of industry, agriculture, municipalities, recreation, and other activities.

Suggested Advisers. F.A. Bombardelli, J.L. Darby, A.L. Forrest, J.D. Herman M.L. Kavvas, J.R. Lund, S.G. Schladow, B.A. Younis

Additional information on areas of specialization and potential faculty advisers can be obtained from the departmental website.

Civil Engineering

Upper Division Required Courses

Engineering 103, 104, 104L, 106......... 12
Engineering 102 or 105......................... 4
Civil and Environmental Engineering 114, 190.. 6
One course from Civil and Environmental Engineering 115, 153; Mathematics 118A; or Statistics 108..................................... 4
Civil & Environmental Engineering Breadth
Select one course from four of the following group options: 14-17
- *Environment:* Civil and Environmental Engineering 140 or 148A or 149
- *Geotechnical:* Both Civil and Environmental Engineering 171 and 171 Lab
- *Structures:* Civil and Environmental Engineering 130
- *Transportation:* Civil and Environmental Engineering 161 or 163 or 165
- *Water Resources:* Both Civil and Environmental Engineering 141 and 141 Lab

Civil & Environmental Engineering Depth
Select two courses from two of the following group options: 15-16
- *Environment:* Civil and Environmental Engineering 140, 148B, 150
- *Geotechnical:* Civil and Environmental Engineering 173, 175, 179
- *Structures:* Civil and Environmental Engineering 131, 132, 135, 136
- *Transportation:* Civil and Environmental Engineering 161, 162, 179
- *Water Resources:* Civil and Environmental Engineering 142, 144, 145, 146
- *Senior Design Requirement:* Must complete at least two of the following courses as part of the Civil & Environmental Engineering depth and elective: Civil & Environmental Engineering 127, 136, 145, 148B, 150, 162, or 173

Civil & Environmental Engineering electives... 20
- Civil & Environmental Engineering electives may include any upper division, letter-graded Civil & Environmental Engineering course not already used towards another degree requirement, Engineering 102 or 105, and may include, but not exceed, a combination of six units from Civil & Environmental Engineering 198 and 199.**

Upper Division Composition Requirement 0-4
- One course from the following (grade of C- or better is required): University Writing Program 101, 102E, 102G, 104A, 104E, 104T or passing the Upper Division Composition Exam.

* No unit of coursework may be used to satisfy two different degree requirements, i.e. although a course may be listed in more than one category, that course may only satisfy one requirement.
** A maximum of 4 units of upper-division courses outside of Civil & Environmental Engineering may be considered on a petition basis. Please consult with the undergraduate staff adviser.

Construction Engineering and Management Minor

To declare this minor program offered by the Department of Civil and Environmental Engineering, students must complete ENG 104 with a C- or better and submit a short personal statement focusing on academic and career goals, including relevant internships/experience. The online Minor Declaration form is available via the Online Advising Student Information System (OASIS) at https://students.ucdavis.edu/. Minimum overall UC GPA at time of declaration: 2.500.

All prerequisites must have been taken for a letter grade; no grade lower than a C- will be accepted in any prerequisite course.

Successful completion and transcript notation of the minor requires both a minimum overall UC GPA of 2.000 and a minimum 2.000 GPA for the coursework completed for the minor, with no grade lower than a C- for any course used for the minor.

Minor Requirements:

Prerequisite courses must be completed prior to enrollment in coursework taken for minor.

UNITS

Construction Engineering and Management 24
Civil and Environmental Engineering 137, 143, 153 12
Twelve units from:
- Civil and Environmental Engineering 179, Agricultural and Resource Economics 112, 155, 157, 171A, 171B, Economics 134, 162; Environmental Science and Policy 161; may include one course from Agricultural and Resource Economics 18, Management 11A............................ 12

Minor advisers. J.L. Darby, J.T. Harvey, J.R. Lund

Sustainability in the Built Environment Minor

All courses must be taken for a letter grade. A grade of C- or better is required for all courses used to satisfy minor requirements with an overall GPA in minor requirement courses of 2.000 or better.

UNITS

Sustainability in the Built Environment.. 20
Civil and Environmental Engineering 123, 143 8
Twelve units from:
- Civil and Environmental Engineering 125, 126, 127, 128, 148A, 149, 155, 162, 165, Engineering 188, Anthropology 101 (same as Environmental Science & Policy 101), 104N, Agricultural and Resource Economics 175, 176, Atmospheric Science 116, Community and Regional Development 142, 154, 172, Environmental Science and Policy 161, 162, 171, Environmental Toxicology 101, 102A, Geology 130, 134, Landscape Architecture 3, 180*, Plant Sciences 101, 141, 150, 162................................ 12

* Due to variability in series course offering, consent of minor adviser is required.

Minor advisers. F.J. Loge, A. Kendall

The Graduate Program in Civil and Environmental Engineering

M.S. and Ph.D.; Designated Ph.D. emphasis available in Biotechnology
http://cee.engr.ucdavis.edu
530-752-1441

With over thirty faculty members, over $20 million in annual research expenditures and over 200 graduate students, the Department of Civil and Environmental Engineering integrates research, education and professional service in areas related to civil infrastructure and the environment. Graduate students benefit from close working relationships with professors who are the leading international experts in their field. They are supported in their study and research by robust funding, and they have access to state-of-the-art research centers. For example, the Center for Geotechnical Modeling, http://cgm.engr.ucdavis.edu, has the largest centrifuge of its kind in the nation and gives researchers access to their peers at other unique centers via high-speed networks. Since 1960, researchers at the J. Amorocho Hydraulics Laboratory (JAHL) have served the state of California by solving ecological, biological, environmental and hydraulic engineering problems. Students may also have the opportunity to work in one of the many modern environmental engineering labs or the structural testing facilities in the department. Our graduates go on to serve the profession and academia by advancing the leading edge of fundamental knowledge, as well as engineering practice.

Generous financial support is available in the form of research assistantships, teaching assistantships, fellowships and financial aid. About 75% of the graduate students in our program are either fully or partially supported.

Research Highlights:

- Alternative fuel transportation infrastructure
- Earthquake engineering
- Environmental engineering
- Environmental planning and management
- Geotechnical engineering
- Hydraulics and fluid mechanics
- Hydrology
- Structural engineering
- Structural health monitoring
- Structural mechanics
- Systems planning and design
- Transportation engineering
- Transportation planning and design
- Water resources engineering

Research Facilities and Partnerships:

- Advanced Transportation Infrastructure Research Center
- Center for Geotechnical Modeling
- Center for Watershed Sciences
- Center for Water-Energy Efficiency
- Institute of Transportation Studies
- J. Amorocho Hydraulics Laboratory (JAHL)
- John Muir Institute of the Environment
- Nano-Engineering and Smart Structures Technologies
- Tahoe Environmental Research Center
- Western Cooling Efficiency Center

Complete Information on our website.

Courses in Engineering: Civil and Environmental (ECI)

Lower Division

3. Civil Infrastructure and Society (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: Mathematics 21A (may be taken concurrently). Pass One restricted to lower division students; Civil Engineering majors. Introduction to civil infrastructure and its relationship with society and the natural environment. Exposure to innovative research on civil engineering and environmental systems. Participation in laboratory experiments illustrative of the solution of representative but simplified engineering problems. Not open for credit to upper division students. GE credit: SciEng or SocSci | OL, SE or SS.—*F. (F.)* Darby

16. Spatial Data Analysis (2)

Lecture—1 hour; laboratory—3 hours. Restricted to Civil Engineering and Biological Systems Engineering majors; non-majors accommodated on a space-available basis. Computer-aided design and geographic information systems in civil engineering practice. GE credit: SciEng | QL, SE.—*S. (S.)* Fa, Bronner

17. Surveying (2)

Lecture—2 hours. Prerequisite: Physics 9A (may be taken concurrently). Restricted to Civil Engineering and Biological Systems Engineering majors; non-majors accommodated on a space-available basis. Theory behind and description of modern methods of land surveying in Civil Engineering. Offered irregularly. GE credit: SciEng | SE.

19. C Programming for Civil and Environmental Engineers (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: Mathematics 21A (may be taken concurrently). Pass One open to Civil Engineering majors and Optical Science and Engineering majors. Computational problem solving techniques for Civil and Environmental Engineering applications using structured C programming. Algorithm design applied to realistic problems. Offered irregularly. GE credit: SciEng | SE.—Jeremic, Kleeman

90X. Lower Division Seminar (1-4)

Seminar—1-4 hours. Prerequisite: consent of instructor. Examination of a special topic in a small group setting. May be repeated for credit. GE credit: SciEng | SE.

92. Internship in Engineering (1-5)

Internship. Prerequisite: lower division standing; approval of project prior to period of internship. Supervised work experience in civil engineering. May be repeated for credit. (P/NP grading only.) GE credit: SE.

98. Directed Group Study (1-5)

Prerequisite: consent of instructor and lower division standing. (P/NP grading only.) GE credit: SE.

99. Special Study for Undergraduates (1-5)

Prerequisite: consent of instructor; lower division standing. (P/NP grading only.) GE credit: SE.

Upper Division

114. Probabilistic Systems Analysis for Civil Engineers (4)

Lecture—4 hours. Prerequisite: C- or better in Mathematics 21C. Probabilistic concepts and models in engineering. Statistical analysis of engineering experimental and field data. Introduction to stochastic processes and models of engineering systems. Not open for credit to students who have completed Statistics 120. GE credit: SciEng | QL, SE.—*W, S. (W, S.)*

115. Computer Methods in Civil & Environmental Engineering (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: Engineering 6 or Computer Science Engineering 30, and Mathematics 22B. Open to Civil Engineering majors only. Presentation, implementation and application of numerical algorithms and computer models for the solution of practical problems in Civil and Environmental Engineering. GE credit: SciEng | SE.—*S. (S.)* Sukumar, Younis

119. Parallel Processing for Engineering Applications (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: C programming or consent of instructor. Fundamental skills in parallel computing for engineering applications; emphasis on structured parallel programming for distributed memory parallel clusters. Not open for credit to students who have completed course 119B. Offered irregularly. GE credit: SciEng | SE.—Kleeman, Jeremic

123. Urban Systems and Sustainability (4)

Lecture—4 hours. Prerequisite: upper division standing. Systems-level approach of how to evaluate and then modify sustainability of urban systems based on interaction with natural environments. Topics include: definition/metrics of urban sustainability; system analyses of urban systems; enabling technology, policies, legislation; measures and modification of ecological footprints. GE credit: SciEng or SocSci, Div, Wrt | ACGH, DD, SE, SL, SS, WE.—*S. (S.)* Kendall

125. Building Energy Performance (4)

Lecture—4 hours. Prerequisite: upper division standing in Engineering. Open to students in the College of Engineering. Mechanisms of energy consumption in buildings including end uses, thermal loads, ventilation, air infiltration, thermal energy distribution, and HVAC systems; energy performance simulation; methods and strategies of energy efficiency. Offered in alternate years. GE credit: SciEng | SE.—*(S.)* Modera

126. Integrated Planning for Green Civil Systems (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: Physics 9C or Landscape Architecture 60 or Design 145 or Environmental Science and Policy 100 or Nature and Culture 120 or Anthropology 100 or Statistics 32 or Plant Sciences 101; consent of instructor. Working within multidisciplinary teams, a heuristic learning environment, and multiple realistic constraints, an integrated design process will be applied to the planning of a project-based green and sustainable civil system. Offered irregularly. GE credit: SciEng | SE.

127. Integrated Design for Green Civil Systems: Senior Design Experience (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: course 126; consent of instructor. Restricted to senior level standing. Working within multidisciplinary teams and a heuristic, project-based learning environment, a green and sustainable civil system will be designed. Evaluate various design options under architectural, structural, cost and environmental constraints, and present designs through oral and written presentations. Offered irregularly. GE credit: SciEng | SE.

128. Integrated Construction for Green Civil Systems (4)

Lecture—2 hours; laboratory—6 hours. Prerequisite: course 127. Working within multidisciplinary teams, a heuristic learning environment, and multiple realistic constraints, an integrated design process will be applied to the construction of a project-based green and sustainable civil system. Offered irregularly. GE credit: SciEng | SE.

130. Structural Analysis (4)

Lecture—4 hours. Prerequisite: C- or better in Engineering 104; Mathematics 22A. Open to Civil Engineering majors. Elastic structural analysis of determinate and indeterminate trusses, beams and frames. Plastic bending and limit analysis. GE credit: SciEng | QL, SE.—*W, S. (F, S.)*

131. Matrix Structural Analysis (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 104; Engineering 6. Open to Engineering majors only. Matrix formulation and computer analysis of statically indeterminate structures. Stiffness and flexibility formulations for elastic structures. Finite element methods for elasticity and bending problems. Offered irregularly. GE credit: SciEng | SE.—*S.*

132. Structural Design: Metallic Elements (4)

Lecture—4 hours. Prerequisite: course 130. Design of metallic beams, columns, and other members for various types of loading and boundary conditions; design of connections between members; member performance within structural systems. GE credit: SciEng | SE, VL.—*F. (W.)* Bolander, Kanvinde

135. Structural Design: Concrete Elements (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: course 130. Restricted to Civil Engineering, Civil Engineering/Materials Science and Engineering, and Materials Science and Engineering majors only. Strength design procedures for columns, rectangular beams, Tbeams and beams of general cross-section. Building code requirements for bending, shear, axial load, combined stresses and bond. Introduction to prestressed concrete. GE credit: SciEng | QL, SE.—*W. (W.)* Chai

136. Building Design: Senior Design Experience (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: course 130 or 131; course 135 or 132. Restricted to senior level standing. Design of a building structure for a specific need under the multiple constraints of safety, serviceability, cost and aesthetics. Offered irregularly. GE credit: SciEng | SE.—*S.*

137. Construction Principles and Project Management (4)

Lecture—3 hours; laboratory—3 hours. Restricted to upper division standing in Engineering. Project management, with civil engineering construction and design applications, including project scope, schedule, resources, cost, quality, risk, and control. Construction industry overview. Interactions between planning, design, construction, operations. Construction operations analysis. Contract issues. Project management software, field trips, guest lectures. Offered irregularly. GE credit: SciEng or SocSci | ACGH, OL, QL, SE or SS, VL, WE.—*W. (W.)* Harvey

138. Earthquake Loads on Structures (4)
Lecture—3 hours; discussion—1 hours. Prerequisite: course 130 or 131. Determination of loads on structures due to earthquakes. Methods of estimating equivalent static lateral forces; response spectrum and time history analysis. Concepts of mass, damping and stiffness for typical structures. Design for inelastic behavior. Numerical solutions and Code requirements. GE credit: SciEng | SE.—*W. (S.)* Kunnath

139. Advanced Structural Mechanics (4)
Lecture—4 hours. Prerequisite: C- or better in Engineering 104. Review of stress, strain, equilibrium, compatibility, and elastic material behavior. Plane stress and plane strain problems in elasticity; energy methods. Theories for unsymmetric bending, straight and curved beams. Beams on elastic foundations; stresses in plates and shells; elastic stability. Offered irregularly. GE credit: SciEng | SE.—Rashid, Sukumar

140. Environmental Analysis of Aqueous Systems (3)
Lecture—3 hours. Prerequisite: Chemistry 2B. Introduction to chemical principles underlying current practices in sampling and analysis of water and wastewater. GE credit: SciEng | SE.—*F. (F.)* Darby, Young

140L. Environmental Analysis of Aqueous Systems Laboratory (1)
Laboratory—3 hours. Prerequisite: Chemistry 2B or the equivalent; course 140 (may be taken concurrently). Restricted to Civil Engineering undergraduate and graduate students. Introduction to "wet chemical" and instrumental techniques commonly used in the examination of water and wastewater and associated data analysis. Offered irregularly. GE credit: SciEng | SE.—*F.* Darby

141. Engineering Hydraulics (3)
Lecture—3 hours. Prerequisite: C- or better in Engineering 103. Nature of flow of a real fluid; flow in pipes; open channel flow; turbomachinery; fluid forces on objects: boundary layers, lift and drag. GE credit: SciEng | SE.—*F, W. (F, W.)* Bombardelli, Schladow, Younis

141L. Engineering Hydraulics Laboratory (1)
Laboratory—3 hours. Prerequisite: course 141 (may be taken concurrently). Open to Engineering students only. Laboratory experiments and demonstrations on flow measurement, sluice gates, hydraulic jump, flow characteristics, and centrifugal pumps. GE credit: SciEng | SE.—*F, W. (F, W.)* Bombardelli, Schladow, Younis

142. Engineering Hydrology (4)
Lecture—4 hours. Prerequisite: course 141 (may be taken concurrently). Restricted to students in the College of Engineering. Hydrologic cycle. Evapotranspiration, interception, depression storage and infiltration. Streamflow analysis and modeling. Flood routing through channels and reservoirs. Frequency analysis of hydrologic variables. Precipitation analysis for hydrologic design. Hydrologic design. GE credit: SciEng | QL, SE.—*F. (F.)* Kavvas

143. Green Engineering Design and Sustainability (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 106; course 148A. Restricted to upper division standing; Pass One restricted to Civil Engineering majors. Application of concepts, goals and metrics of sustainability, green engineering and industrial ecology to engineering design. Other course topics include life-cycle assessments, analysis of environmental management systems, and economics of pollution prevention and sustainability. GE credit: SciEng | QL, SE, SL, WE.—*W. (W.)* Bronner

144. Groundwater Systems Design (4)
Lecture—4 hours. Prerequisite: course 141. Groundwater occurrence, distribution, and movement; groundwater flow systems; radial flow to wells and aquifer testing; aquifer management; groundwater contamination; solute transport by groundwater; fate and transport of subsurface contaminants. Groundwater supply and transport modeling. GE credit: SciEng | SE.—*F. (F.)*

144L. Groundwater Systems Design Laboratory (1)
Laboratory—3 hours. Prerequisite: course 144, taken concurrently. Computer modeling of groundwater flow under regional gradient, well injection/withdrawal, and natural and engineered boundary conditions. Use of Groundwater Vistas computer program. Offered irregularly.—Ginn

145. Hydraulic Structure Design: Senior Design Experience (4)
Lecture—2 hours; discussion—1 hour; laboratory—3 hours. Prerequisite: C- or better in course 141. Restricted to senior level standing. Project-based course covering the design of an integrated urban drainage system, including consideration of design alternatives, multiple realistic constraints (public safety, economic, environmental, sustainability and health), quantification of hydrologic uncertainty, codes and standards, design drawings and specifications and cost analysis. Offered irregularly. GE credit: SciEng | SE.—*S. (S.)* Younis

146. Water Resources Simulation (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103. Computer simulation techniques in the analysis, design and operation of surface water systems; modeling concepts and practices with application to surface runoff; water quality in rivers and streams and dispersion of contaminants in water bodies. GE credit: SciEng, Wrt | SE.—*W. (W.)* Bombardelli, Younis

148A. Water Quality Management (4)
Lecture—4 hours. Prerequisite: C- or better in Chemistry 2B. Basic concepts of water quality measurements and regulations. Introduction to physical, biological and chemical processes in natural waters. Fundamentals of mass balances in water and wastewater treatment. GE credit: SciEng | SE.—*W. (W.)* Bronner, Young

148B. Water and Wastewater Treatment System Design: Senior Design Experience (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 103 and course 148A. Restricted to senior level standing. Design and evaluation of water and wastewater treatment systems. GE credit: SciEng | QL, SE, VL, WE.—*S. (S.)* Darby

149. Air Pollution (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Mathematics 21D, 22B; C- or better in Chemistry 2B; Atmospheric Science 121A or C- or better in Engineering 103. Physical and technical aspects of air pollution. Emphasis on geophysical processes and air pollution meteorology as well as physical and chemical properties of pollutants. (Same course as Atmospheric Science 149.) GE credit: SciEng | QL, SE, SL.—*F. (F.)* Cappa

150. Air Pollution Control System Design: Senior Design Experience (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Atmospheric Science 149 or course 149. Restricted to senior level standing. Design and evaluation of air pollution control devices and systems. GE credit: SciEng | SE.—*W. (W.)* Cappa

153. Deterministic Optimization and Design (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Mathematics 21C and 22A; computer programming course. Operations research. Optimization techniques such as linear programming, dynamic programming, and non-linear programming. Applications in civil engineering disciplines, including multiple realistic constraints, through computer-based course projects. GE credit: SciEng | QL, SE, SL.—*F. (F.)* Fan

155. Water Resources Engineering Planning (4)
Lecture—4 hours. Prerequisite: Engineering 106 or Economics 1A; course 114. Basic engineering planning concepts; role of engineering, economic, environmental and social information and analysis; institutional, political and legal aspects. Case studies and computer models illustrate the planning of water resource systems. GE credit: SciEng or SocSci, Wrt | QL, SE or SS, SL, WE.—*S. (W.)* Herman, Lund

161. Transportation System Operations (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in both Mathematics 21C and Physics 9A. Principles of transportation system operations; traffic characteristics and methods of measurement; models of transportation operations and congestion applied to urban streets and freeways. GE credit: SciEng | QL, SE.—*F. (F.)* Zhang

162. Transportation Land Use Sustainable Design: Senior Design Experience (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in course 148A or 161 or 163. Restricted to senior level standing. Interactions between land use and transportation systems design. Generalized design paradigm; project-based solutions for transportation land use. Students will select from various strategies to satisfy multiple constraints including cost, effectiveness and environmental sustainability. Oral, poster and written presentations required. GE credit: SciEng | SE, SL.—*S. (S.)* Niemeier

163. Energy and Environmental Aspects of Transportation (4)
Lecture—3 hours; extensive writing. Prerequisite: Economics 1A or Engineering 106. Engineering, economic, and systems planning concepts. Analysis and evaluation of energy, air quality and selected environmental attributes of transportation technologies. Strategies for reducing pollution and petroleum consumption in light of institutional and political constraints. Evaluation of vehicle emission models. (Same course as Environmental Science and Policy 163.) Offered in alternate years. GE credit: SciEng or SocSci, Wrt | SE or SS, SL, WE.—*F.* Sperling

165. Transportation Policy (3)
Lecture—3 hours. Transportation and associated environmental problems confronting urban areas, and prospective technological and institutional solutions. Draws upon concepts and methods from economics, engineering, political science and environmental studies. Offered in alternate years. GE credit: SciEng or SocSci, Wrt | QL, SE or SS.—*(F.)* Sperling

171. Soil Mechanics (4)
Lecture—4 hours. Prerequisite: C- or better in Engineering 104; Engineering 103 (may be concurrent); course 171L (co-requisite). Restricted to Civil Engineering and Civil Engineering/Materials Science and Engineering majors only. Soil formations, mass-volume relationships, soil classification, effective stress, soil-water-void relationships, compaction, seepage, capillarity, compressibility, consolidation, strength, states of stress and failure, lateral earth pressures, and slope stability. GE credit: SciEng | SE.—*F, S. (F, S.)* Kutter

171L. Soil Mechanics Laboratory (1)
Laboratory—3 hours. Prerequisite: course 171 must be taken concurrently. Laboratory studies utilizing standard testing methods to determine physical, mechanical and hydraulic properties of soil and demonstration of basic principles of soil behavior. GE credit: SciEng | SE.—*F, S. (F, S.)* Kutter

173. Foundation Design: Senior Design Experience (4)
Lecture—4 hours. Prerequisite: course 171. Restricted to senior level standing. Soil exploration and determination of properties for design; design of shallow and deep foundations for bearing capacity and settlements; design of retaining structures;

selection and evaluation of foundation alternatives; excavation support and dewatering; major design experience and design report preparation. GE credit: SciEng | SE.—*W. (W.)* Boulanger

175. Geotechnical Earthquake Engineering (4)

Lecture—4 hours. Prerequisite: C- or better in course 171. Earthquakes, faults, seismology and ground motions; complex notation for vibratory motions, the wave equation, reflection and refraction; dynamic soil properties, linear and nonlinear 1-D site response analysis; introduction to soil-structure interaction. Not open for credit to students who have taken course 287A. GE credit: SciEng | SE.—*W. (W.)* Boulanger, Kutter

179. Pavement Engineering (4)

Lecture—3 hours; discussion/laboratory—3 hours. Prerequisite: C- or better in Engineering 104. Pavement types (rigid, flexible, unsurfaced, rail), their applications (roads, airfields, ports, rail) and distress mechanisms. Materials, traffic and environment characterization. Empirical and mechanistic-empirical design procedures. Maintenance, rehabilitation and reconstruction; construction quality; asphalt concrete mix design. GE credit: SciEng | QL, SE, SL, VL.—*F. (F.)* Harvey

189A. Selected Topics in Civil Engineering; Environmental Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Environmental Engineering. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189B. Selected Topics in Civil Engineering; Hydraulics and Hydrologic Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Hydraulics and Hydrologic Engineering. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189C. Selected Topics in Civil Engineering; Engineering Planning (1-5)

Prerequisite: consent of instructor. Directed group study in Engineering Planning. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189D. Selected Topics in Civil Engineering; Geotechnical Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Geotechnical Engineering. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189E. Selected Topics in Civil Engineering; Structural Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Structural Engineering. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189F. Selected Topics in Civil Engineering; Structural Mechanics (1-5)

Prerequisite: consent of instructor. Directed group study in Structural Mechanics. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189G. Selected Topics in Civil Engineering; Transportation Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Transportation Engineering. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189H. Selected Topics in Civil Engineering; Transportation Planning (1-5)

Prerequisite: consent of instructor. Directed group study in Transportation Planning. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189I. Selected Topics in Civil Engineering; Water Resources Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Water Resources Engineering. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

189J. Selected Topics in Civil Engineering; Water Resources Planning (1-5)

Prerequisite: consent of instructor. Directed group study in Water Resources Planning. May be repeated for credit when the topic is different. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)*

190. The Civil Engineer in Society (2)

Lecture—1 hours; laboratory—3 hours. Open to upper division Civil Engineering majors. The Civil Engineering profession; introduction to concepts in business, management, public policy and leadership including the importance of professional licensure and a discussion of professional ethical and societal issues related to civil engineering. GE credit: SocSci | SS.—*F, S. (F, S.)* Bronner, Kunnath

190C. Research Group Conferences in Civil and Environmental Engineering (1)

Discussion—1 hour. Prerequisite: upper division standing in Civil and Environmental Engineering; consent of instructor. Research group conferences. May be repeated for credit. (P/NP grading only.) GE credit: SE.—*F, W, S. (F, W, S.)*

192. Internship in Engineering (1-5)

Internship. Prerequisite: upper division standing; approval of project prior to the period of the internship. Supervised work experience in civil engineering. May be repeated for credit. (P/NP grading only.) GE credit: SE.

198. Directed Group Study (1-5)

Prerequisite: consent of instructor. (P/NP grading only.) GE credit: SE.

199. Special Study for Advanced Undergraduates (1-5)

Prerequisite: consent of instructor. (P/NP grading only.) GE credit: SE.—*F, W, S. (F, W, S.)*

Graduate

201. Introduction to Theory of Elasticity (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 104. Fundamental equations of elasticity in three dimensions; plane stress and plane strain; flexture and torsion of bars of various shapes. Introduction to variational and approximate methods.—*F. (F.)* Rashid

203. Inelastic Behavior of Solids (3)

Lecture—3 hours. Prerequisite: course 201. Fundamentals of theories of plasticity, viscoelasticity and viscoplasticity for solids. Macroscopic constitutive modelling for engineering materials, e.g., metals, polymers, soils, etc., and microscopic motivation. Offered in alternate years.—*(W.)* Dafalias

205. Continuum Mechanics (3)

Lecture—3 hours. Prerequisite: course 201. Tensor formulation of the field equations for continuum mechanics, including large deformation effects. Invariance and symmetry requirements. Introduction to nonlinear thermoelasticity and thermodynamics. Solution of three-dimensional problems. Selected topics. Offered in alternate years.—*F.* Dafalias

206. Fracture Mechanics (4)

Lecture—4 hours. Prerequisite: course 201; Engineering 104. Linear and nonlinear fracture mechanics, stress analysis, energy concepts, brittle fracture criteria, path independent integrals, Dugdale- Barenblatt model, general cohesive zone models, ductile fracture criteria, crack tip fields for stationary and propagating cracks, fatigue. Application of numerical methods for fracture mechanics. Offered in alternate years.—*(W.)* Sukumar

211. Advanced Matrix Structural Analysis (4)

Lecture—4 hours. Prerequisite: course 131. Analysis of complex frameworks by the displacement method; treatment of tapered beams, curved beams, and beams on elastic foundations; partially rigid connections; geometric and material nonlinearities; buckling; flexibility-based formulations; FEM-software for nonlinear analysis of structures.—*F. (F.)* Kunnath

212A. Finite Element Procedures in Applied Mechanics (4)

Lecture—4 hours. Prerequisite: Applied Science Engineering 115, or Mathematics 128A and Mathematics 128B (may be taken concurrently). Weighted-residual and Rayleigh-Ritz methods. Weak/variational formulation and development of discrete equations using finite element approximations. Application to one- and two-dimensional problems (heat conduction).—*W. (W.)* Sukumar

212B. Finite Elements: Application to Linear and Non-Linear Structural Mechanics Problems (4)

Lecture—4 hours. Prerequisite: course 212A. Application to linear and nonlinear structural mechanics problems. Linear elasticity, weak form, and finite element approximation. Incompressible media problems. Non-linear problems with material nonlinearity.—*S. (S.)* Sukumar

213. Analysis of Structures Subjected to Dynamic Loads (4)

Lecture—4 hours. Prerequisite: course 211 (may be taken concurrently). Analysis of structures subjected to earthquake, wind and blast loading; distributed, consistent and lumped mass techniques; computer implementation; nonlinear response spectrum; frequency and time domain analysis; seismic protection of structures; numerical methods in linear and nonlinear structural dynamics.—*F. (F.)* Kunnath

214. Probabilistic Seismic Hazard Analysis and Design Ground Motions (4)

Lecture—4 hours. Probabilistic seismic hazard analysis for use in developing design spectra and for seismic risk analyses, including the development of earthquake ground motion time series for use in dynamic analyses of structures. Offered in alternate years.—*F. (F.)* Abrahamson

216. Meshfree Methods and Partition of Unity Finite Elements (4)

Lecture—4 hours. Prerequisite: course 201 and 212A. Advanced discretization techniques such as meshfree methods and partition of unity finite elements for the Galerkin solution of boundary-value problems in solid and structural mechanics. Application of meshfree and extended finite element methods in computational fracture. Offered irregularly.—Sukumar

221. Theory of Plates and Introduction to Shells (3)

Lecture—3 hours. Prerequisite: course 201 (may be taken concurrently). Development of classical and refined plate theories. Application to isotropic, orthotropic and composite plates. Solutions for rectangular and circular plates. Membrane theory for axisymmetric shells and bending of circular shells.

223. Advanced Dynamics, Signal Processing, and Smart Structures Technology (4)

Lecture—4 hours. Prerequisite: course 213 or equivalent. Signal processing and system identification of structures under dynamic excitations; Fourier and Laplace transforms; data acquisition and sensor design fundamentals; sensor technologies/techniques for nondestructive evaluation; structural control; actuators and dampers for smart structures; piezoelectrics and acoustic emissions; micro- and nano-fabrication.

232. Advanced Topics in Concrete Structures (4)

Lecture—4 hours. Prerequisite: course 130, 135, 138 and graduate standing. Ductility of reinforced concrete; strength of two-way slabs; modified compression field theory.—*S. (S.)* Chai

233. Advanced Design of Steel Structures (4)

Lecture—4 hours. Prerequisite: courses 130 or 131, 132. Review of Load and Resistance Factor Design (LRFD); steel-plate girder design; plastic design of indeterminate systems; moment frames and bracing systems; connection design; seismic design of steel structures; vibration of flooring systems; steel-concrete composite design.—*S. (S.)* Bolander

234. Prestressed Concrete (4)
Lecture—4 hours. Prerequisite: courses 130 or 131, 135. Survey of methods and applications; prestressing materials and systems; prestress losses; flexural design; design for shear and torsion; deflection computation and control; continuous beams and indeterminate structures; floor systems; partial prestressing; design of compression members; strut-and-tie models. Offered in alternate years.—Bolander

235. Cement Composites (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Engineering 104. Applications of cement composites; materials selection and proportioning; component and composite properties; hydration reactions and microstructure development; mechanisms of failure; nondestructive test methods; fiber reinforcement; concrete durability; novel reinforcing materials; ferrocement; repair and retrofit technologies; applications to structural design. Offered in alternate years.—*W.* Bolander

236. Design of Fiber Reinforced Polymer Composite Structures (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 135. Basics of mechanics and design of polymer matrix composites: composite classification, manufacturing process, micromechanical property determination, classical lamination theory, strength theories, first-ply-failure, test methods, design practice, strengthening and retrofitting of existing reinforced concrete structures.—*(S.)* Cheng

237. Bridge Design (4)
Lecture—4 hours. Prerequisite: courses 130, 135; course 234 recommended. Open to graduate students only. Bridge types, behavior and construction characteristics; design philosophy, details according to Caltrans and American Association of State Highway and Transportation Officials codes, principles; seismic design and retrofit of concrete bridges; modern bridges using advanced fiber reinforced polymer composites; fieldtrip required.—*S. (S.)* Cheng

238. Performance-Based Seismic Engineering (4)
Lecture—4 hours. Prerequisite: Courses 138 and 213. Modern seismic design; performance-based seismic design; seismic hazard; seismic demands: linear and nonlinear procedures; performance assessment: deterministic and probabilistic procedure; review of FEMA-350, FEMA-356, ATC-40 and other performance-based guidelines.—*(W.)* Kunnath

240. Water Quality (4)
Lecture—4 hours. Prerequisite: courses 141 and 142. Quality requirements for beneficial uses of water. Hydrologic cycle of quality. Hydromechanics in relation to quality of surface and groundwaters; transport and fate of waterborne pollutants. Heat budget for surface waters; predictive methods; introduction to water quality modeling.—*W. (W.)* Schladow

241. Environmental Reactive Chemical Transport Modeling (4)
Lecture—4 hours. Prerequisite: Chemistry 2A, or Chemistry 2B, or course 149, or equivalent. Modeling of reactive chemical transport in air and water including kinetic reactions, equilibrium reactions, and phase partitioning. Emphasis on numerical solution schemes and programming techniques to provide deeper insight into model performance and limitations. Offered in alternate years.—*S.*s Kleeman

242. Air Quality (4)
Lecture—4 hours. Prerequisite: Engineering 105, course 141, 149 or the equivalent. Factors determining air quality. Effects of air pollutants. Physical and chemical fundamentals of atmospheric transport and reaction. Introduction to dispersion modeling. Offered in alternate years.—*(F.)* Kleeman

243A. Water and Waste Treatment (4)
Lecture—4 hours. Prerequisite: course 148A or the equivalent. Characteristics of water and airborne wastes; treatment processes and process kinetics; treatment system design.—*F. (F.)*

243B. Water and Waste Treatment (4)
Lecture—4 hours. Prerequisite: course 243A. Continuation of course 243A. Aeration, thickening, biological processes, design of biological treatment systems.—*W. (W.)* Loge

243L. Pilot Plant Laboratory (4)
Lecture—1 hour; Discussion—1 hour; Laboratory—6 hours. Prerequisite: course 243A and 243B (may be taken concurrently) or consent of instructor; graduate standing. Laboratory investigation of physical, chemical, and biological processes for water and wastewater treatment.—*W. (W.)* Darby

244. Life Cycle Assessment for Sustainable Engineering (4)
Lecture—4 hours. Prerequisite: graduate standing. Life cycle assessment methodology is taught emphasizing applications to infrastructure and energy systems. Life cycle design, life cycle cost methods, other tools from industrial ecology, and links to policy are covered as well.—*(F.)* Kendall

245A. Applied Environmental Chemistry: Inorganic (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 105, Chemistry 2B or the equivalent, course 140; Chemistry 2C or 107A recommended. Chemistry of natural and polluted waters. Topics include chemical, kinetic and equilibrium principles, redox reactions, gas solution and solid-solution equilibria, thermodynamics, carbonate systems, coordination chemistry, interfacial phenomena. Offered in alternate years.—*(S.)* Young

245B. Applied Environmental Chemistry: Organic (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Chemistry 128A, 128B, 128C, or the equivalent; Chemistry 2C or 107A recommended. Transport and transformation of organic chemicals in the environment. Topics include application of thermodynamics to predict solubility and activity coefficients; distribution of organic chemicals between the aqueous phase and air, solvent, or solid phases; chemical, photochemical and biological transformation reactions. Offered in alternate years.—*S.* Young

246. Pilot Plant Laboratory (4)
Lecture—1 hour; discussion—1 hour; laboratory—6 hours. Prerequisite: course 243A, 243B (may be taken concurrently) or consent of instructor, graduate standing. Laboratory investigation of physical, chemical, and biological processes for water and wastewater treatment.—*W. (W.)* Darby

246N. Understanding Climate Change: Causes and Consequences (4)
Lecture—4 hours. Open to graduate students. Diverse physical processes that govern climate and drive climate change. Observational, experimental and modeling techniques and methods used in the development of our scientific understanding of the Earth system.—*S. (S.)* Cappa

247. Aerosols (4)
Lecture—4 hours. Prerequisite: Engineering 103, 105, course 141, 149. Behavior of airborne particles including particle formation, modification, and removal processes. Offered in alternate years.—*F.* Kleeman

247L. Aerosols Laboratory (4)
Lecture—2 hours; laboratory—6 hours. Prerequisite: course 247. Methods of generation and characterization of aerosols. Detailed topics may include flow rate measurement, aerosol generation, aerosol collection, ions measurement, metals measurement, and carbon measurement. May be repeated one time for credit.—Kleeman

248. Biofilm Processes (4)
Lecture—4 hours. Prerequisite: Soil Science 111 or 211 or course 243B or consent of instructor; calculus and basic cell molecular biology recommended. Natural and engineered biofilms, including biofilm occurrence and development, spatial structure, microbial processes, fundamental and applied research tools, biofilm reactors, beneficial uses, and detrimental effects.

249. Probabilistic Design and Optimization (4)
Lecture—4 hours. Prerequisite: courses 114 and 153 and Engineering 106, or equivalents. Design by optimization for probabilistic systems, decision theory, the value of information, probabilistic linear programming, probabilistic dynamic programming, nonlinear probabilistic optimization. Applications in civil engineering design, project evaluation, and risk management. Offered in alternate years.—*W.* Lund

250. Civil Infrastructure System Optimization and Identification (4)
Lecture—4 hours. Prerequisite: Mathematics 21C, 22A, programming course; Applied Science Engineering 115 and mathematical modeling course recommended. Applied mathematics with a focus on modeling, identifying, and controlling dynamic, stochastic, and underdetermined systems. Applications in transportation networks, water resource planning, and other civil infrastructure systems. Offered in alternate years.—*(S.)* Fan

251. Transportation Demand Analysis (4)
Lecture—4 hours. Prerequisite: course 114 or the equivalent. Procedures used in urban travel demand forecasting. Principles and assumptions of model components (trip generation, trip distribution, model split). New methods of estimating travel demand. Computer exercises using empirical data to calibrate models and forecast travel demand.—*F. (F.)* Niemeier

252. Sustainable Transportation Technology and Policy (3)
Lecture—2 hours; discussion—1 hour. Prerequisite: course 165. Role of technical fixes and demand management in creating a sustainable transportation system. Emphasis on technology options, including alternative fuels, electric propulsion, and IVHS. Analysis of market demand and travel behavior, environmental impacts, economics and politics. (Same course as Environmental Science and Policy 252.) Offered in alternate years—*S.* Sperling

253. Dynamic Programming and Multistage Decision Processes (4)
Lecture—4 hours. Prerequisite: Mathematics 21C, 22A, programming course; Applied Science Engineering 115 recommended. Operations research. Optimization techniques with a focus on dynamic programming in treating deterministic, stochastic, and adaptive multistage decision processes. Brief review of linear programming and non-linear programming. Applications in transportation networks and other civil infrastructure systems.—*S. (S.)* Fan

254. Discrete Choice Analysis of Travel Demand (4)
Lecture—4 hours. Prerequisite: course 114. Behavioral and statistical principles underlying the formulation and estimation of discrete choice models. Practical application of discrete choice models to characterization of choice behavior, hypothesis testing, and forecasting. Emphasis on computer exercises using real-world data sets. (Same course as Geography 279.)

256. Urban Traffic Management and Control (4)
Lecture—4 hours. Prerequisite: course 114. Basic concepts, models, and methods related to the branch of traffic science that deals with the movement of vehicles on a road network, including travel speed, travel time, congestion concepts, car-following and hydrodynamic traffic models.—*F. (F.)* Zhang

257. Flow in Transportation Networks (4)
Lecture—4 hours. Prerequisite: course 153; 161 or 256 recommended. Elements of graph theory, a survey of pertinent optimization techniques, extremal principles in network flow problems, deterministic equilibrium assignment, stochastic equilibrium assignment, extensions of equilibrium assignments and dynamic transportation network assignment.—*W. (W.)* Zhang

258. Transportation Planning in Developing Countries (3)
Lecture—3 hours. Prerequisite: course 160 or consent of instructor. Investigation of the role that transportation investments and policies play in the development of regions and countries. Emphasis is on identifying appropriate technologies, policies, and planning methods for designing transportation systems in regions of differing socioeconomic, geographic, and institutional settings. Offered in alternate years.—*(S.)* Sperling

259. Asphalt and Asphalt Mixes (4)
Lecture—4 hours. Prerequisite: course 179 or consent of instructor. Asphalts and asphalt mix types and their use in civil engineering structures, with primary emphasis on pavements. Asphalt, aggregate properties and effects on mix properties. Design, construction, recycling. Recent developments and research. Offered in alternate years.—*(W.)* Harvey

260. Sediment Transport (4)
Lecture—4 hours. Prerequisite: course 141 or equivalent. Sediment transport in hydrologic systems. Process-oriented course which will emphasize how sediment moves and the physical processes that affect sediment transport. Field trip. Offered in alternate years.

264A. Transport, Mixing and Water Quality in Rivers and Lakes (4)
Lecture—4 hours. Prerequisite: course 141 and 240. Principal causes of mixing and transport in rivers, lakes and reservoirs, and their impacts on water quality. Case studies of specific lakes and rivers. Offered in alternate years.—*F. (S.)* Schladow

264B. Transport, Mixing and Water Quality in Estuaries and Wetlands (4)
Lecture—4 hours. Prerequisite: courses 141 and 240. Principal causes of mixing and transport in estuaries and wetlands, and their impacts on water quality. Topics include advection/diffusion; tides; transverse mixing; longitudinal dispersion; sediment transport; nutrient cycling; computer modeling of estuaries. Case studies of specific systems. Offered in alternate years.—Schladow

265. Stochastic Hydrology and Hydraulics (4)
Lecture—4 hours. Prerequisite: course 266 or consent of instructor. Physics-based stochastic methods in modeling hydrologic and hydraulic processes; theory for modeling hydrologic-hydraulic governing equations as stochastic partial differential equations applied to various hydrologic-hydraulic processes under uncertainty, including transport, open channel flow, overland flow, soil water flow, and groundwater. Offered in alternate years.—*(F.)* Kavvas

266. Applied Stochastic Methods in Engineering (4)
Lecture—4 hours. Prerequisite: course 114 or Mathematics 131 or Statistics 130A or 131A; Mathematics 118A (may be taken concurrently). Stochastic processes classification; Gaussian random fields; stochastic calculus in mean square; Ito and Stratonovich stochastic differential equations; Fokker-Planck equation; stochastic differential equations with random coefficients. Offered in alternate years.—*F.* Kavvas

267. Water Resource Management (3)
Lecture—3 hours. Prerequisite: course 114, 141, and 142; course 153 recommended. Engineering, institutional, economic, and social basis for managing local and regional water resources. Examples in the context of California's water development and management. Uses of computer modeling to improve water management. (Same course as Geography 212.)—*F. (F.)* Lund

268. Infrastructure Economics (3)
Lecture—3 hours. Prerequisite: Economics 1A, Engineering 106 or the equivalent. Economics applied to infrastructure engineering planning, operations, maintenance, and management problems; microeconomic and macroeconomic theories; benefit-cost analysis; effect of uncertainty; optimization economics; non-classical economics; public finance. Offered in alternate years.—*(W.)* Lund

269. Transportation-Air Quality: Theory and Practice (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 149 or the equivalent. Health and regulatory aspects of airborne pollutants. Principles of modeling vehicle emissions. Conformity issues and the regulatory framework. Regional and micro-scale modeling. Offered in alternate years.—*S.* Niemeier

270. Advanced Water Resources Management (3)
Lecture—3 hours. Prerequisite: courses 153 and 267 or the equivalent. Discussion of technical papers related to planning theory, system maintenance, regionalization, multi-objective methods, risk analysis, institutional issues, pricing model application, economic development, forecasting, operations, and other topics. Offered in alternate years.—Lund

271. Inverse Problems (4)
Lecture—3 hours. Prerequisite: courses 114 and 144 or equivalents. Inverse calibration of distributed parameter models, using data representing model outputs. Forward and inverse mappings, stability, uniqueness, identifiability. Optimization formulation of inverse problems, maximum likelihood and other objective functions, indirect and direct approaches, solution by UCODE in hands-on project format.

272A. Advanced Hydrogeology (4)
Lecture—4 hours. Prerequisite: course 144; Mathematics 118A recommended. Flow in confined, unconfined, and leaky aquifers. Geological aspects of aquifers. Regional groundwater flow and hydraulics of pumping and recharging wells. Identification of aquifer parameters. Isotope hydrogeology and recharge estimation.

272B. Advanced Hydrogeology (4)
Lecture—4 hours. Prerequisite: courses 212A and 272A. Processes of subsurface flows and transport. Numerical methods of subsurface fluid flow and transport systems. Flow in the unsaturated zone. Fresh water/salt water interface in coastal aquifers. Macrodispersion. Identification of regional aquifer parameters. Modeling of aquifer systems. Offered in alternate years.

272C. Multiphase Reactive Transport (4)
Lecture—4 hours. Prerequisite: courses 142, 144, 148A. Multicomponent reactive transport including multiple phases. Advective/dispersive transport, chemical equilibria, and mass transformation kinetics. Natural chemical/microbiological processes including sorption, complexation, biodegradation, and diffusive mass transfer. Eulerian and Lagrangean averaging methods. Applications to contaminant remediation problems in river and subsurface hydrology. Offered in alternate years.

273. Water Resource Systems Engineering (3)
Lecture—3 hours. Prerequisite: courses 114 and 153 or the equivalent. Planning, design, and management of water resource systems. Application of deterministic and stochastic optimization techniques. Water allocation, capacity expansion, and design and operation of reservoir systems. Surface water and groundwater management. Offered in alternate years.—*(F.)* Lund

275. Hydrologic Time-Series Analysis (4)
Lecture—4 hours. Prerequisite: course 114 and 142. Application of statistical methods for analysis and modeling of hydrologic series. Statistical simulation and prediction of hydrologic sequences using time series methodology. Offered in alternate years.—Kavvas

276. Watershed Hydrology (4)
Lecture—4 hours. Prerequisite: course 142 or the equivalent. Analysis and mathematical modeling of hydrologic processes taking place in a watershed. Precipitation analysis and modeling. Theory of overland flow and its kinematic wave approximation. Analysis and modeling of saturated and unsaturated subsurface flow processes taking place on a hill slope.—Kavvas

277A. Computational River Mechanics I (4)
Lecture—4 hours. Prerequisite: Applied Science Engineering 115, course 141 (both may be taken concurrently). Unsteady open channel flows, computation of water surface profiles, shallow water equations, St. Venant equations, method of characteristics, finite difference methods, stability and accuracy of explicit and implicit schemes, flood routing in simple and compound channels, advection of plumes. Not open for credit to students who have completed course 277.—*F. (F.)* Younis

277B. Computational River Mechanics II (4)
Lecture—4 hours. Prerequisite: course 277A. Open channel flows, physical aspects of river mechanics, formulation of depth-averaged equations, boundary conditions, coordinates transformation and grid generation, finite-difference solution techniques, applications to two-dimensional momentum and pollutant transport in rivers. Offered irregularly.—Younis

277C. Turbulence and Mixing Processes (4)
Lecture—4 hours. Prerequisite: graduate standing. Nature of turbulent flows, conservation equations, momentum, heat and mass transport in free and wall-bounded flows, body forces and mixing, roughness effects, turbulence modeling and simulation. Offered irregularly.—Younis

278. Hydrodynamics (3)
Lecture—3 hours. Prerequisite: course 141. Perturbation methods. Basic water waves. Governing equations for fluid motion on a rotating earth. Rotation effects, vorticity dynamics, Ekman layer. Stratification effects, internal waves and turbulent mixing. Combined effects. Offered in alternate years.—*F.*

279. Advanced Mechanics of Fluids (4)
Lecture—4 hours. Prerequisite: course 141. Rotational flows. Navier-Stokes equations and solutions for laminar flow; boundary layer equations and solution techniques. Nature of turbulence. Reynolds equations. Introduction to turbulence modeling. Offered in alternate years.—Bombardelli

280A. Nonlinear Finite Elements for Elastic-Plastic Problems (4)
Lecture—4 hours. Prerequisite: consent of instructor. State of the art finite element methods and tools for elasticplastic problems, including computational techniques based on the finite element method and the theory of elastoplasticity. Offered in alternate years.—*W.* Jeremic

280B. Nonlinear Dynamic Finite Elements (4)
Lecture—4 hours. Prerequisite: consent of instructor. State of the art computational methods and tools for analyzing linear and nonlinear dynamics problems. Offered in alternate years.—*S.* Jeremic

281A. Advanced Soil Mechanics (4)
Lecture—4 hours. Prerequisite: course 171. Consolidation and secondary compression. Preloading and wick drains. Seepage and seepage pressures. Filtration, drainage, and dewatering. Shear strength: friction, cohesion, dilatancy and critical states.—*F. (F.)* Jeremic

281B. Advanced Soil Mechanics (5)
Lecture—4 hours; laboratory—3 hours. Prerequisite: course 281A. Site investigation and soil characterization within the context of slope stability analysis.—*W. (W.)* DeJong

282. Pavement Design and Rehabilitation (4)
Lecture—4 hours. Prerequisite: course 179 or consent of instructor. Advanced pavement design and structural/functional condition evaluation for concrete and asphalt pavements. Highways, airfields, port facilities; new facilities, rehabilitation, reconstruction. Mechanistic-empirical procedures, materials, climate and traffic characterization. Use of current design methods; recent developments and research. Offered in alternate years.—Harvey

283. Physico-Chemical Aspects of Soil Behavior (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 171. Study of the geotechnical behavior of soils considering formation, transport, mineralogy,

soil-fluid-electrolyte systems, surface tension, particle mechanics, shape, fabric, and structure. Laboratories demonstrate effects of fundamental interparticle forces (contact, Van Der Waals, capillarity and chemical). Offered in alternate years.—*F.* Kutter

284. Theoretical Geomechanics (4)

Lecture—4 hours. Prerequisite: course 171. Elasticity, plasticity, micromechanics, coupled behavior and large deformations for geomaterials. Prediction of stress-strain-volume change behavior of geomaterials. Monotonic and cyclic loading, anisotropy, bifurcation of deformation.—*W. (W.)* Jeremic

286. Advanced Foundation Design (4)

Lecture—4 hours. Prerequisite: course 173. Design and analysis of pile and pier foundations, including seismic effects; deep excavation systems; tie-back, nailing, and anchor systems; coffer dams; loads on buried conduits; ground modification techniques; and other related topics.—*F. (F.)* DeJong

287. Geotechnical Earthquake Engineering (4)

Lecture—4 hours. Prerequisite: courses 138 and 281A. Characteristics and estimation of earthquake ground motions; wave propagation and local site response; liquefaction potential and remediation; residual strength and stability considerations; ground deformations; dynamic soil-structure interaction.—*S. (S.)* DeJong

288. Earth and Rockfill Dams (4)

Lecture—4 hours. Prerequisite: courses 281A and 281B (may be taken concurrently). Site selection; design considerations; layout; seismic effects including considerations of fault movements; construction; environmental considerations, instrumentation; maintenance remediation and retrofit of existing dams. Offered in alternate years.—*(W.)* Boulanger

289A. Selected Topics in Civil Engineering; Environmental Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Environmental Engineering. May be repeated for credit.—*F, W, S. (F, W, S.)*

289B. Selected Topics in Civil Engineering; Hydraulics and Hydrologic Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Hydraulics and Hydrologic Engineering. May be repeated for credit.—*F, W, S. (F, W, S.)*

289C. Selected Topics in Civil Engineering; Engineering Planning (1-5)

Prerequisite: consent of instructor. Directed group study in Engineering Planning. May be repeated for credit.—*F, W, S. (F, W, S.)*

289D. Selected Topics in Civil Engineering; Geotechnical Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Geotechnical Engineering. May be repeated for credit.—*F, W, S. (F, W, S.)*

289E. Selected Topics in Civil Engineering; Structural Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Structural Engineering. May be repeated for credit.—*F, W, S. (F, W, S.)*

289F. Selected Topics in Civil Engineering; Structural Mechanics (1-5)

Prerequisite: consent of instructor. Directed group study in Structural Mechanics. May be repeated for credit.—*F, W, S. (F, W, S.)*

289G. Selected Topics in Civil Engineering; Transportation Engineering (1-5)

Prerequisite: consent of instructor. Directed group study in Transportation Engineering. May be repeated for credit.—*F, W, S. (F, W, S.)*

289H. Selected Topics in Civil Engineering; Transportation Planning (1-5)

Prerequisite: consent of instructor. Directed group study in Transportation Planning. May be repeated for credit.—*F, W, S. (F, W, S.)*

289I. Selected Topics in Civil Engineering; Water Resources Engineering (1-5)

Lecture; laboratory; lecture/laboratory. Prerequisite: consent of instructor. Directed group study in Water Resources Engineering. May be repeated for credit.—*F, W, S. (F, W, S.)*

290. Seminar (1)

Seminar—1 hour. Discussion of current graduate research, and guest lectures on recent advances. Oral presentation of individual study. Course required of graduate degree candidates. (S/U grading only.)—*F, W, S. (F, W, S.)*

290C. Graduate Research Group Conference (1)

Discussion—1 hour. Research problems, progress, and techniques in civil engineering. May be repeated for credit. (S/U grading only.)—*F, W, S. (F, W, S.)*

296. Topics in Water and Environmental Engineering (1)

Seminar—2 hours. Seminars presented by visiting lecturers, UC Davis faculty and, graduate students. May be repeated for credit. (S/U grading only.)—*F, W, S. (F, W, S.)*

298. Group Study (1-5)

Prerequisite: consent of instructor. (S/U grading only.)

299. Research (1-12)

(S/U grading only.)

Professional

390. The Teaching of Civil Engineering (1)

Discussion—1 hour. Prerequisite: meet qualifications for teaching assistant and/or associate-in in Civil Engineering. Participation as teaching assistant or associate-in in a designated engineering course. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports. May be repeated for total of 9 units. (S/U grading only.)—*F, W, S. (F, W, S.)*

Engineering: Computer Science

(College of Engineering)

Nina Amenta, Ph.D., Chairperson of the Department

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Faculty

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Hao Chen, Ph.D., Associate Professor
Ian Davidson, Ph.D., Professor
Premkumar T. Devanbu, Ph.D., Professor
David Doty, Ph.D., Assistant Professor
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Matthew K. Farrens, Ph.D., Professor
Vladimir Filkov, Ph.D., Associate Professor
Matthew Franklin, Ph.D., Professor
Dipak Ghosal, Ph.D., Professor
Daniel Gusfield, Ph.D., Professor
Francios Gygi, Ph.D., Professor
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Cho-Jui Hsieh, Ph.D., Assistant Professor
Patrice Koehl, Ph.D., Professor
Yong Jae Lee, Ph.D., Assistant Professor
Karl Levitt, Ph.D., Professor
Xin Liu, Ph.D., Associate Professor
Kwan-Liu Ma, Ph.D., Professor
Norman S. Matloff, Ph.D., Professor
Nelson Max, Ph.D., Distinguished Professor
Prasant Mohapatra, Ph.D., Professor
Biswanath Mukherjee, Ph.D., *Distinguished Professor*
Distinguished Graduate Mentoring Award
Michael Neff, Ph.D., Associate Professor
Ronald A. Olsson, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Phillip Rogaway, Ph.D., Professor
Cindy Rubio Gonzalez, Ph.D., Assistant Professor
Zhendong Su, Ph.D., Professor
Ilias Tagkopoulos, Ph.D., Associate Professor
S. Felix Wu, Ph.D., Professor

Emeriti Faculty

John Bruno, Ph.D., Professor Emeritus
Kenneth I. Joy, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Peter Linz, Ph.D., Professor Emeritus
Charles U. Martel, Ph.D., Professor
Raju Pandey, Ph.D., Associate Professor
Richard F. Walters, Ph.D., Professor Emeritus
Academic Senate Distinguished Teaching Award

Affiliated Faculty

Peer-Timo Bremer, Ph.D., Adjunct Associate Professor
Matt Butner, M.S., Lecturer
Sean Davis, M.S., Lecturer
Todd J. Green, Ph.D., Assistant Professor
Hans Hagen, Ph.D., Adjunct Professor
Rob Gysel, Ph.D., Lecturer
Bertram Ludaescher, Ph.D., Professor
Christopher Nitta, Ph.D., Assistant Adjunct Professor
Sean Peisert, Ph.D., Assistant Adjunct Professor
Massimo Tornatore, Ph.D., Adjunct Associate Professor
Gunther Weber, Ph.D., Assistant Adjunct Professor

The Computer Science and Engineering Program

The Department of Computer Science administers two curricula: Computer Science and Engineering in the College of Engineering, and Computer Science in the College of Letters and Science. It also administers two minors: Computer Science in the College of Letters and Science, and Computational Biology in the College of Engineering. For information on the Computer Science curriculum and minor; see Computer Science, on page 230.

The Computer Science Engineering major (below) prepares students to do further work in hardware, software, theory, or electronics, either in industry or in postgraduate study.

The primary differences between the Computer Science Engineering and the Computer Science majors are the extent of course work covering hardware and the flexibility of the curriculum. The Computer Science Engineering major develops a solid understanding of the entire machine, including hands-on experience with its hardware components. The Computer Science major has some course work on hardware, at the digital-design level, on simulators. The Computer Science Engineering major has fewer free electives. The CS major's more generous electives make it easier to complete a minor or double major.

A key theme of the Computer Science Engineering curriculum is the hardware/software interaction, a theme reflected in the courses required and the orientation of the courses themselves.

The Computer Science and Engineering major provides students with a solid background in mathematics, physics, chemistry, and electronic circuits and systems, all supporting the computer hardware and computer software courses that constitute the focus of the curriculum.

Mission. The University of California, Davis, is, first and foremost, an institution of learning and teaching, committed to serving the needs of society. The Department of Computer Science contributes to the mission in three ways. First, its undergraduate and graduate education programs seek to educate students in the fundamental principles of computer science and the skills needed to solve the complex technological problems of modern society. The breadth of coursework provides a framework for life-long learning and an appreciation for multidisciplinary activities. Second, through its research programs, the department contributes to the development and progress of computer science, and software and information technology, to provide innovative, creative solutions for societal needs. Finally, the department disseminates its research-to