Civil and Environmental Engineering

The Department of Civil and Environmental Engineering (CEE) at Berkeley is a place of intellectual vitality. This vitality is evident in its creative and forward-looking curricula and classroom teaching, its attentive academic mentoring, and the innovative research conducted by students and faculty.

CEE focuses on developing future leaders for the engineering profession, for academia, and for applying engineering methods in the broader societal context. CEE conducts cutting-edge research, defining what constitutes the evolving domain of civil and environmental engineering.

We offer both Master’s (the Master of Science (https://ce.berkeley.edu/grad/degrees/promote/ms/) and the Master of Engineering (https://ce.berkeley.edu/grad/degrees/promote/meng/)) and Doctoral degree (https://ce.berkeley.edu/grad/degrees/) programs. We support 7 programs of study for the MS and the PhD, each of which has its own prerequisites for admission and degree requirements. CEE offers 2 programs of study for the MEng. CEE also offers three concurrent degree programs and two certificate programs.

Master of Science (MS) and Doctor of Philosophy (PhD)

These degrees emphasize the application of the natural sciences to the analysis and solution of engineering problems. Advanced courses in mathematics, chemistry, physics, and the life sciences are normally included in a program that incorporates the engineering systems approach for analysis of problems.

Students in these degree programs select one of the following seven concentrations:

1. **Energy, Civil Infrastructure and Climate:**
   Energy, climate, and infrastructure systems are closely tied together, and these connections manifest in many forms. Our society cannot function without energy and infrastructure systems. Energy systems with the lowest possible greenhouse gas footprint are a key to mitigating climate change. Civil infrastructure systems are a backbone of society, and they are also major users of energy that needs to be reduced for a more sustainable development.

   The objective of the Energy, Civil Infrastructure and Climate (ECIC) Program is to educate a cadre of professionals who will be able to analyze from engineering, environmental, economic, and management perspectives complex problems such as energy efficiency of buildings, environmentally informed design of transportation systems, embodied energy of construction materials, electricity from renewable sources, and biofuels, and address such overarching societal problems as mitigation of greenhouse gas emissions and adaptation of infrastructure to a changing climate. ECIC also promotes research at the intersection of energy, infrastructure and climate science.

2. **Engineering and Project Management:** The Engineering and Project Management (E&PM) Program educates professionals to become leaders in managing projects and companies in Architecture-Engineering-Construction (AEC) and in other industries. E&PM graduates find a wide range of employment opportunities in private industry and in the public sector, for example in engineering consulting-, building-, transportation-, and industrial construction firms, as well as in public- and private owner organizations, both domestically as well as internationally.

   As infrastructure systems become more complex, tomorrow's industry leaders must add innovative management thinking to a solid foundation in design and construction. The E&PM Program is uniquely specialized in teaching and researching such new management concepts as Lean Construction, Cost and Schedule Forensics, and Sustainability Engineering. Our teaching and research emphasizes new concepts, technologies, developments, and techniques applicable to both domestic and international project and corporate management. The Program emphasizes the interrelationships of all life-cycle components: planning, design, manufacturing, construction, operation, maintenance, and re-purposing/decommissioning.

   As we are located in the San Francisco Bay Area—the center of major local, national, and international project management and construction activity—our Program is strongly interlinked with industry. Our class projects and research leverage the ability to go observe as well as study specific local and international projects. We draw on examples from commercial building-, industrial-, and heavy civil construction throughout our curriculum. We also invite industry practitioners to present guest lectures describing industry challenges and solutions.

3. **Environmental Engineering:** Management of environmental resources to protect human health and the systems that support life is one of the biggest challenges facing modern society. In recognition of the interdisciplinary nature of these challenges, Berkeley's Environmental Engineering Program provides you with the education needed to address current and future environmental issues. Graduate coursework and research is focused in three Areas of Emphasis (https://ce.berkeley.edu/programs/env/areas/):
   - Air Quality Engineering (AQE)
   - Environmental Fluid Mechanics and Hydrology (EFMH)
   - Water Quality Engineering (WQE)

   You are encouraged to develop a broad set of problem-solving skills through courses and research in related fields such as:
   - Berkeley Atmospheric Sciences Center (http://www.atmos.berkeley.edu/)
   - Earth and Planetary Sciences (http://eps.berkeley.edu/)
   - Energy & Resources Group (http://erg.berkeley.edu/)
   - Environmental Science, Policy & Management (http://espm.berkeley.edu/)
   - Integrative Biology (http://ib.berkeley.edu/)
   - Mechanical Engineering (http://www.me.berkeley.edu/)
   - Plant & Microbial Biology (http://plantbio.berkeley.edu/)
   - School of Public Health (http://sph.berkeley.edu/)

4. **GeoSystems:** The GeoSystems Program encompasses a broad area of teaching and research in geotechnical and geological engineering, environmental geotechnics, and applied geophysics. The focus is on the evaluation of engineering properties of geologic materials and on providing engineering solutions for dealing with geologic environment and processes, and natural hazards.
To this end we pursue studies of the mechanical behavior of soil and rock masses, laboratory and field characterization of material properties, development and application of geophysical techniques for site and subsurface characterization, development of advanced analysis methods, and evaluation of static and dynamic (seismic) performance of soil deposits, earth structures, and underground space.

The GeoSystems graduate program has a long tradition of excellence and its graduates are leaders in the industry and academia. The strength and breadth of Berkeley’s GeoSystems is enhanced by close ties with faculty in other areas of Civil and Environmental Engineering and Earth Sciences. Close interaction of the faculty with consulting companies and practitioners also provides opportunity for exposure to the state-of-the-art practice through invited lectures and site visits to ongoing engineering projects in the San Francisco Bay Area.

Due to the broad interdisciplinary nature of the field we welcome students with a wide range of backgrounds in Engineering and Earth Sciences.

5. **Structural Engineering, Mechanics, and Materials:** CEE’s Structural Engineering, Mechanics, and Materials (SEMM) Program has an international reputation for excellence. Many of the fundamental developments underlying the state-of-the-art in structural engineering, mechanics, and materials were pioneered by SEMM faculty and students. This tradition of excellence continues today through vigorous programs of basic and applied research, and careful attention to instruction.

The active involvement of SEMM faculty in the forefront of research projects and in the solution of challenging real world engineering problems results in an instructional program that is up-to-date and relevant. SEMM offers excellent opportunities for study and research leading to advanced degrees in the areas of structural analysis and design, mechanics of structures and solids, and materials in structures and construction.

The curriculum provides a strong basis for advanced professional practice, research, or teaching. Programs of study can be tailored easily to fit individual needs and interests, whether broad-based and multidisciplinary, or narrowly focused and highly technical. Graduates from the SEMM Program have gone on to become world leaders in private practice, government service, education, and research.

6. **Systems (Civil Systems):** The focus of the Systems Engineering Program (Systems) is understanding complex large-scale systems and developing tools for their design and operation. Such systems encompass built elements in the broad sense (infrastructures transportation, structures, etc.), societal systems (social networks, populations enterprises), and natural systems (land water, air). These systems are at the core of Civil and Environmental Engineering of the 21st Century.

The understanding of how such systems work requires knowledge about the constitutive laws that govern them, such as traffic flow, fluid mechanics, structural mechanics, and smart networks. It also requires an understanding of the theoretical paradigms that are used to model, control and optimize such systems. These include the theories of computation, control theory, optimization, behavioral economics, sensor networks, statistics, and signal processing.

In response to these challenges, the Systems Program provides courses that cover both field knowledge and technical/theoretical tools. This is reflected in the curriculum. We offer masters and doctoral degree programs providing the key skills, e.g., technological, mathematical, or social scientific, as well as the knowledge for a broad range of engineering domains. Our graduates lead the next generation of research, start-ups, industrial corporations, and public-sector organizations.

7. **Transportation Engineering:**
Graduate study in transportation at the University of California, Berkeley prepares you for a professional, teaching, and research career. Emphasis is on the acquisition of advanced knowledge concerning planning, design, operations, maintenance, rehabilitation, performance, and evaluation of transportation systems, including their economic and public policy aspects. The program stresses development of analytic, problem-solving, design, and management skills suitable for public and private sector professional work.

Transportation Engineering faculty with diverse backgrounds and research interests, including emeriti professors, teach transportation courses. In addition, faculty from City and Regional Planning (http://dcrp.berkeley.edu/), Economics (http://emlab.berkeley.edu/econ/), Industrial Engineering and Operations Research (http://www.ieor.berkeley.edu/), Business Administration (http://www.haas.berkeley.edu/), Political Science (http://www.polisci.berkeley.edu/), and other departments offer courses related to transportation.

Students also have the opportunity to work and interact with research staff at the Institute of Transportation Studies (http://www.its.berkeley.edu/).

Students in the PhD program have the option of pursuing a designated emphasis (p. ) (DE) to supplement their study.

**Master of Engineering (MEng)**
This professional degree emphasizes solving technical, sociological, environmental, and economic problems involved in the design, construction, and operation of engineering structures, processes, and equipment. Studies include courses in the engineering sciences necessary to the engineering interpretation of the latest scientific developments. Courses in design, operation, humanities, and economics provide a basis for the analysis and solution of problems in professional engineering.

Students in this degree program select either a concentration in Systems (Civil Systems) or Transportation Engineering (see above descriptions). There are options for either full-time or part-time enrollment.

CEE’s MEng program is offered in conjunction with the Fung Institute for Engineering Leadership (http://funginstitute.berkeley.edu/).

**Concurrent Degrees**
The concurrent degree program is a formal arrangement of two existing, but separate, master's degree programs, which result in the students earning two master’s degrees. CEE offers the following concurrent degree programs:

1. Structural Engineering (http://ced.berkeley.edu/academics/architecture/programs/concurrent-programs/structure-engineering/) and Architecture (http://ced.berkeley.edu/admissions/graduate/)(MArch/MS)

2. Transportation Engineering (http://ced.berkeley.edu/academics/city-regional-planning/programs/concurrent-programs/)
transportation-engineering/) and City and Regional Planning (http://ced.berkeley.edu/academics/city-regional-planning/) (MCP/MS).
3. Any CEE graduate program and Public Policy (http://socrates.berkeley.edu/%7Egspp/) (MPP/MS).

For further information regarding these programs, please see the department’s website (http://www.ce.berkeley.edu/grad/degrees/).

Certificates
Certificate in Engineering and Business for Sustainability: The Engineering and Business for Sustainability (EBS) Certificate Program trains UC Berkeley graduate students to understand the complexity and urgency of their role in engineering, business, and environmental management, and to work across boundaries to achieve sustainable solutions to pressing societal problems. This program allows students to tap into multidisciplinary educational resources from the College of Engineering (http://coe.berkeley.edu/), Haas School of Business (http://haas.berkeley.edu/), Energy and Resources Group (http://erg.berkeley.edu/), Goldman School of Public Policy (http://gspp.berkeley.edu/), College of Natural Resources (http://nature.berkeley.edu/site/), and the School of Public Health (http://sph.berkeley.edu/), to learn how to have a lasting beneficial impact on the global environment. This program is open to all Berkeley graduate students who meet the EBS Certificate course requirements. For further information regarding this program, see the department’s website (http://sustainable-engineering.berkeley.edu/).

Certificate in Intelligent Transportation Systems: Jointly sponsored by CEE, the Department of Electrical Engineering & Computer Science and Mechanical Engineering, this program is designed to assist students in studying ITS in a systematic and focused way. Faculty advisers help students design a personalized study program to meet their goals. For more information regarding this program, see the department’s website (http://www.ce.berkeley.edu/programs/trans/graduate-requirements/).

Designated Emphasis
Berkeley Ph.D. students are eligible to pursue a Designated Emphasis (http://grad.berkeley.edu/policy/degrees-policy/#f21-doctoral-degrees-with-a-designated-emphasis) as part of their doctoral studies. Common Designated Emphases for CEE doctoral students include:
• Computational and Data Science and Engineering (http://citris-uc.org/dece-mission/)
• Global Metropolitan Studies (http://live-global-metropolitan-studies.pantheon.berkeley.edu/designated-emphasis/)
• Development Engineering (http://deveng.berkeley.edu/)

A designated emphasis is a specialization, such as a new method of inquiry or an important field of application, which is relevant to two or more existing doctoral degree programs. You are required to complete the academic work in the area of specialization and all the requirements of the doctoral program. You must be admitted to the DE before taking the qualifying examination. A complete list of Designated Emphases is here (http://grad.berkeley.edu/policy/degrees-policy/#f21-doctoral-degrees-with-a-designated-emphasis).

Admission to the University
Minimum Requirements for Admission
The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:
1. A bachelor’s degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 on a 9-point scale (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

Applicants Who Already Hold a Graduate Degree
The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without the need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master’s or professional master’s degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master’s degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master’s degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master’s degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:
1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master’s degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

Required Documents for Applications
1. Transcripts: Applicants may upload unofficial transcripts with your application for the departmental initial review. If the applicant is admitted, then official transcripts of all college-level work will be required. Official transcripts must be in sealed envelopes as issued by the school(s) attended. If you have attended Berkeley, upload your unofficial transcript with your application for the departmental initial review. If you are admitted, an official transcript with evidence of degree conferral will not be required.
2. Letters of recommendation: Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.
3. Evidence of English language proficiency: All applicants from countries or political entities in which the official language is not
English are required to submit official evidence of English language proficiency. This applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People’s Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:

• courses in English as a Second Language,
• courses conducted in a language other than English,
• courses that will be completed after the application is submitted, and
• courses of a non-academic nature.

If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests. Official TOEFL score reports must be sent directly from Educational Test Services (ETS). The institution code for Berkeley is 4833. Official IELTS score reports must be mailed directly to our office from the British Council. TOEFL and IELTS score reports are only valid for two years.

Where to Apply
Visit the Berkeley Graduate Division application page (http://grad.berkeley.edu/admissions/apply/).

Admission to the Program
In addition to the above University requirements, CEE has minimum graduate admission requirements, listed below. **Note: These are minimum requirements and may not be competitive.

• Due to the pandemic, CEE will NOT be requiring the GRE for admission to Fall 2021. For subsequent years, we require the score of the general Graduate Record Examination (GRE (http://www.gre.org/)) taken during the past five years. CEE does not require a GRE subject test but the General GRE Test is required. Both the ‘Old’ GRE and the ‘Revised’ GRE are accepted.
  • If you are pursuing a PhD, a Master’s of Science degree from an accredited university and a minimum GPA of 3.5, OR apply to the MS degree and add the PhD during the first year of the MS program. Direct to PhD admissions is approved on an exception basis.
  • In addition, each of the 7 CEE programs has its own admissions prerequisite requirements (see below).

Energy, Civil Infrastructure, and Climate
Prerequisites

• 1 year of college-level calculus
• 1 semester probability and statistics
• 1 semester elementary linear algebra
• 1 year college-level physical science (e.g., PHYSICS 7A and PHYSICS 7B)
• A course in thermodynamics or energy conversion (e.g., ENGIN 115, MEC ENG 40, MEC ENG 254, CHM ENG 141, MEC ENG 146). This can be taken as part of graduate study.

Engineering and Project Management
Prerequisites

• 1 year college-level calculus
• 1 year college-level physical science (e.g., PHYSICS 7A and PHYSICS 7B)
• 1 semester probability and statistics
• 1 semester elementary linear algebra

Environmental Engineering
Prerequisites

Minimum requirements for entry into the Environmental Engineering program consist of:

• Math: equivalent of 2 years, including calculus, linear algebra and differential equations
• Science: 1 semester of physics (PHYSICS 7A), 2 additional semesters of science (physics, chemistry, biology)

Additionally, it is strongly recommended that applicants have:

• Experience with Matlab or other high-level programming language
• Physics and/or chemistry coursework beyond the minimum listed above

The Environmental Engineering program also considers the following courses to be additional prerequisites of the program. These courses can be taken during a student's graduate study, but if they are, the courses would not count towards the graduate degree: Elementary Fluid Mechanics (CIV ENG 100), Environmental Engineering (CIV ENG 111), Introduction to Hydrology (CIV ENG 103) and Water Chemistry (CIV ENG 115). Either Introduction to Hydrology OR Water Chemistry may be taken as part of the graduate study.

Note: Applications from non-engineering students are strengthened if engineering classes, particularly those considered prerequisite to the program, have already been taken at the time of application.

GeoSystems (Geoengineering)
Prerequisites

• Math: equivalent of 2 years, including calculus, linear algebra and differential equations
• Science: 1 semester of physics (PHYSICS 7A), 1 semester of chemistry (CHEM 1A)
• Introduction to Solid Mechanics (e.g., CIV ENG C30)
• Engineering Geology (e.g., CIV ENG 70)
• Geotechnical and Geoenvironmental Engineering (e.g., CIV ENG 175)

Structural Engineering, Mechanics and Materials
Prerequisites

• 2 years college level calculus (e.g., MATH 1A, MATH 1B, MATH 53, MATH 54)
• 1 year college level physical science (e.g., PHYSICS 7A and PHYSICS 7B)
• 1 semester probability and statistics (e.g., STAT 20 or CIV ENG 93)
• 1 semester matrix structural analysis (e.g., CIV ENG 121)
Systems (Civil Systems)

Prerequisites
- 1.5 years college-level calculus (e.g., MATH 1A, MATH 1B, MATH 53)
- 1 year college-level physical science (e.g., PHYSICS 7A/PHYSICS 7B)
- 1 semester probability and statistics
- 1 semester elementary linear algebra
- A GPA for the junior/senior years of at least 3.25

Transportation Engineering

Prerequisites
- 1 year college-level calculus
- 1 year college-level physical science, including mechanics and waves (e.g., PHYSICS 7A/PHYSICS 7B)
- 1 semester probability and statistics (See Statistics/linear algebra diagnostic below.)
- 1 semester elementary linear algebra

Transportation Engineering requires strong analytical and quantitative preparation, but an engineering degree is not necessary. Applicants must be fluent with quantitative concepts of the above courses. Deficiencies in preparation must be remedied by additional work that may not count toward the degree. Students should discuss their preparation with their faculty adviser.

Statistics/linear algebra diagnostic: Incoming Transportation Engineering students, including transfers from within Berkeley, must take a diagnostic test at the beginning of their first semester in the program to see if their linear algebra, and probability and statistics preparation is adequate, i.e., on a level similar to CIV ENG 93. Consisting of 4 or 5 problems, the diagnostic test does not emphasize memorization. Rather, it tests whether students are capable of applying linear algebra and statistical concepts to solve simple transportation problems. If students do not solve most of the problems easily, or do not take the test, they must enroll in CIV ENG 262 during their first semester. This requirement cannot be put off to a later time.

Lack of linear algebra knowledge may be remedied by working through a suitable book, such as the Schaum's Outline Series.

See Example Statistics Diagnostic for First Year TE Grad Students (http://www.ce.berkeley.edu/sites/default/files/assets/programs/trans/Diagnostic2013.pdf)

Curriculum

The doctoral program is research-based and is not solely based on the curricula below. All doctoral students are expected to fulfill a major and two minors which total a minimum of 30 units or its equivalent, not including CIV ENG 298, CIV ENG 299, CIV ENG 301, or CIV ENG 602. Each PhD student must have a graduate adviser to provide general academic guidance, and a research adviser to supervise the student's dissertation and to assist in identifying funding paths. A minimum 3.5 GPA is required in major course work and a 3.0 in minor course work. Students must have a master's degree from an accredited institution or earn the master's and then continue on for the PhD. An approved program of study is required, a tentative program upon entrance into the PhD and a final program of study before the qualifying examination. During the first or second year, a prequalifying examination is required.

The qualifying examination is taken during the third year. For detailed information, see the department website (http://www.ce.berkeley.edu/home?destination=home/). All first time graduate student instructors (GSIs) must take during the first semester of teaching a teaching pedagogy course, CIV ENG 301, attend the first time GSI conference the week before the start of the semester, and take an online ethics course prior to the third week of the semester.

Energy, Civil Infrastructure and Climate Concentration (ECIC) (http://www.ce.berkeley.edu/programs/ecic/graduate-requirements/)

The major core courses are listed below (9 units out of 12) but a total of 12 units must be in CEE. In addition to the major courses, an ECIC doctoral student must take at least 15 units of elective courses (http://www.ce.berkeley.edu/programs/ecic/courses/) from each of the following core areas (http://www.ce.berkeley.edu/programs/ecic/courses/) (maximum 6 units in any one area): Environment Science & Engineering, Civil Infrastructure, and Economics & Policy. 9 units are required in each of the two minor fields (one minor may be within the CEE).

CIV ENG 218A Air Quality Engineering 3
CIV ENG 256 Transportation Sustainability 3
CIV ENG 268E Civil Systems and the Environment 3
CIV ENG 295 Data Science for Energy 3

Energy and Project Management Concentration (EPM) (http://www.ce.berkeley.edu/programs/ecic/graduate-requirements/)

18 units in EPM are required from the courses below, related to the thesis, along with two approved, complementary minor fields, one comprised of courses outside CEE. The minor typically consists of 8 units from two or three graduate or advanced undergraduate level courses.

CIV ENG 268A Lean Construction Concepts and Methods 3
CIV ENG 268B Lean Construction and Supply Chain Management 3
CIV ENG 268D Law for Engineers 3
CIV ENG 268E Civil Systems and the Environment 3
CIV ENG 268H Advanced Project Planning and Control 3
CIV ENG 268I Business Fundamentals for Engineers 3
CIV ENG 292A Technologies for Sustainable Societies 1

Environmental Engineering Concentration (ENV) (http://www.ce.berkeley.edu/programs/env/graduate-requirements/)

For the major field, a minimum of 12 approved units from the list below, or its equivalent. Two minors, minimum 6 units each, for a total of 12 minor units, with at least one minor outside of CEE and 30 units in total. No ENV courses may count towards a minor.

CIV ENG 200A Environmental Fluid Mechanics I 3
CIV ENG 200B Environmental Fluid Mechanics II 3
CIV ENG 202A Vadose Zone Hydrology 3
CIV ENG 203N Surface Water Hydrology 3
CIV ENG 206 Water Resources Management 3
CIV ENG 209 Design for Sustainable Communities 3
CIV ENG 210 Control of Water-Related Pathogens 3
CIV ENG 211A Environmental Physical-Chemical Processes 3
CIV ENG 211B Environmental Biological Processes 3
CIV ENG 217 Environmental Chemical Kinetics 3
CIV ENG 218A Air Quality Engineering 3
CIV ENG 219 Fluid Flow in Environmental Processes 3

GeoSystems Concentration (GEO) (http://www.ce.berkeley.edu/programs/geo/graduate-requirements/)

A study list tailored to the student’s research interests must be approved by the faculty adviser. The major field consists of 18 units of graduate CEE courses focusing on a GeoSystems area of research. The two minor fields of 8 units each, one of which consists of courses outside CEE, support the dissertation topic. Minimum 30 units overall. Possible courses include:

CIV ENG 202A Vadose Zone Hydrology 3
CIV ENG 270 Advanced Geomechanics 3
CIV ENG 271 Sensors and Signal Interpretation 3
CIV ENG 272 Numerical Modelling in Geomechanics 3
CIV ENG 273 Advanced GeoEngineering Testing and Design 3
CIV ENG 275 Geotechnical Earthquake Engineering 3
CIV ENG C276 Seismic Hazard Analysis and Design Ground Motions 3
CIV ENG 277 Advanced Foundation Engineering 3
CIV ENG 281 Engineering Geology 3
CIV ENG 285C Seismic Methods in Applied Geophysics 3
CIV ENG 286 Digital Data Processing 3
CIV ENG 290J Advanced Topics in Geotechnical Engineering 3

Structural Engineering, Mechanics & Materials Concentration (SEMM) (http://www.ce.berkeley.edu/programs/semm/graduate-requirements/)

Out of a minimum of 33 units in the program of study, 21 units of SEMM courses for the major field are required. At least 15 units must be the graduate, 200-level, SEMM courses. For the two minors, one should address the student’s technical base and research background and include at least two graduate-level courses. One minor must be in mathematics or statistics in one of these areas: traditional mathematics, modern mathematics, numerical analysis, or statistics. If a minor in computer science is chosen, it should cover one of the following areas: databases, computer graphics, software engineering, or artificial intelligence. See program website (http://www.ce.berkeley.edu/programs/semm/graduate-requirements/) for more details.

Students studying Structural Materials have different requirements (http://www.ce.berkeley.edu/programs/semm/graduate-requirements/). Please see program website (https://www.ce.berkeley.edu/programs/semm/graduate-requirements/) for further details. For Materials, one minor may be in structural and the second outside of CEE. The materials student’s program of study is subject to the approval of the Vice Chair for Academic Affairs.

CIV ENG 220 Structural Analysis Theory and Applications 3
CIV ENG 221 Nonlinear Structural Analysis 3
CIV ENG 222 Finite Element Methods 3
CIV ENG 223 Earthquake Protective Systems 3
CIV ENG 225 Dynamics of Structures 3

CIV ENG 226 Stochastic Structural Dynamics 3
CIV ENG 227 Earthquake-Resistant Design 3
CIV ENG 228 Advanced Earthquake Analysis 3
CIV ENG 229 Structural System Reliability 3
CIV ENG C231 Mechanics of Solids 3
CIV ENG 232 Structural Mechanics 3
CIV ENG 233 Computational Mechanics 3
CIV ENG 234 Computational Inelasticity 3
CIV ENG C235 Introduction to Statistical Mechanics for Engineers 3
CIV ENG C236 Micromechanics 3
CIV ENG C237 Computational Nano-mechanics 3
CIV ENG 240 Civil Engineering Materials 3
CIV ENG 241 Concrete Technology 3
CIV ENG 244 Reinforced Concrete Structures 3
CIV ENG 245 Behavior of Reinforced Concrete 3
CIV ENG 246 Prestressed Concrete Structures 3
CIV ENG 247 Design of Steel and Composite Structures 3
CIV ENG 248 Behavior and Plastic Design of Steel Structures 3
CIV ENG 249 Experimental Methods in Structural Engineering 3

Systems Engineering Concentration (SYS) (http://www.ce.berkeley.edu/programs/sys/graduate-requirements/)

Systems requires at least 17 units (excluding research) in the major, 3 of which may be upper division undergraduate units. For the two minor fields, only one can be in CEE. Each minor is a group of three upper division and/or graduate courses. Program of study must total at least 33 units.

CIV ENG 262 Analysis of Transportation Data 3
CIV ENG 263N Scalable Spatial Analytics 3
CIV ENG 264 Behavioral Modeling for Engineering, Planning, and Policy Analysis 3
CIV ENG 271 Sensors and Signal Interpretation 3
CIV ENG 290I Civil Systems: Control and Information Management 3
CIV ENG C291F Control and Optimization of Distributed Parameters Systems 3
CIV ENG 295 Data Science for Energy 3

Transportation Engineering Concentration (TE) (http://www.ce.berkeley.edu/programs/trans/graduate-requirements/)

A broad range of courses in addition to the core courses (below) are required. Also required are two minors, one outside the department, selected in consultation with an adviser. A total of 30 units minimum comprise a program of study. See the department website (http://www.ce.berkeley.edu/programs/trans/graduate-requirements/) for more details.

Core Courses
CIV ENG 251 Operation of Transportation Facilities 3
CIV ENG 252 Systems Analysis in Transportation 3
CIV ENG 262 Analysis of Transportation Data (or equivalent, such as Stat 134/135) 3

Elective courses (in CEE)
Curriculum

Each program has two options for the MS degree: Plan I is a thesis option, usually two years in duration, with a minimum of 20 units of course work plus research, and Plan II is a 9-month plan, including a comprehensive exam or project (paper) with at least 24 units of course work. No more than 4 units of research (CIV ENG 299) may count towards the overall units required. These courses may not count towards the total units of the degree: CIV ENG 297, CIV ENG 298, CIV ENG 301, CIV ENG 601, CIV ENG 602. A minimum of 12 units must be taken per semester. See the department website (http://www.ce.berkeley.edu/grad/) for detailed and current degree program information.

Energy, Civil Infrastructure & Climate Concentration (ECIC) (http://www.ce.berkeley.edu/programs/ecic/graduate-requirements/)

Thesis option: 20 units total; 12 of the 20 units must be CEE graduate courses. The core courses below, maximum 3 units of research (CIV ENG 299), plus at least 6 units from courses (http://www.ce.berkeley.edu/programs/ecic/courses/) in the three core areas (http://www.ce.berkeley.edu/programs/ecic/courses/), Environmental Science and Engineering, Civil Infrastructure, and Economics and Policy, but no more than 3 units in any one area. A thesis signed by three committee members, one preferably outside the department, is also required. Two year program, one of courses and one of research.

Comprehensive Exam option: 24 units total, 12 graduate level in CEE. The core courses below plus 9 units from courses (http://www.ce.berkeley.edu/programs/ecic/courses/) in the three core areas (http://www.ce.berkeley.edu/programs/ecic/courses/) of Environmental Science and Engineering, Civil Infrastructure, and Economics and Policy, but no more than 6 units in any one area. The written comprehensive examination will take place at the end of the spring semester. Please see department website for more elective courses in ECIC (https://ce.berkeley.edu/programs/ecic/courses/).

Required Courses

CIV ENG 218A   Air Quality Engineering  3
CIV ENG 256   Transportation Sustainability  3
CIV ENG 268E   Civil Systems and the Environment  3
CIV ENG 295   Data Science for Energy  3

Environmental Engineering & Project Management Concentration (EPM) (http://www.ce.berkeley.edu/programs/epm/graduate-requirements/)

Thesis option: Total 20 units with a minimum of 8 units from the list below, not including Civ Eng 298. Remaining courses, minimum 12 units, comes from courses approved by the faculty adviser. No more than 4 units of CE 299 may count towards the 20 total units. A thesis with a three-person committee is required with two CEE members, at least one from EPM. Two year program, one of courses and one of research.

Comprehensive Exam option: 12 units from the list below are required, not including Civ Eng 298, and 12 units from a course list approved by the faculty adviser. No more than 4 units of CE 299 may count. A written comprehensive examination is required in the spring.

Required Courses

CIV ENG 268A   Lean Construction Concepts and Methods  3
CIV ENG 268B   Lean Construction and Supply Chain Management  3
CIV ENG 268D   Law for Engineers  3
CIV ENG 268E   Civil Systems and the Environment  3
CIV ENG 268H   Advanced Project Planning and Control  3
CIV ENG 268I   Business Fundamentals for Engineers  3
CIV ENG 292A   Technologies for Sustainable Societies  1
CIV ENG 298   Group Studies, Seminars, or Group Research  1-6

Environmental Engineering Concentration (ENV) (http://www.ce.berkeley.edu/programs/env/graduate-requirements/)

Thesis option: Minimum 20 units with 8 units of graduate-level courses in the major with no more than 4 units of CIV ENG 299. Individualized study list must be approved by advisor and a thesis approved by a committee of three, including two environmental faculty and preferably one member outside CEE. Two year program, one of courses and one of research.

Comprehensive Exam option: Minimum 24 units with 12 units of graduate-level courses in the major with no more than 4 units of CIV ENG 299. Individualized study list plus three courses from following (must be from different areas) as well as a written comprehensive exam in fall or spring.

Required Courses (one from each of the areas below)

Environmental Fluid Mechanics
CIV ENG 200A   Environmental Fluid Mechanics I  3
CIV ENG 219   Fluid Flow in Environmental Processes  3
Air Quality
CIV ENG 218A   Air Quality Engineering  3
Environmental Fluid Mechanics and Hydrology (EFMH) course:
CIV ENG 202A   Vadose Zone Hydrology  3
CIV ENG 203N   Surface Water Hydrology  3
Water Quality Engineering (WQE) course:
CIV ENG 206   Water Resources Management  3
CIV ENG 211A   Environmental Physical-Chemical Processes  3
CIV ENG 211B   Environmental Biological Processes  3
GeoSystems Engineering Concentration (GEO) (http://www.ce.berkeley.edu/programs/geo/graduate-requirements/)

Thesis option: 20 units with 9 in approved graduate courses and the remaining 11 units from a list approved by the faculty adviser. The remaining units may be CIV ENG 299 research units. Minimum 12 units per semester. Two year program, one of courses and one of research.

Comprehensive option: 24 units with 12 units in approved graduate courses. A written report from at least 3 units of CIV ENG 299 or a capstone project from CIV ENG 273 is required.

Approved Graduate Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 202A</td>
<td>Vadose Zone Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 270</td>
<td>Advanced Geomechanics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 271</td>
<td>Sensors and Signal Interpretation</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 272</td>
<td>Numerical Modelling in Geomechanics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 273</td>
<td>Advanced GeoEngineering Testing and Design</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 275</td>
<td>Geotechnical Earthquake Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG C276</td>
<td>Seismic Hazard Analysis and Design Ground Motions</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 277</td>
<td>Advanced Foundation Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 281</td>
<td>Engineering Geology</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 285C</td>
<td>Seismic Methods in Applied Geophysics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 286</td>
<td>Digital Data Processing</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 290J</td>
<td>Advanced Topics in Geotechnical Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Structural Engineering, Mechanics & Materials Concentration (SEMM) (http://www.ce.berkeley.edu/programs/semm/graduate-requirements/)

Thesis option: 20 units with at least 8 units from the list below. Remaining courses, minimum 12 units, must be approved by the faculty adviser. No more than 4 units of CIV ENG 299 may count. A thesis with a three-person committee is required with two CEE members. Two year program, one of courses and one of research.

Comprehensive Project/Exam option: 24 units with 14 units of graduate-level SEMM courses are required. Remaining courses, a minimum of 10 units, must be approved by the faculty adviser. No more than 4 units of CIV ENG 299 may count. A written comprehensive examination, or report approved by two faculty, is required in the spring.

Approved Graduate Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 220</td>
<td>Structural Analysis Theory and Applications</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 221</td>
<td>Nonlinear Structural Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 222</td>
<td>Finite Element Methods</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 223</td>
<td>Earthquake Protective Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 225</td>
<td>Dynamics of Structures</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 226</td>
<td>Stochastic Structural Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 227</td>
<td>Earthquake-Resistant Design</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 228</td>
<td>Advanced Earthquake Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 229</td>
<td>Structural System Reliability</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG C231</td>
<td>Mechanics of Solids</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 232</td>
<td>Structural Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 233</td>
<td>Computational Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 234</td>
<td>Computational Inelasticity</td>
<td>3</td>
</tr>
</tbody>
</table>

CIV ENG C235  Introduction to Statistical Mechanics for Engineers  3
CIV ENG C236  Micromechanics                             3
CIV ENG C237  Computational Nano-mechanics              3
CIV ENG 240  Civil Engineering Materials                3
CIV ENG 241  Concrete Technology                        3
CIV ENG 244  Reinforced Concrete Structures             3
CIV ENG 245  Behavior of Reinforced Concrete            3
CIV ENG 246  Prestressed Concrete Structures            3
CIV ENG 247  Design of Steel and Composite Structures   3
CIV ENG 248  Behavior and Plastic Design of Steel Structures  3
CIV ENG 249  Experimental Methods in Structural Engineering  3

Systems Engineering Concentration (SYS) (http://www.ce.berkeley.edu/programs/sys/graduate-requirements/)

Thesis option: 24 units; minimum 21 units comprised of four of the courses below, 3 units of research (CIV ENG 299), and electives selected in conjunction with the Systems’ graduate adviser. For the thesis committee, one adviser must be from the Systems faculty, a second from the department, and a third preferably from outside the department. Two year program, one of courses and one of research.

Comprehensive Report option: Minimum 24 units and a capstone report. Students take four of the Systems courses listed below. Additionally, the student takes four elective courses making up a coherent subject specialization chosen with approval of the systems graduate adviser. A capstone report is completed in one of the Systems core courses.

Approved Graduate Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 262</td>
<td>Analysis of Transportation Data</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 263N</td>
<td>Scalable Spatial Analytics</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 264</td>
<td>Behavioral Modeling for Engineering, Planning, and Policy Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 271</td>
<td>Sensors and Signal Interpretation</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 290I</td>
<td>Civil Systems: Control and Information Management</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG C291F</td>
<td>Control and Optimization of Distributed Parameters Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 295</td>
<td>Data Science for Energy</td>
<td>3</td>
</tr>
</tbody>
</table>

Transportation Engineering Concentration (TE) (http://www.ce.berkeley.edu/programs/trans/graduate-requirements/)

Thesis option: Minimum 8 units of the required 20 must be graduate transportation courses; 2 units may be in CE 299, individual study. The remaining 12 units (made up of undergraduate and graduate courses) can include 2 more units of CE 299. Thesis required with a 3 person committee, one member outside the department. Two year program, one of courses and one of research.

Comprehensive exam option: 12 units of the required 24 must be in graduate transportation courses; 2 units may be in CE 299, individual study. The remaining 12 units (made up of undergraduate and graduate courses) can include 2 more units of CE 299. Faculty approval of program of study required. The comprehensive exam is at the end of the semester that all requirements are completed.
To assure sufficient breadth and depth, students are required to take, in addition to the fundamentals, courses in the following areas (https://ce.berkeley.edu/programs/trans/courses):

- Transportation Engineering students: take one course in each area of Policy, Modal, and Analysis
- Transportation Systems students: take one course in each area of Modal, Analysis, and Systems
- Joint MS/MCP (City and Regional Planning): take a total of three courses in both Modal and Analysis

No course can count in more than one area.

**Required Courses**

**Fundamentals (all are required):**
- CIV ENG 251 Operation of Transportation Facilities 3
- CIV ENG 252 Systems Analysis in Transportation 3
- CIV ENG 262 Analysis of Transportation Data (or equivalent; must pass exam) 3

**Policy area:**
- CIV ENG C250N Transportation Policy and Planning 3
- CIV ENG 256 Transportation Sustainability 3

**Modal area:**
- CIV ENG 153 Transportation Facility Design 3
- CIV ENG 253 Intelligent Transportation Systems 3
- CIV ENG 255 Highway Traffic Operations 3
- CIV ENG 259 Public Transportation Systems 3
- CIV ENG 260 Air Transportation 3

**Analysis area:**
- CIV ENG 254 Transportation Economics 3
- CIV ENG 258 Logistics 3
- CIV ENG 261 Infrastructure Systems Management 3
- CIV ENG 264 Behavioral Modeling for Engineering, Planning, and Policy Analysis 3

**Systems area:**
- CIV ENG 271 Sensors and Signal Interpretation 3
- CIV ENG 290I Civil Systems: Control and Information Management 3
- CIV ENG C291F Control and Optimization of Distributed Parameters Systems 3

**Curriculum**

This professional degree emphasizes solving technical, sociological, environmental, and economic problems involved in the design, construction, and operation of engineering structures, processes, and equipment.

Studies include courses in the engineering sciences necessary to the engineering interpretation of the latest scientific developments. Courses in design, operation, humanities, and economics provide bases for the analysis and solution of problems in professional engineering.

The MEng program offers both technical and business coursework that prepares students for managerial and leadership positions. The capstone projects (https://funginstitute.berkeley.edu/programs-centers/full-time-program/capstone-experience/) offer students the opportunity to work in cooperative, interdisciplinary teams interacting with world-class faculty and industry mentors to come up with innovative solutions to real-world problems.

The curriculum is comprised of 12 units of technical courses and 13 units of professionally-oriented leadership courses taught in conjunction with the Fung Institute. A capstone project approved by two faculty members, one from the home program, is required at the end of the spring semester. Both concentrations offer full and part-time options. You can find information about these and other programs on the Fung Institute website which includes details on part-time/full time enrollment (http://funginstitute.berkeley.edu/programs/how-apply/), curriculum models (http://funginstitute.berkeley.edu/programs/curriculum-model/), and possible career paths (http://funginstitute.berkeley.edu/programs-master-engineering/career-paths/) of graduates.

Students must have a BS degree in an accredited engineering curricula or satisfy the equivalent of a BS degree in engineering as determined by the department. See program requirements (http://www.ce.berkeley.edu/grad/degrees/requirements/).

**Systems Engineering Concentration (Large Cyber-Physical Systems)** (http://www.ce.berkeley.edu/programs/sys/graduate-requirements/)

This program prepares a student to use computational innovations for sensor networks, cloud computing, behavioral science, mobile communications and distributed parameter control to create entrepreneurial solutions for industries such as transportation, water, or energy.

**Required Courses**

**Core Technical Courses (12 units) choose 4 courses:**
- CIV ENG 263N Scalable Spatial Analytics 3
- CIV ENG 264 Behavioral Modeling for Engineering, Planning, and Policy Analysis 3
- CIV ENG 271 Sensors and Signal Interpretation 3
- CIV ENG 290I Civil Systems: Control and Information Management 3
- CIV ENG C291F Control and Optimization of Distributed Parameters Systems 3
- CIV ENG 295 Data Science for Energy 3

**Core Leadership courses:**
- ENGIN 270A Organizational Behavior for Engineers 1
- ENGIN 270B R&D Technology Management & Ethics 1
- ENGIN 270C Teaming & Project Management 1
- ENGIN 270D Entrepreneurship for Engineers 1
- ENGIN 270G Marketing & Product Management 1
- ENGIN 270H Accounting & Finance for Engineers 1
- ENGIN 270I Digital Platform Strategy for Engineering Leaders 1
- ENGIN 270J Industry Analysis for Engineering Leaders 1
- ENGIN W270K Coaching for High Performance Teams 1
- ENGIN 295 Communications for Engineering Leaders 1
- ENGIN 296MA Master of Engineering Capstone Project 2
- ENGIN 296MB Master of Engineering Capstone Project 3
Transportation Engineering Concentration
(Intelligent Transportation Systems) (http://www.ce.berkeley.edu/programs/trans/graduate-requirements/)

Expanded surveillance, communication and computing technologies are enabling unprecedented opportunities for developing and deploying innovation that benefit managers, service providers, and system users. This program prepares you to use a mix of technical and business skills to capitalize on the opportunities in the transportation infrastructure.

**Required Courses**

Core Technical courses (both required):

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 251</td>
<td>Operation of Transportation Facilities</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 252</td>
<td>Systems Analysis in Transportation</td>
<td>3</td>
</tr>
</tbody>
</table>

And two courses (6 units) from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIV ENG 253</td>
<td>Intelligent Transportation Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 255</td>
<td>Highway Traffic Operations</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 259</td>
<td>Public Transportation Systems</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 260</td>
<td>Air Transportation</td>
<td>3</td>
</tr>
<tr>
<td>CIV ENG 264</td>
<td>Behavioral Modeling for Engineering, Planning, and Policy Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

Core Leadership courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGIN 270A</td>
<td>Organizational Behavior for Engineers</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270B</td>
<td>R&amp;D Technology Management &amp; Ethics</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270C</td>
<td>Teaming &amp; Project Management</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270D</td>
<td>Entrepreneurship for Engineers</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270G</td>
<td>Marketing &amp; Product Management</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270H</td>
<td>Accounting &amp; Finance for Engineers</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270I</td>
<td>Digital Platform Strategy for Engineering Leaders</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 270J</td>
<td>Industry Analysis for Engineering Leaders</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 295</td>
<td>Communications for Engineering Leaders</td>
<td>1</td>
</tr>
<tr>
<td>ENGIN 296MA</td>
<td>Master of Engineering Capstone Project</td>
<td>2</td>
</tr>
<tr>
<td>ENGIN 296MB</td>
<td>Master of Engineering Capstone Project</td>
<td>3</td>
</tr>
</tbody>
</table>

**Civil and Environmental Engineering**

Expand all course descriptions [+]Collapse all course descriptions [-]

**CIV ENG 200A Environmental Fluid Mechanics I 3 Units**

Terms offered: Fall 2020, Fall 2019, Fall 2018

Fundamental fluid mechanics with application to the environment. Analytical solutions and numerical modeling of advection-diffusion and Navier-Stokes equations, with a focus on understanding both the numerical techniques needed to predict environmental flow and transport and the underlying physical processes described by the mathematical equations. Fluid kinematics, scalar transport, numerical error and stability analysis, scaling analysis, channel flows, Stokes flows, and introduction to turbulence.

Environmental Fluid Mechanics I: Read More [+] Rules & Requirements

Prerequisites: Undergraduate fluid mechanics, basic computer programming or permission of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Letter grade.

Instructors: Chow, Stacey

Environmental Fluid Mechanics I: Read Less [-]

**CIV ENG 200B Environmental Fluid Mechanics II 3 Units**

Terms offered: Spring 2020, Spring 2019, Spring 2018

Fundamental fluid mechanics with application to the environment, including turbulent channel flows and boundary layers, surface waves, and sediment transport. Turbulence modeling and development of analytical and numerical solutions for the equations governing flow and transport in the environment. Scaling analysis and numerical techniques applied to examples from surface water and atmospheric flows.

Environmental Fluid Mechanics II: Read More [+] Rules & Requirements

Prerequisites: Civ Eng 200A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Letter grade.

Instructors: Chow, Stacey

Environmental Fluid Mechanics II: Read Less [-]
**CIV ENG 200C Transport and Mixing in the Environment 3 Units**

Terms offered: Spring 2017, Spring 2016, Spring 2014

Application of fluid mechanics to transport and mixing in the environment. Fundamentals of turbulence, turbulent diffusion, and shear dispersion in steady and oscillatory flows and the effects of stratification. Application to rivers, wetlands, lakes, estuaries, the coastal ocean, and the lower atmosphere.

Transport and Mixing in the Environment: Read More [+]

**Rules & Requirements**

**Prerequisites:** 100, Math 53 and 54, or equivalent

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Civil and Environmental Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Stacey

Formerly known as: 209A

Transport and Mixing in the Environment: Read Less [-]

---

**CIV ENG 202A Vadose Zone Hydrology 3 Units**

Terms offered: Spring 2019, Spring 2018, Spring 2016

Course addresses fundamental and practical issues in flow and transport phenomena in the vadose zone, which is the geologic media between the land surface and the regional water table. A theoretical framework for modeling these phenomena will be presented, followed by applications in the areas of ecology, drainage and irrigation, and contaminant transport. Hands-on applications using numerical modeling and analysis of real-life problems and field experiments will be emphasized.

Vadose Zone Hydrology: Read More [+]

**Rules & Requirements**

**Prerequisites:** 173 or equivalent

**Credit Restrictions:** Students will receive no credit for 202A after taking 202 before fall 1998.

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Civil and Environmental Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Rubin

Formerly known as: 202

Vadose Zone Hydrology: Read Less [-]

---

**CIV ENG 203A Graduate Hydrology 3 Units**

Terms offered: Fall 2018, Fall 2014

Hydrology is presented and analyzed in the context of a continuum extending from the atmosphere to the land surface to the subsurface to free water bodies. In this class, we develop the theoretical frameworks required to address problems that both lie within individual components and span these traditionally separate environments. Starting from a development of the fundamental dynamics of fluid motion, we examine applications within the subsurface, the atmosphere and surface water systems.

Graduate Hydrology: Read More [+]

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Additional Details**

**Subject/Course Level:** Civil and Environmental Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Rubin

Graduate Hydrology: Read Less [-]

---

**CIV ENG 203N Surface Water Hydrology 3 Units**

Terms offered: Spring 2018, Fall 2016, Fall 2015

Course addresses topics of surface water hydrology, such as processes of water in the atmosphere, over land surface, and within soil; advanced representation and models for infiltration and evapotranspiration processes; partition of water and energy budgets at the land surface; snow and snowmelt processes; applications of remote sensing; flood and drought, and issues related to advanced hydrological modeling. Students will address practical problems and will learn how to use the current operational hydrologic forecasting model, and build hydrological models.

Surface Water Hydrology: Read More [+]

**Rules & Requirements**

**Prerequisites:** 103 or equivalent, or consent of instructor

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Civil and Environmental Engineering/Graduate

**Grading:** Letter grade.

**Instructor:** Rubin

Formerly known as: 203

Surface Water Hydrology: Read Less [-]
CIV ENG 205B Margins of Quality for Engineered Systems 3 Units
Terms offered: Fall 2009, Fall 2007, Fall 2000
Processes and procedures to define and determine the demands and capacities of the structures and hardware elements of engineered systems during their life-cycles: margins of quality. The objective of this course is to provide students with the knowledge and skills to define and evaluate system demands, capacities, and reliability targets to be used in design, requalification, construction, operation, maintenance, and decommissioning of engineered systems.
Margins of Quality for Engineered Systems: Read More [+]
Rules & Requirements
Prerequisites: 125, 193 or equivalents and senior design experience
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Bea
Margins of Quality for Engineered Systems: Read Less [-]

CIV ENG 206 Water Resources Management 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
The course provides a framework to address contemporary water-resources problems, and to achieve water security for local areas and broader regions. Students will become aware of critical water-resources issues at local, national and global scales, and learn to formulate solutions for water-resources problems using engineering, natural-scientific and social-scientific tools. The main focus is on California and the Western United States, with comparative analysis for other regions.
Water Resources Management: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or senior undergrad with consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Bales
Water Resources Management: Read Less [-]

CIV ENG 209 Design for Sustainable Communities 3 Units
Terms offered: Spring 2016, Spring 2015, Spring 2014
This course provides conceptual and hands-on experience in design and implementation of innovative products or processes for improving the sustainability of resource-constrained communities (mostly poor ones in the developing countries). Teams of students will take on practical projects, with guidance from subject experts.
Design for Sustainable Communities: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Gadgill
Design for Sustainable Communities: Read Less [-]

CIV ENG 210 Control of Water-Related Pathogens 3 Units
Terms offered: Fall 2018, Spring 2018, Spring 1996
Comprehensive strategies for the assessment and control of water-related human pathogens (disease-causing microorganisms). Transmission routes and life cycles of common and emerging organisms, conventional and new detection methods (based on molecular techniques), human and animal sources, fate and transport in the environment, treatment and disinfection, appropriate technology, regulatory approaches, water reuse.
Control of Water-Related Pathogens: Read More [+]
Rules & Requirements
Prerequisites: Basic course in microbiology recommended; graduate standing or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Nelson
Formerly known as: Civil and Environmental Engineering 210A
Control of Water-Related Pathogens: Read Less [-]
CIV ENG 211A Environmental Physical-Chemical Processes 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Fundamental concepts of physical-chemical processes that affect water quality in natural and engineered environmental systems. Focus is on developing a qualitative understanding of mechanisms as well as quantitative tools to describe, predict, and control the behavior of physical-chemical processes. Topics include reactor hydraulics and reaction kinetics, gas transfer, adsorption, particle characteristics, flocculation, gravitational separations, filtration, membranes, and disinfection.
Environmental Physical-Chemical Processes: Read More [+]
Rules & Requirements
Prerequisites: Civil and Environmental Engineering 111 or equivalent and course work in aquatic chemistry, or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Nelson
Environmental Physical-Chemical Processes: Read Less [-]

CIV ENG 211B Environmental Biological Processes 3 Units
Terms offered: Fall 2020, Fall 2019, Spring 2019
Fundamental concepts of biological processes that are important in natural and engineered environmental systems, especially those affecting water quality. Incorporates basic fundamentals of microbiology into a quantifiable engineering context to describe, predict, and control behavior of environmental biological systems. Topics include the stoichiometry, energetics and kinetics of microbial reactions, suspended and biofilm processes, carbon and nutrient cycling, and bioremediation applications.
Environmental Biological Processes: Read More [+]
Rules & Requirements
Prerequisites: Civil and Environmental Engineering 111 or equivalent and course work in microbiology, or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Alvarez-Cohen
Environmental Biological Processes: Read Less [-]

CIV ENG 213 Watersheds and Water Quality 3 Units
Terms offered: Fall 1996
Overview of approaches used by engineers to preserve or improve water quality at the watershed scale. Characterization and modeling of nutrients, metals, and organic contaminants in watersheds. Application of ecosystem modification and pollutant trading to enhance water quality. The course emphasizes recent case studies and interdisciplinary approaches for solving water quality problems.
Watersheds and Water Quality: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Credit Restrictions: Students will receive no credit for 213 after taking 290C.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Sedlak
Watersheds and Water Quality: Read Less [-]

CIV ENG 217 Environmental Chemical Kinetics 3 Units
Terms offered: Spring 2020, Spring 2017, Spring 2015
Environmental Chemical Kinetics: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor; 115 or 214 or equivalent
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Sedlak
Environmental Chemical Kinetics: Read Less [-]
CIV ENG 218A Air Quality Engineering 3 Units
Terms offered: Fall 2020, Spring 2020, Fall 2018
Quantitative overview of the characterization and control of air pollution problems. Summary of fundamental chemical and physical processes governing pollutant behavior. Analysis of key elements of the air pollution system: sources and control techniques, atmospheric transformation, atmospheric transport, modeling, and air quality management.
Air Quality Engineering: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing in engineering or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Harley
Air Quality Engineering: Read Less [-]

CIV ENG 218B Atmospheric Aerosols 3 Units
Terms offered: Spring 2013, Fall 2008, Spring 2006
Atmospheric Aerosols: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor, Civil and Environmental Engineering 218A recommended

Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture and 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Variano, Stacey
Atmospheric Aerosols: Read Less [-]

CIV ENG 218C Air Pollution Modeling 3 Units
Terms offered: Spring 2010, Spring 2008, Spring 2005
Air Pollution Modeling: Read More [+]

Rules & Requirements
Prerequisites: 218A

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Harley
Air Pollution Modeling: Read Less [-]

CIV ENG 219 Fluid Flow in Environmental Processes 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Transport and mixing of solutes in water. Focus on rivers, lakes, estuaries, and wetlands, with some discussion of groundwater and the atmosphere. Basic equations of fluid motion will be used to contextualize and/or derive applied empirical equations for use in specific cases of applied environmental engineering practice. Example applications include outfalls, total maximum daily loads, residence time, and longitudinal dispersion.
Fluid Flow in Environmental Processes: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or senior undergrad with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Variano, Stacey
Fluid Flow in Environmental Processes: Read Less [-]
CIV ENG 220 Structural Analysis Theory and Applications 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2015
Rules & Requirements
Prerequisites: 121 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Filippou

Structural Analysis Theory and Applications: Read Less [-]

CIV ENG 220N Nonlinear Structural Analysis 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Rules & Requirements
Prerequisites: Civ Eng 121 or equivalent
Credit Restrictions: Students who have previously taken Civ Eng 221 will not receive credit for this course

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Filippou, Govindjee

Nonlinear Structural Analysis: Read Less [-]

CIV ENG 221 Nonlinear Structural Analysis 3 Units
Terms offered: Spring 2020, Spring 2016, Spring 2015
Rules & Requirements
Prerequisites: 220

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Filippou

Nonlinear Structural Analysis: Read Less [-]

CIV ENG 222 Finite Element Methods 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Rules & Requirements
Prerequisites: 220 or equivalent, 131 or 231

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Filippou, Govindjee

Finite Element Methods: Read Less [-]
CIV ENG 223 Earthquake Protective Systems
3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Conceptual basis for earthquake protective systems including seismic isolation and energy absorbing techniques. Design rules for seismic isolation, energy absorbing and self-centering systems. Characteristics of isolation bearings, frictional, metallic and energy absorbing devices, code provision for earthquake protective systems. Applications to new and existing structures.
Earthquake Protective Systems: Read More [+]
Rules & Requirements
Prerequisites: 220, 225, or consent of instructor
Credit Restrictions: Students will receive no credit for 223 after taking 290D.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Konstantinidis
Formerly known as: 290D
Earthquake Protective Systems: Read Less [-]

CIV ENG 225 Dynamics of Structures 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Evaluation of deformations and forces in structures, idealized as single-degree of freedom or discrete-parameter multi-degree of freedom systems, due to dynamic forces. Evaluation of earthquake-induced deformations and forces in structures by linear response history analysis; estimation of maximum response by response spectrum analysis; effects of inelastic behavior. Laboratory demonstrations.
Dynamics of Structures: Read More [+]
Rules & Requirements
Prerequisites: 220 (may be taken concurrently) or equivalent
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: DeJong
Dynamics of Structures: Read Less [-]

CIV ENG 226 Stochastic Structural Dynamics
3 Units
Terms offered: Spring 2016, Spring 2014, Spring 2012
Stochastic Structural Dynamics: Read More [+]
Rules & Requirements
Prerequisites: 225
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Stochastic Structural Dynamics: Read Less [-]

CIV ENG 227 Earthquake-Resistant Design 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Earthquake-Resistant Design: Read More [+]
Rules & Requirements
Prerequisites: 220 and 225
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Moehle, Becker
Earthquake-Resistant Design: Read Less [-]
CIV ENG 228 Advanced Earthquake Analysis
3 Units
Terms offered: Spring 2015, Spring 2013, Spring 2012
Advanced topics in time-domain dynamic analysis of structures.
Advanced Earthquake Analysis: Read More [+]
Rules & Requirements
Prerequisites: 225
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Advanced Earthquake Analysis: Read Less [-]

CIV ENG 229 Structural System Reliability 3 Units
Terms offered: Spring 2020, Spring 2015, Spring 2013
Structural System Reliability: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Structural System Reliability: Read Less [-]

CIV ENG 228 Advanced Earthquake Analysis
3 Units
Terms offered: Spring 2015, Spring 2013, Spring 2012
Advanced topics in time-domain dynamic analysis of structures.
Advanced Earthquake Analysis: Read More [+]
Rules & Requirements
Prerequisites: 225
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Advanced Earthquake Analysis: Read Less [-]

CIV ENG C231 Mechanics of Solids 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Mechanics of Solids: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Govindjee
Also listed as: MAT SCI C211
Mechanics of Solids: Read Less [-]

CIV ENG 232 Structural Mechanics 3 Units
Terms offered: Spring 2020, Spring 2018, Spring 2016
The goal of this course is to study the theories of structural mechanics within the framework of nonlinear continuum mechanics of solids. Finite elasticity; invariance. Energy principles: principles of virtual and complementary virtual work; primary and mixed variational principles. Theory of stability: Euler method; stability under follower loads. Classical theories of beams: planar, torsional, and lateral buckling. Plate theories. Invariant theories of structural mechanics: directed continua; Cosserat theories of rods.
Structural Mechanics: Read More [+]
Rules & Requirements
Prerequisites: 231 or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Armero
Structural Mechanics: Read Less [-]
CIV ENG 233 Computational Mechanics 3 Units
Terms offered: Fall 2020, Fall 2018, Fall 2016
Computational Mechanics: Read More [+]

Rules & Requirements
Prerequisites: 222, or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Armero

Computational Mechanics: Read Less [-]

CIV ENG 234 Computational Inelasticity 3 Units
Terms offered: Spring 2011, Fall 2007, Fall 2005
Computational methods applied to inelastic deformations of solids; 1, 2, and 3-D large and small-deformation continuum plasticity and viscoelasticity models and their algorithmic approximations; viscoplastic regularizations and softening; thermodynamics and its relationship to algorithmic stability; return mappings, closest-point projections and operator splits; application to metals, soils, concrete, and polymers and incorporation into finite element codes.
Computational Inelasticity: Read More [+]

Rules & Requirements
Prerequisites: 231 or Materials Science and Engineering 211 or Mechanical Engineering 185

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Armero, Govindjee

Computational Inelasticity: Read Less [-]

CIV ENG C235 Introduction to Statistical Mechanics for Engineers 3 Units
Terms offered: Spring 2020, Spring 2017, Fall 2013
Introduction to Statistical Mechanics for Engineers: Read More [+]

Objectives & Outcomes
Course Objectives: To provide a modern introduction to the application of statistical mechanics for engineering with a particular emphasis on mechanical response.

Rules & Requirements
Prerequisites: CE C231 or MSE C211 or ME 185 or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Govindjee, Papadopoulos

Also listed as: MEC ENG C279
Introduction to Statistical Mechanics for Engineers: Read Less [-]
CIV ENG C236 Micromechanics 3 Units
Terms offered: Spring 2018, Spring 2016, Spring 2014
Basic theories, analytical techniques, and mathematical foundations of micromechanics. It includes 1. physical micromechanics, such as mathematical theory of dislocation, and cohesive fracture models; 2. micro-elasticity that includes Eshelby's eigenstrain theory, comparison variational principles, and micro-crack/micro-cavity based damage theory; 3. theoretical composite material that includes the main methodologies in evaluating overall material properties; 4. meso-plasticity that includes meso-damage theory, and the crystal plasticity; 5. homogenization theory for materials with periodic structures.
Micromechanics: Read More [+]
Prerequisites: Consent of instructor
Rules & Requirements
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Govindjee, Li
Also listed as: MAT SCI C214
Micromechanics: Read Less [-]

CIV ENG C237 Computational Nano-mechanics 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017, Fall 2014
Basic mathematics foundations, physical models, computational formulations and algorithms that are used in nanoscale simulations and modelings. They include (1) cohesive finite element methods and discontinuous Galerkin methods; (2) meshfree methods, partition of unity methods, and the eXtended finite element methods (X-FEM); (3) quasicontinuum method; (4) molecular dynamics; (5) multiscale simulations; (6) Boltzmann method. Computational Nano-mechanics: Read More [+]
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Li
Also listed as: NSE C237
Computational Nano-mechanics: Read Less [-]

CIV ENG 240 Civil Engineering Materials 3 Units
Terms offered: Fall 2020, Fall 2018, Fall 2016
Microstructures of concrete, wood, and steel. Differences and similarities in response to loading and environmental effects on these materials, with emphasis on strength, elastic properties, creep, shrinkage, thermal stresses, and failure mechanisms.
Civil Engineering Materials: Read More [+]
Rules & Requirements
Prerequisites: An undergraduate course in civil engineering materials
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Monteiro, Ostertag
Civil Engineering Materials: Read Less [-]

CIV ENG 241 Concrete Technology 3 Units
Terms offered: Spring 2019, Spring 2015, Spring 2013
Concrete Technology: Read More [+]
Rules & Requirements
Prerequisites: 165 or equivalent
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Monteiro
Concrete Technology: Read Less [-]
CIV ENG 244 Reinforced Concrete Structures 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Analysis and design of reinforced concrete elements and systems that are common in building and bridge structures, with an emphasis on seismic response and design; structural design methods; reinforced concrete materials; confined concrete; line elements under axial, flexural, and shear loadings; bond, anchorage, and development; seismic design principles; earthquake-resistant building frames, walls, diaphragms, and foundations; earthquake-resistant bridges.
Reinforced Concrete Structures: Read More [+]

Rules & Requirements
Prerequisites: Civil and Environmental Engineering 123

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Moehle

Reinforced Concrete Structures: Read Less [-]

CIV ENG 245 Behavior of Reinforced Concrete 3 Units
Terms offered: Spring 2015, Spring 2013, Spring 2011
Advanced topics in reinforced concrete construction, including inelastic flexural behavior; applications of plastic analysis to reinforced concrete frames; behavior in shear and torsion; yield-line analysis of slabs; behavior under cyclic and reversed loading; seismic rehabilitation.
Behavior of Reinforced Concrete: Read More [+]

Rules & Requirements
Prerequisites: 123 and 220

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Moehle

Behavior of Reinforced Concrete: Read Less [-]

CIV ENG 246 Prestressed Concrete Structures 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Behavior and design of statically determinate prestressed concrete structures under bending moment, shear, torsion and axial load effects. Design of continous prestressed concrete beams, frames, slabs, and shells. Time-dependent effects and deflections of prestressed concrete structures. Applications to the design and construction of bridges and buildings.
Prestressed Concrete Structures: Read More [+]

Rules & Requirements
Prerequisites: 244 or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Filippou, Moehle

Prestressed Concrete Structures: Read Less [-]

CIV ENG 247 Design of Steel and Composite Structures 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Design of Steel and Composite Structures: Read More [+]

Rules & Requirements
Prerequisites: 122 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Astaneh, Mahin

Design of Steel and Composite Structures: Read Less [-]
CIV ENG 248 Behavior and Plastic Design of Steel Structures 3 Units
Terms offered: Fall 2015, Fall 2012, Fall 2010
Topics related to inelastic behavior and plastic design of steel members and structures. Behavior of plastic hinge in members subjected to bending moment, axial force, shear, and their combinations. Collapse mechanisms of steel members and structures such as moment frames and braced systems. Inelastic cyclic behavior of steel components. Introduction to fracture and fatigue of steel components.

Rules & Requirements
Prerequisites: 122 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.

Behavior and Plastic Design of Steel Structures: Read More [+]

CIV ENG 249 Experimental Methods in Structural Engineering 3 Units
Terms offered: Fall 2019, Fall 2017, Fall 2015
This course covers the following topics: similitude laws, design of structural models, instrumentation and measurement techniques; use of computers to acquire data and control tests; pseudo-dynamic testing method; standard proof-testing for capacity assessment; non-destructive testing for condition assessment, and virtual experimentation. Upon completing this course, the students will be able to use experimental methods to investigate the behavior of a structure and to evaluate its condition.

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Mosalam

Experimental Methods in Structural Engineering: Read Less [-]

CIV ENG C250N Transportation Policy and Planning 3 Units
Terms offered: Spring 2020, Fall 2018, Spring 2018
Policy issues in urban transportation planning; measuring the performance of transportation systems; the transportation policy formulation process; transportation finance, pricing, and subsidy issues; energy and air quality in transportation; specialized transportation for elderly and disabled people; innovations in transportation policy.

Rules & Requirements
Prerequisites: 213 or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Also listed as: CY PLAN C217

Transportation Policy and Planning: Read Less [-]

CIV ENG 251 Operation of Transportation Facilities 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Cassidy, Daganzo

Operation of Transportation Facilities: Read Less [-]

Experimental Methods in Structural Engineering: Read More [+]

Transportation Policy and Planning: Read More [+]

Operation of Transportation Facilities: Read More [+]

Experimental Methods in Structural Engineering: Read Less [-]
CIV ENG 252 Systems Analysis in Transportation 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Systems Analysis in Transportation: Read More [+]

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Hansen

CIV ENG 253 Intelligent Transportation Systems 3 Units
Terms offered: Spring 2019, Spring 2017, Fall 2015
The use of advanced surveillance, navigation, communication, and computer technology to monitor, analyze, and improve the performance of transportation systems. Enabling technologies. Application to monitoring, analysis, evaluation, and prediction of transportation system performance and behavior. Intervention strategies. Feasibility studies. Human factors and institutional issues. Case studies. In the laboratory, students carry out a term project under the supervision of an ITS researcher.
Intelligent Transportation Systems: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Sengupta, Skabardonis

CIV ENG 254 Transportation Economics 3 Units
Terms offered: Spring 2019, Spring 2010, Spring 2009
Transportation Economics: Read More [+]

Rules & Requirements
Prerequisites: 252 or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Hansen, Kanafani

CIV ENG 255 Highway Traffic Operations 3 Units
Terms offered: Spring 2020, Spring 2018, Spring 2016
Operational planning and management of the highway transportation system. The highway system is presented as a set of operating environments with each having its unique analytical framework. Major topics to be covered include policy and institutional issues, selection of strategies and tactics, evaluation of objectives and measures of effectiveness.
Highway Traffic Operations: Read More [+]

Rules & Requirements
Prerequisites: 251 or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Cassidy
CIV ENG 256 Transportation Sustainability 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
This multi-disciplinary course is intended to introduce students to the fundamentals of sustainable transportation, with an emphasis on: 1) current trends, climate and energy science, and the policy context; 2) methodological and analysis techniques; 3) vehicle technology, fuels, and intelligent transportation systems (ITS) solutions (supply side); and 4) land use, public transportation, and demand management.
Transportation Sustainability: Read More [+]

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Horvath

CIV ENG 257 Sustainable Aviation and Infrastructure 3 Units
Principles of “green” and “sustainable” aviation, and analysis methods for evaluating aviation sustainability metrics and measurements. Aircraft operations and airport systems in the context of global warming, aviation noise, local and global emissions, third-party risk, environmental economics and resilience. Models of carbon reduction, and technology and operations alternatives are studied. Future concepts, such as urban and regional air mobility using electric aircraft and vertiports.
Sustainable Aviation and Infrastructure: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Credit Restrictions: Students will receive no credit for CIV ENG 257 after completing CIV ENG 257, or CIV ENG 257. A deficient grade in CIV ENG 257 may be removed by taking CIV ENG 257, or CIV ENG 257.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Rakas
Sustainable Aviation and Infrastructure: Read Less [-]

CIV ENG 258 Logistics 3 Units
Terms offered: Fall 2013, Fall 2011, Fall 2010
Vehicle routing. Transportation-inventory-production interrelationships, physical distribution networks, many-to-many networks (airlines, postal, etc.), the role of transshipments and terminals in logistic systems for the transportation of goods and passengers, public and private transportation system design. Relevant methodologies.
Logistics: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Daganzo
Logistics: Read Less [-]

CIV ENG C258 Supply Chain and Logistics Management 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Supply chain analysis is the study of quantitative models that characterize various economic trade-offs in the supply chain. The field has made significant strides on both theoretical and practical fronts. On the theoretical front, supply chain analysis inspires new research ventures that blend operations research, game theory, and microeconomics. These ventures result in an unprecedented amalgamation of prescriptive, descriptive, and predictive models characteristic of each subfield. On the practical front, supply chain analysis offers solid foundations for strategic positioning, policy setting, and decision making.
Supply Chain and Logistics Management: Read More [+]

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Shen
Also listed as: IND ENG C253
Supply Chain and Logistics Management: Read Less [-]
CIV ENG 259 Public Transportation Systems
3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Analysis of mass transit systems, their operation, and management. Technology of transit vehicles and structures. Public policy and financing. Public Transportation Systems: Read More [+]
Rules & Requirements
Prerequisites: 251, 252, and 262 (or equivalent course)
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Cassidy, Daganzo
Public Transportation Systems: Read Less [-]

CIV ENG 260 Air Transportation 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Nature of civil aviation; structure of the airline industry; aircraft characteristics and performance; aircraft noise; navigation and air traffic control; airport planning and design; airline operations; aviation system planning. Air Transportation: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Hansen, Kanafani
Air Transportation: Read Less [-]

CIV ENG 261 Infrastructure Systems Management 3 Units
Terms offered: Spring 2014, Spring 2013, Spring 2011
Integrated treatment of quantitative and analytical methods for the management of infrastructure facilities over their life. The focus of the course is on statistical modeling and numerical optimization methods and their application to managing systems of civil infrastructure, with an emphasis on transportation facilities. Infrastructure Systems Management: Read More [+]
Rules & Requirements
Prerequisites: 252 or equivalent, 262 or equivalent
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Cassidy, Daganzo
Infrastructure Systems Management: Read Less [-]

CIV ENG 262 Analysis of Transportation Data 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Probabilistic models in transportation. The use of field data. Data gathering techniques, sources of errors, considerations of sample size. Experiment design for demand forecasting and transportation operations analysis. Analysis techniques. Analysis of Transportation Data: Read More [+]
Rules & Requirements
Prerequisites: College calculus or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Daganzo, Hansen
Analysis of Transportation Data: Read Less [-]
CIV ENG 263N Scalable Spatial Analytics 3 Units
Terms offered: Fall 2020, Spring 2019, Fall 2016
Introduction to modern methods of data analysis, spatial data handling and visualization technologies for engineers and data scientists. Theoretical coverage includes a selection of methods from spatial statistics, exploratory data analysis, spatial data mining, discriminative and generative approaches of machine learning. Projects and assignment tasks are targeted at real-world scalable implementation of systems and services based on data analytics in environmental remote sensing, transportation, energy, location-based services and the domain of “smart cities” in general.
Scalable Spatial Analytics: Read More [+]
Rules & Requirements
Prerequisites: Civil and Environmental Engineering 290I or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Scalable Spatial Analytics: Read Less [-]

CIV ENG 264 Behavioral Modeling for Engineering, Planning, and Policy Analysis 3 Units
Terms offered: Spring 2020, Spring 2018, Spring 2017
Many aspects of engineering, planning, and policy involve a human element, be it consumers, businesses, governments, or other organizations. Effective design and management requires understanding this human response. This course focuses on behavioral theories and the use of quantitative methods to analyze human response. A mix of theory and practical tools are covered, with applications drawn from infrastructure investment and use, urban growth and design, health, and sustainability.
Behavioral Modeling for Engineering, Planning, and Policy Analysis: Read More [+]
Rules & Requirements
Prerequisites: 262 or City and Regional Planning 204 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Walker
Behavioral Modeling for Engineering, Planning, and Policy Analysis: Read Less [-]

CIV ENG C265 Traffic Safety and Injury Control 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
This course applies principles of engineering, behavioral science, and vision science to preventing traffic collisions and subsequent injury. A systematic approach to traffic safety will be presented in the course, and will include (1) human behavior, vehicle design, and roadway design as interacting approaches to preventing traffic crashes and (2) vehicle and roadway designs as approaches to preventing injury once a collision has occurred. Implications of intelligent transportation system concepts for traffic safety will be discussed throughout the course.
Traffic Safety and Injury Control: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Ragland
Also listed as: PB HLTH C285
Traffic Safety and Injury Control: Read Less [-]

CIV ENG 268A Lean Construction Concepts and Methods 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Inspired by the ‘lean’ resolution in manufacturing, production management concepts and methods are woven into a lean project delivery system. Key concepts include flow, value, variability, and waste. Key methods include procurement system design, target costing, value stream mapping, and work flow control. Student teams apply concepts and methods in field studies of real project management processes and construction operations. The course includes a tour of the NUMMI Auto Plant in Fremont.
Lean Construction Concepts and Methods: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing in Civil and Environmental Engineering

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Tommelein
Formerly known as: 290M
Lean Construction Concepts and Methods: Read Less [-]
CIV ENG 268B Lean Construction and Supply Chain Management 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Principles and practices of 'lean' production are applied to project delivery in the AEC industry. Case studies illustrate the concepts. Project delivery is viewed holistically with a focus on work structuring and supply chain management. Topics include systems dynamics, uncertainty, and variation; materials management; logistics; e-commerce; building information modeling (BIM); and integrated product and process design. Students use process simulation to assess performance of different system configurations and develop a case study applying concepts on a real project.

CIV ENG 268D Law for Engineers 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Engineering involves many parties with diverse interests. Legal principles form the framework for their interaction. Contracts for engineering services establish both risk allocation and reciprocal liabilities. Issues of contract formation, performance, breach, and remedy are covered in detail. Standard of care and professional negligence are emphasized during the discussion of tort law. Other topics include regulation, legal relationships, litigation, and alternative dispute resolution.

CIV ENG 268E Civil Systems and the Environment 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Methods and tools for economic and environmental analysis of civil engineering systems. Focus on construction, transportation, and operation, and maintenance of the built infrastructure. Life-cycle planning, design, costing, financing, and environmental assessment. Industrial ecology, design for environment, pollution prevention, external costs. Models and software tools for life-cycle economic and environmental inventory, impact, and improvement analysis of civil engineering systems.

CIV ENG 268F Advanced Project Planning and Control 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Cost and time estimating and controlling techniques for projects. Evaluation of labor, material, equipment, and subcontract resources, scheduling techniques, earned value concepts. Measuring project percent complete. Contractual risk allocation. Project investment analysis techniques.
CIV ENG 268I Business Fundamentals for Engineers 3 Units
Terms offered: Spring 2019, Spring 2017, Spring 2016
This course will provide a broad survey of management practices critical to starting and managing a business in the engineering and construction industries. Topics that are covered include the entrepreneurial process; organizing and staffing; establishing and applying production control systems; means of protecting products and services from competitive threat; and financial management.

Rules & Requirements

Prerequisites: 167 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Ibbs

CIV ENG 268S Buildings and Sustainability 3 Units
Terms offered: Spring 2018
Overview of what makes buildings and their systems “green” and “sustainable,” and analysis throughout their life cycle (design, materials, construction, operation, maintenance, renovation, end of life) and in interaction with infrastructure systems (energy, transportation, water, waste management), the economy, natural environment, society, innovative approaches, expectations for future developments. Cost-benefit analysis. Life-cycle management. Net-zero buildings. Case studies.

Objectives & Outcomes

Course Objectives: 1.
Provide overview of the importance of buildings to resource management, particularly focused on energy, transportation systems, water, waste, and land use
2. Introduce the major design considerations, practices, and outcomes associated with green buildings
3. Develop students’ ability to think critically about the role of buildings in society.
4. Critically evaluate tradeoffs in building systems design subject to time, cost, material, social, and environmental constraints, and ethical considerations.
5. Consider the future of the green building industry in the context of real-world developments and practice, equity, and justice.
6. Evaluate the interplay between buildings and policy, including use of local case studies.

Rules & Requirements

Prerequisites: Graduate or senior undergraduate standing with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Horvath

CIV ENG 268K Human and Organizational Factors: Quality and Reliability of Engineered Systems 3 Units
Terms offered: Spring 2011, Spring 2010, Fall 2009
This course addresses human and organizational factors in development of desirable quality and reliability in engineered systems during their life-cycles (concept development through decommissioning). Applications tested and verified proactive, reactive, and interactive approaches are developed and illustrated.

Rules & Requirements

Prerequisites: Graduate standing

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Formerly known as: 290A

Human and Organizational Factors: Quality and Reliability of Engineered Systems: Read Less [-]
CIV ENG 270 Advanced Geomechanics 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Advanced treatment of topics in soil mechanics, including state of stress, consolidation and settlement analysis, shear strength of cohesionless and cohesive soils, and slope stability analysis.
Advanced Geomechanics: Read More [+]

Rules & Requirements
Prerequisites: 175 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Bray, Soga

Formerly known as: 270A
Advanced Geomechanics: Read Less [-]

CIV ENG 271 Sensors and Signal Interpretation 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
An introduction to the fundamentals of sensor usage and signal processing, and their application to civil systems. In particular, the course focuses on how basic classes of sensors work, and how to go about choosing the best of the new MEMS-based devices for an application. The interpretation of the data focuses on analysis of transient signals, an area typically ignored in traditional signal processing courses. Goals include development of a critical understanding of the assumptions used in common sensing and analysis methods and their implications, strengths, and limitations.
Sensors and Signal Interpretation: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Glaser

Sensors and Signal Interpretation: Read Less [-]

CIV ENG 272 Numerical Modelling in Geomechanics 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Constitutive laws for geotechnical materials including inelastic hyperbolic and elasto-plastic Cam-clay; soil behavior and critical-state soil mechanics; application of the finite element method to static analysis of earth structures; the Discontinuous Deformation Analysis method.
Numerical Modelling in Geomechanics: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructors: Bray, Soga

Numerical Modelling in Geomechanics: Read Less [-]

CIV ENG 273 Advanced GeoEngineering Testing and Design 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Field and laboratory testing of soils to support analysis and design of earth structures. In situ field testing, including SPT, CPT, and vane shear, undisturbed sampling of soil, and laboratory testing of soil, including advanced equipment, instrumentation, data acquisition, and measurement techniques. Consolidation and static and cyclic triaxial and simple shear testing under stress- and strain-control with pore pressure measurements. Preparation of an engineering report.
Advanced GeoEngineering Testing and Design: Read More [+]

Rules & Requirements
Prerequisites: 270 or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 1.5 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Bray

Formerly known as: 270L
Advanced GeoEngineering Testing and Design: Read Less [-]
CIV ENG 275 Geotechnical Earthquake Engineering 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Seismicity, influence of soil conditions on site response, seismic site response analysis, evaluation and modelling of dynamic soil properties, analysis of seismic soil-structure interaction, evaluation and mitigation of soil liquefaction and its consequences, seismic code provisions and practice, seismic earth pressures, seismic slope stability and deformation analysis, seismic safety of dams and embankments, seismic performance of pile foundations, and additional current topics.

CIV ENG 276 Seismic Hazard Analysis and Design Ground Motions 3 Units
Terms offered: Spring 2019, Spring 2018, Fall 2017, Spring 2017
Deterministic and probabilistic approaches for seismic hazard analysis. Separation of uncertainty into aleatory variability and epistemic uncertainty. Discussion of seismic source and ground motion characterization and hazard computation. Development of time histories for dynamic analyses of structures and seismic risk computation, including selection of ground motion parameters for estimating structural response, development of fragility curves, and methods for risk calculations.

CIV ENG 277 Advanced Foundation Engineering 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
Advanced treatment of topics in foundation engineering, including earth pressure theories, design of earth retaining structures, bearing capacity, ground improvement for foundation support, analysis and design of shallow and deep foundations.

CIV ENG 281 Engineering Geology 3 Units
Terms offered: Fall 2020, Fall 2019, Fall 2018
Influence of geologic origin and history on the engineering characteristics of soils and rocks. Application of geology in exploration, design, and construction of engineering works.
CIV ENG 285C Seismic Methods in Applied Geophysics 3 Units
Terms offered: Spring 2011, Spring 2006, Spring 2002
This course gives an overview of seismic methods used to image the subsurface. Acquisition, processing, and interpretation of seismic data are discussed, with application to petroleum production, environmental site characterization, earthquake engineering, and groundwater.
Seismic Methods in Applied Geophysics: Read More [+]

Rules & Requirements
Prerequisites: C178 or equivalent (introductory course in applied geophysics); Engineering 7 or 77 or equivalent (introductory course in computer programming)
Credit Restrictions: Students will receive no credit for 285C after taking Mineral Engineering 236 before Fall 2001.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Rector
Formerly known as: Mineral Engineering 236
Seismic Methods in Applied Geophysics: Read Less [-]

CIV ENG 286 Digital Data Processing 3 Units
Terms offered: Spring 2019, Spring 2017, Spring 2013
Digital Data Processing: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor
Credit Restrictions: Students will receive no credit for 286 after taking Mineral Engineering 240 taken before Fall 2001.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Rector
Formerly known as: Mineral Engineering 240
Digital Data Processing: Read Less [-]

CIV ENG C289 Embedded System Design: Modeling, Analysis, and Synthesis 4 Units
Terms offered: Spring 2020, Spring 2019, Spring 2016, Spring 2015
Principles of embedded system design. Focus on design methodologies and foundations. Platform-based design and communication-based design and their relationship with design time, re-use, and performance. Models of computation and their use in design capture, manipulation, verification, and synthesis. Mapping into architecture and systems platforms. Performance estimation. Scheduling and real-time requirements. Synchronous languages and time-triggered protocols to simplify the design process.
Embedded System Design: Modeling, Analysis, and Synthesis: Read More [+]

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Sangiovanni-Vincentelli
Formerly known as: Electrical Engineering C249/Civil and Environmental Engineering C289
Also listed as: EL ENG C249B
Embedded System Design: Modeling, Analysis, and Synthesis: Read Less [-]

CIV ENG 290 Advanced Special Topics in Civil and Environmental Engineering 1 - 3 Units
Terms offered: Fall 2020, Spring 2020, Fall 2019
This course covers current topics of interest in civil and environmental engineering. The course content may vary from semester to semester depending upon instructor.
Advanced Special Topics in Civil and Environmental Engineering: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Advanced Special Topics in Civil and Environmental Engineering: Read Less [-]
CIV ENG 290F Advanced Topics in Seismology 3 Units
Terms offered: Spring 2018, Spring 2016, Spring 2014
Active areas of research in applied seismology. Subjects include: anisotropic and viscoelastic wave propagation, borehole seismology, crosswell seismology, including crosswell seismic tomography, vertical seismic profiling, reservoir monitoring including passive seismic methods.
Advanced Topics in Seismology: Read More [+]

Rules & Requirements

Prerequisites: Introductory course in seismology; 286 or Mineral Engineering 240

Repeat rules: Course may be repeated for credit with instructor consent.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Rector
Formerly known as: Mineral Engineering 290C
Advanced Topics in Seismology: Read Less [-]

CIV ENG 290J Advanced Topics in Geotechnical Engineering 3 Units
Advanced treatment of developing areas of geomechanics and geotechnical earthquake engineering, including the development of generalized nonlinear soil constitutive models, new developments in soil dynamics and geotechnical earthquake engineering, soil improvement, geosynthetics and earth structures, and case studies of geotechnical problems.
Advanced Topics in Geotechnical Engineering: Read More [+]

Rules & Requirements

Prerequisites: Advanced graduate standing in Geoengineering

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of seminar per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Letter grade.
Instructor: Bray
Advanced Topics in Geotechnical Engineering: Read Less [-]

CIV ENG 290T Advanced Topics in Transportation Theory 1 Unit
Terms offered: Fall 2008, Spring 2008, Fall 2007
Selected topics in the mathematical analysis of transportation systems. Topics will vary from year to year.
Advanced Topics in Transportation Theory: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.
Instructors: Cassidy, Daganzo
Advanced Topics in Transportation Theory: Read Less [-]
CIV ENG C290U Transportation and Land Use Planning 3 Units
Terms offered: Fall 2020, Fall 2019, Spring 2019
Examination of the interactions between transportation and land use systems; historical perspectives on transportation; characteristics of travel and demand estimation; evaluation of system performance; location theory; models of transportation and urban structure; empirical evidence of transportation-land use impacts; case study examinations.
Transportation and Land Use Planning: Read More [+]

Rules & Requirements
Prerequisites: 113A or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Letter grade.

Instructors: Chatman, Cervero

Also listed as: CY PLAN C213

Transportation and Land Use Planning: Read Less [-]

CIV ENG 291G Advanced Estimation, Control, and Optimization of Partial Differential Equations 3 Units
Terms offered: Prior to 2007
This course will cover advanced methods in estimation, control, and optimization of distributed parameter systems (partial differential equations in particular). The course builds on 291 and covers discrete methods relying on finite differencing such as quadratic programming for optimal control and variational data assimilation, (ensemble, extended) Kalman filtering. The course covers distributed transfer function analysis and frequency responses of PDEs, and characteristics-based stability analysis.
Advanced Estimation, Control, and Optimization of Partial Differential Equations: Read More [+]

Rules & Requirements
Prerequisites: Civil and Environmental Engineering C291F/Electrical Engineering C291/Mechanical Engineering C236 or equivalent, or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Letter grade.

Instructor: Bayen

Advanced Estimation, Control, and Optimization of Partial Differential Equations: Read Less [-]

CIV ENG C291F Control and Optimization of Distributed Parameters Systems 3 Units
Terms offered: Fall 2017, Spring 2016, Spring 2015, Spring 2014
Control and Optimization of Distributed Parameters Systems: Read More [+]

Rules & Requirements
Prerequisites: Engineering 77, Mathematics 54 (or equivalent), or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Letter grade.

Also listed as: EL ENG C291/MEC ENG C236

Control and Optimization of Distributed Parameters Systems: Read Less [-]

CIV ENG 292A Technologies for Sustainable Societies 1 Unit
Terms offered: Fall 2018, Fall 2017, Fall 2016
Exploration of selected important technologies that serve major societal needs, such as shelter, water, food, energy, and transportation, and waste management. How specific technologies or technological systems do or do not contribute to a move toward sustainability. Specific topics vary from year to year according to student and faculty interests.
Technologies for Sustainable Societies: Read More [+]

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 1.5 hours of seminar per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: Horvath, Nazaroff

Technologies for Sustainable Societies: Read Less [-]
CIV ENG 295 Data Science for Energy 3 Units
Terms offered: Spring 2020, Spring 2019, Spring 2018
This course introduces students to the fundamentals of data science methods for the design and operation of energy systems. The course is oriented towards students pursuing a technical career in cleantech, or a PhD in the energy sciences and engineering. Course contents include: mathematical modeling & analysis, state estimation, optimization, machine learning, and optimal control. Homework assignments are designed around case studies, including lithium-ion batteries, oil & gas systems, renewable power systems, smart buildings, and electrified transportation. Student teams also execute a self-defined project.

Objectives & Outcomes

Course Objectives: This course provides an introduction to emerging smart energy systems and the associated fundamental concepts in control systems theory.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Letter grade.

Instructor: Moura

CIV ENG 297 Field Studies in Civil and Environmental Engineering 1 - 12 Units
Terms offered: Fall 2020, Summer 2020 10 Week Session, Summer 2020 3 Week Session

Supervised experience in off-campus companies relevant to specific aspects and applications of civil and environmental engineering. Written report required at the end of the semester. Course does not satisfy unit or residence requirements for a master's or doctoral degree.

Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-2 hours of fieldwork per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

CIV ENG 298 Group Studies, Seminars, or Group Research 1 - 6 Units
Terms offered: Fall 2020, Spring 2020, Fall 2019

Advanced studies in various subjects through special seminars on annually selected topics, informal group studies of special problems, group participation in comprehensive design problems, or group research on complete problems for analysis and experimentation.

Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-2 hours of seminar per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

CIV ENG 299 Individual Research 1 - 12 Units
Terms offered: Fall 2020, Summer 2020 10 Week Session, Summer 2020 3 Week Session

Research or investigation in selected advanced subjects.

Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 3-36 hours of independent study per week

Summer: 8 weeks - 6-68 hours of independent study per week

Additional Details

Subject/Course Level: Civil and Environmental Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.
CIV ENG 301 Workshop for Future Civil and Environmental Engineering Teachers 1 - 3 Units
Terms offered: Fall 2020, Spring 2020, Fall 2019
The course will include supervised teaching of laboratory sections of civil engineering courses, group analysis of videotapes, reciprocal classroom visitations, and an individual project.
Workshop for Future Civil and Environmental Engineering Teachers: Read More [+]
Rules & Requirements
Prerequisites: Teaching assistant or graduate student status
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Professional course for teachers or prospective teachers
Grading: Offered for satisfactory/unsatisfactory grade only.
Workshop for Future Civil and Environmental Engineering Teachers: Read Less [-]

CIV ENG 601 Individual Study for Master's Students 1 - 6 Units
Terms offered: Fall 2020, Spring 2020, Fall 2019
Individual study for the comprehensive or language requirements in consultation with the major field adviser. Units may not be used to meet either unit or residence requirements.
Individual Study for Master's Students: Read More [+]
Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate examination preparation
Grading: Offered for satisfactory/unsatisfactory grade only.
Individual Study for Master's Students: Read Less [-]

CIV ENG 602 Individual Study for Doctoral Students 1 - 6 Units
Terms offered: Fall 2020, Spring 2020, Fall 2019
Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare for the various examinations required of candidates for doctoral degrees. May not be used for unit or residence requirements.
Individual Study for Doctoral Students: Read More [+]
Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week
Additional Details
Subject/Course Level: Civil and Environmental Engineering/Graduate examination preparation
Grading: Offered for satisfactory/unsatisfactory grade only.
Individual Study for Doctoral Students: Read Less [-]