

Civil & Environmental Engineering
Stanford University

**STRUCTURAL
ENGINEERING
AND
GEOMECHANICS**

2007 - 2008

Curriculum Brochure

OVERVIEW

The Structural Engineering and Geomechanics Program is designed to prepare students for careers as consulting engineers or as engineers in industry, government, and universities. The program offers courses and research opportunities in the areas of earthquake engineering and structural dynamics, reliability and risk analysis, structural analysis and design, computational mechanics, geomechanics, and computer-aided engineering. Academic programs can be designed to meet the needs of students wishing to launch careers as practicing engineers, researchers, or members of the academic community. Students have the opportunity to balance strong engineering fundamentals with modern computational methods.

Coursework in earthquake engineering and structural dynamics provides an understanding of earthquake phenomena and the resulting ground shaking, and an in-depth knowledge on the behavior, analysis, and design of various types of structures under seismic or other dynamic forces. Automated structural monitoring systems and devices, and the utilization of advanced materials for civil infrastructures and seismic retrofits are part of ongoing research activities in this program. Advanced analytical and experimental research in earthquake engineering is conducted at the John A. Blume Earthquake Engineering Center, which houses static and dynamic testing facilities, including two small shaking tables.

Reliability and risk analysis focuses on instruction and research in advanced methods for structural safety evaluation and design, including methods for loss estimation from damage and failures of structures and lifeline systems. Coursework combines a strong background in structural analysis and design with probability theory and statistics. Researching this area deals with seismic risk and reliability of large structural systems, wind hazards, regional loss and damage evaluation, and reliability of marine structures.

Courses and research in structural analysis in design focus on conceptual and detailed design of structural systems and on computational methods for predicting the static and dynamic, linear and nonlinear response of structures. Included are courses that emphasize earthquake-resistant design and computer-based design concepts. Related coursework is available from other departments such as aeronautics and astronautics, mechanical engineering, materials sciences and engineering, and computer science. In collaboration with the Center for Integrated Facility Engineering, issues involving design for constructibility, engineering information management and collaborative engineering are addressed as an integral part of research in this area.

Computational mechanics emphasizes the application of modern computing methods to structural engineering and geomechanics. It draws on the disciplines of mechanics, mathematics, and computer science and encompasses numerical structural and geotechnical analysis, including finite element analysis and boundary element methods. Strong teaching and research ties exist between our program and the Mechanics and Computation Division in the Department of Mechanical Engineering. There is collaborative research in advanced material modeling with mechanical engineering and materials science departments and high-performance computing with Scientific Computing and Computational Mathematics Program of the Department of Computer Science.

Students with primary interest in the application of principles of applied mechanics to problems involving geological and geotechnical materials have the option of enrolling in a degree program in geomechanics. This program focuses on instruction and research in theoretical soil and rock mechanics, computational methods, modeling and simulation for geotechnical earthquake engineering applications, constitutive modeling of geomaterials, and analysis and design of foundations and earth structures. In addition to the program's course offerings, related courses are available in structural engineering, construction engineering, earth sciences, petroleum engineering, and the environmental fluid mechanics program. There is a collaborative research in strain localization, fracture, and damage in geomaterials with the Department of Geological and Environmental Sciences.

Degree Programs

Master of Science in Civil and Environmental Engineering

- **Structural Engineering**
- **Geomechanics**

The Master of Science Degree is a 45-unit program devoted primarily to coursework. Students interested in participating in research projects may enroll for up to 6 units in CEE299.

Students are given flexibility in selecting courses focusing on the area within the program which is of greatest interest to them. Diversity is encouraged. In addition to the Civil and Environmental Engineering Department's offerings, related coursework is also available from other schools and departments such as earth sciences, computer science, mechanical engineering, and management science and engineering.

Engineer - Civil and Environmental Engineering

A student with an M.S. degree in structural engineering or geomechanics may satisfy the requirements for the degree of Engineer by completing at least 45 units of work, including an acceptable thesis for 12 to 15 units. Details of this degree program are published in the CEE brochure, "A Guide to Forms and Procedures for the Engineer Student."

Doctor of Philosophy - Civil and Environmental Engineering

A student with an M.S. degree may satisfy the requirements for the Ph.D. degree by completing at least 26 units of approved coursework and a comprehensive dissertation. Details of this degree program are published in the CEE brochure on "A Guide to Forms and Procedures for the Ph.D. Student."

P LANNING GUIDELINES

The Master of Science Program in Structural Engineering and Geomechanics combines a group of required breadth courses, selected from within each area of the program, with a broad range of electives, permitting each student to design a program focusing on aspects of particular interest. Our goal is to make your time at Stanford as productive as possible. You are encouraged to use electives to build a program that fits your special strengths and interests. However, except for the seminar classes, all courses from your major program area must be taken for a letter grade.

If you are planning to continue for the Engineer or Ph.D. degrees, your first-year program might well include additional courses in related topics supporting your research interest. As you select electives, feel free to consult the course instructors and check the detailed course descriptions in the Stanford Bulletin.

Undergraduate Prerequisites

The Structural Engineering and Geomechanics Program is open to applicants with backgrounds in all areas of engineering and science. Certain basic subjects from the traditional areas of civil engineering are considered essential for student who will receive the master's degree in civil and environmental engineering. These requirements are usually fulfilled by an ABET accredited bachelor's degree in civil engineering, but if you lack any of the courses on the following list, you must include them in your graduate studies.

These courses must be taken for a letter grade, but prerequisites to these courses may be taken pass/no credit. Up to six units of credit may be counted toward the master's degree for undergraduate prerequisites taken at Stanford.

Mechanics of Materials	CEE101A	4	Winter	Baker
Geotechnical Engineering	CEE101C	3-4	Autumn	Borja
Structural Analysis	CEE180	4	Spring	Kiremidjian
Design of Steel Structures	CEE181	4	Autumn	Law
Design of Reinforced Concrete Structures	CEE182	4	Winter	Staff
Integrated Building Design	CEE183	4	Spring	Deierlein
Programming Methodology	CS106A or CS106X	3-4	Autumn Winter Spring	Staff

MASTER OF SCIENCE IN CIVIL AND ENVIRONMENTAL ENGINEERING (STRUCTURAL ENGINEERING)

Structural Engineering Required and Breadth Electives

(Choose one from each of the five subject areas)

1. Structural Analysis & Mechanics

Advanced Structural Analysis*	CEE280	3-4	Autumn	Deierlein
Finite Element Structural Analysis	CEE281	3-4	Spring	Law
Nonlinear Structural Analysis	CEE282	3-4	Winter	Deierlein

2. Dynamics and Vibrations

Structural Dynamics*	CEE283	3-4	Autumn	Law
Computational Methods in Structural Dynamics	CEE284	3	2008-2009	Staff
Random Vibrations	CEE289	2	2008-2009	Staff

3. Structural Design and Materials

Structural Materials Testing and Simulation (Limited Enrollment)	CEE205	3-4	Spring	Billington
Behavior of Structural Systems for Buildings*	CEE285	3-4	Winter	Krawinkler
Advanced Modeling and Design of Structural Concrete	CEE286	3-4	Autumn	Billington
Earthquake Resistant Design and Construction	CEE287	3	Spring	Miranda

STRUCTURAL ENGINEERING

Structural Engineering Required and Breadth Electives

(continued)

4. Geomechanics and Foundations

Foundation Engineering	CEE293	3	Winter	Staff
Computational Geomechanics	CEE294	3	Spring	Borja
Plasticity Modeling and Computation	CEE295	3	2008-2009	Borja

5. Engineering Risk and Reliability

Probabilistic Models in Civil Engineering*	CEE203	3-4	Autumn	Baker
Earthquake Hazard and Risk Analysis	CEE288	3-4	Winter	Kiremidjian
Structural Reliability	CEE204	3-4	Spring	Baker

- * Courses marked with an asterisk are prerequisites for many other classes, and are taken by most students to fulfill the associated requirements.

STRUCTURAL ENGINEERING

Suggested Courses For Various Areas of Interests

The following groupings are of courses to consider if your interests, whether in practice or in research, fall in these general areas. Please note that there are not concentrations (majors or minors) in the SEG graduate program. These groupings are simply suggestions tied to areas of interest.

To complete the 45-unit M.S. program, the 45 units must include 36 units of courses within the School of Engineering, 30 units of which must be within the graduate level Structural Engineering and Geomechanics Program. In addition, the 45 units can include no more than 10 undergraduate level course units and no more than 3 units of seminar courses. Your study list must be coordinated with and approved by your academic advisor.

Advanced Materials

Mechanics of Composites	AA256	3	Winter	Chang
Structural Materials Testing and Simulation	CEE205	3-4	Spring	Billington
Experimental Stress Analysis	ME348	3	Spring	Nelson
Mechanical Properties of Materials	MATSCI208	3	Winter	Dauskardt
Fracture and Fatigue of Engineering Materials	MATSCI358	3	Spring	Dauskardt

Analysis and Computation

Advanced Structural Analysis	CEE280	3-4	Autumn	Deierlein
Finite Element in Structural Engineering	CEE281	4	Spring	Law
Nonlinear Structural Analysis	CEE282	3-4	Winter	Deierlein
Structural Dynamics	CEE283	3-4	Autumn	Law
Computational Methods in Structural Dynamics	CEE284	3	2008-2009	Staff
Computational Geomechanics	CEE294	3	Spring	Borja
Plasticity Modeling and Computation	CEE295	3	2008-2009	Borja
Finite Element Analysis	ME335A	3	Autumn	Pinsky
Finite Element Analysis	ME335B	3	Winter	Pinsky
Finite Element Analysis	ME335C	3	Spring	Pinsky

Earthquake Engineering

Nonlinear Structural Analysis	CEE282	3-4	Winter	Deierlein
Structural Dynamics	CEE283	3-4	Autumn	Law
Behavior of Structural Systems of Buildings	CEE285	3-4	Winter	Krawinkler
Advanced Modeling and Design of Structural Concrete	CEE286	3-4	Autumn	Billington
Earthquake Resistant Design and Construction	CEE287	3	Spring	Miranda
Earthquake Hazard and Risk Analysis	CEE288	3-4	Winter	Kiremidjian
Earthquake Seismology	GEOPHYS287	3	2008-2009	Staff

STRUCTURAL ENGINEERING

Suggested Courses For Various Areas of Interests (continued)

Forensic Engineering

Structural Materials Testing and Simulations	CEE205	3-4	Spring	Billington
Finite Element Methods in Structural Engineering	CEE281	4	Spring	Staff
Nonlinear Structural Analysis	CEE282	3-4	Winter	Deierlein
Issues in Geotechnical and Environmental Failures	CEE297	3	Spring	Meehan
Structural Performance and Failures	CEE290	2	Spring	Moncarz
Experimental Stress Analysis	ME348	3	Spring	Nelson

Geomechanics

See page 9 of this document for detailed information regarding Geomechanics course offerings.

Risk and Reliability Engineering

Probabilistic Models in Civil Engineering	CEE203	3-4	Autumn	Baker
Structural Reliability	CEE204	3-4	Spring	Baker
Earthquake Hazard and Risk Analysis	CEE288	3-4	Winter	Kiremidjian
Random Vibrations	CEE289	2	2008-2009	Staff
Engineering Risk Analysis	MS&E250A	2-3	Winter	Pate-Cornell
Decision Analysis	MS&E252	3-4	Autumn	Howard

Structural and Geotechnical Design and Consulting

Finite Element Methods in Structural Engineering	CEE281	4	Spring	Law
Nonlinear Structural Analysis	CEE282	3-4	Winter	Deierlein
Behavior of Structural Systems for Buildings	CEE285	3-4	Winter	Krawinkler
Advanced Modeling and Design of Structural Concrete	CEE286	3-4	Autumn	Billington
Earthquake Resistant Design and Construction	CEE287	3	Spring	Miranda
Foundation Engineering	CEE293	3	Winter	Staff
Computer Integrated Architecture/Engineering/Construction	CEE222A	3	Winter	Fruchter
Computer Integrated Architecture/Engineering/Construction	CEE222B	2	Spring	Fruchter
Design and Construction of Steel Structures	CEE223A	3	Autumn	Miranda
Design and Construction of Concrete Structures	CEE223B	3	Winter	Miranda
Finite Element Analysis in Mechanical Design	ME309	3	Winter	Kuhl

MASTER OF SCIENCE IN CIVIL AND ENVIRONMENTAL ENGINEERING (GEOMECHANICS)

Geomechanics Required Courses

(15 units)

Finite Element Analysis	ME335A	3	Autumn	Pinsky
Structural Geology and Rock Mechanics	CEE297G	3	Autumn	Pollard
Continuum Mechanics	ME338A	3	Winter	Lew
Foundation Engineering	CEE293	3	Winter	Staff
Computational Geomechanics	CEE294	3	Spring	Borja

Breadth Electives

(Select courses totaling
at least 15 units)

Construction Methods

Design and Management of Construction Operations	CEE240	3	Autumn	Fischer
Managing Fabrication and Construction	CEE241	4	Autumn	Fischer
Cases in Estimating Costs	CEE254	3	Autumn	Clough
Legal Aspects of Engineering and Construction	CEE202	3-4	Winter	London

Geotechnical Problems, Structural Geology, and Geophysics

Issues in Geotechnical and Environmental Failures	CEE297	3	Spring	Meehan
Advanced Structural Geology and Rock Mechanics	CEE297H	3, 5	Winter	Pollard
Crustal Deformation	Geophys288A	3-5	Winter	Segall
Crustal Deformation	Geophys288B	3-5	Spring	Segall
Engineering Geology Practice	CEE196	3	Spring	Holzer

GEOMECHANICS

Breadth Electives

(continued)

Continuum Mechanics and Numerical Methods

Linear Algebra with Application to Engineering Computations	ME300A	3	Autumn	Moin
Partial Differential Equations in Engineering	ME300B	3	Winter	Shaafeh
Introduction to Numerical Methods for Engineering	ME300C	3	Spring	Moin
Finite Elements Analysis	ME335B	3	Winter	Pinsky
Finite Element Analysis	ME335C	3	Spring	Pinsky
Mechanics	ME333	3	Autumn	Lew
Mechanical Properties of Materials	MATSCI208	3	Winter	Dauskardt

Structural Engineering

Advanced Structural Analysis	CEE280	3-4	Autumn	Deierlein
Structural Dynamics	CEE283	3-4	Autumn	Law
Behavior of Structural Systems for Buildings	CEE285	3-4	Winter	Krawinkler
Advanced Modeling and Design of Structural Concrete	CEE286	3-4	Autumn	Billington

Earthquake and Reliability Engineering

Probabilistic Models in Civil Engineering	CEE203	3-4	Autumn	Baker
Structural Reliability	CEE204	3-4	Spring	Baker
Earthquake Hazard and Risk Analysis	CEE288	3-4	Winter	Kiremidjian
Earthquake-Resistant Design and Construction	CEE287	3	Spring	Miranda

Free Electives

(Take additional courses as necessary to complete the 45 unit M.S. coursework requirement)

Select additional courses from the list of breadth electives and from course offerings from the engineering and engineering-related disciplines that contribute to coherent program of study.

Structural Engineering and Geomechanics

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