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GRADUATE STUDY IN GEOLOGICAL ENGINEERING
UNIVERSITY OF WISCONSIN - MADISON

Geological Engineering is a field of study that integrates two disciplines: geology and engineering. Geological engineers help find the best ways to use the Earth's resources for solving technical problems while protecting the environment. The need for geological engineering graduate education has been brought about by modern developments in science and industry that have an impact on earth materials including soil, rock, and water. The area of study combines research and application methodologies of geology and several engineering and science disciplines to address engineering problems in which the geologic nature of a site or geologic process constitute major design objectives or constraints.

The emphasis of the Graduate Program in Geological Engineering at the University of Wisconsin is on development of a student's ability to originate and perform analytical, numerical, and laboratory and field analysis techniques to address new and challenging earth-related problems associated with modern land-use practices, earthen construction, mineral extraction, and environmental pollution control and remediation. The Program is interdisciplinary and draws on faculty and courses from several departments including Materials Science and Engineering, Civil and Environmental Engineering, Engineering Physics, Soil Science, and Geology and Geophysics. The Program appeals to a wide audience of students with varied backgrounds and with different areas of intended emphasis. Students typically have backgrounds in engineering (especially mining, civil, environmental, and mechanics) or the physical sciences (especially geology and/or geophysics, and soil science). Degree criteria are flexible so that a student's program of study and research can be tailored to suit their individual needs. Typical programs of study and research include topics in geotechnical engineering, geoenvironmental engineering, geophysical engineering, hydrology and hydrogeology, numerical and analytical modeling of rock and soil masses, remote sensing, rock mechanics, and rock engineering.

Research assistantships, teaching assistantships, fellowships and other forms of financial support are available to qualified applicants either immediately or one or two semesters after entering the program. All financial support is offered on a competitive basis.

Admission to Program

Students wishing to be admitted to the Graduate Program in Geological Engineering must satisfy the admission requirements of the U.W. Graduate School and the College of Engineering. After a student enters the Geological Engineering Program, they meet with the faculty and then choose an advisor in their area of interest. The student and advisor then form a three-person *Mentor and Evaluation Committee*. The chair will approve the committee. The purpose of this committee is:

(i) to determine if any deficiencies exist in the student's undergraduate background that must be rectified,

(ii) to establish course and/or thesis-independent study requirements for the graduate degree being pursued, and to determine if these requirements have been satisfactorily met,

(iii) to ensure that the student's course of study has appropriate breadth to practice and potentially become licensed in their discipline, and

(iv) to participate in qualifying, preliminary, and dissertation exams for PhD students and the final exam for MS students.

The Mentor and Evaluation Committee will include at least one member from the College of Engineering and at least one member from the Dept. of Geology and Geophysics. Not all faculty need to be from the Geological Engineering Program.

For a student to be admitted to the program without deficiencies, the student must have an undergraduate-level of expertise in several, but not all, of the areas of study associated with an undergraduate degree in Geological Engineering, consisting of geology and engineering science. In particular this should include courses in soil mechanics, rock mechanics, hydrogeology, structural geology, and applied geophysics. In addition, all students must have mathematics through differential equations, at least one chemistry course, at least one calculus-based physics course, and a statistics course. Students who are deficient in background will be required to take one or more "remedial" courses to remedy the deficiencies. Required remedial courses that are below the 300 hundred level will be required in addition to those required for the degree, while those at or above the 300 level can be applied toward the degree.

MS IN GEOLOGICAL ENGINEERING

Curriculum

There is no specific course sequence required for the MS in Geological Engineering. The student and their Mentor and Evaluation Committee will collaboratively develop a curriculum in the student's area of interest. The Mentor and Evaluation Committee must approve the curriculum prior to graduation. The curriculum will balance overall exposure to advanced concepts in geological engineering and with concentrated study in the student's selected area of expertise.

Specific Requirements

The following must be satisfied to obtain the MS in Geological Engineering:

(i) Completion of all general regulations of the Graduate School, including the residency requirement.

(ii) A grade-point average of 3.0 (on 4.0 scale) or higher in all graduate work. Credits for a course in which the student receives a grade of less than B cannot be applied towards the degree requirements unless specifically approved by the Mentor and Evaluation Committee.

(iii) At least 24 graduate credits must be completed following the course guidelines established by the student's Mentor and Evaluation Committee. If the Mentor and Evaluation Committee require a thesis, then up to 6 credits of the 24 can be used for Thesis Research. If the Mentor and Evaluation Committee requires independent study, then up to 3 credits of the 24 can be used for Independent Study. At least 3 credits must be in advanced graduate course work. Although the specific courses are to be determined by the student's Mentor and Evaluation Committee, such courses are normally numbered 700 or higher.

(iv) Students must enroll in two graduate level seminars per year. GLE 900 must be taken once a year for 1 credit. The student must also take a second seminar that is approved by the student's advisor. This second seminar can also be GLE 900. In the event of unusual extenuating circumstances, students may petition the Program for a revision or waiver of this requirement.

Because the program appeals to students with a wide variety of backgrounds and with different areas of intended emphasis, there are no specific courses that are uniformly taken by all students. Furthermore, depending on a student's area of emphasis, career goals, and intentions regarding additional graduate degrees, the student's Mentor and Evaluation Committee may or may not recommend or require a master's thesis and/or independent study.

Transfer Credits

A student transferring graduate credits from another institution may count those credits towards the degree requirements with the approval of the Mentor and Evaluation Committee and provided that they complete at least half of their credits for the MS degree at UW-Madison. For graduate courses to be transferable, the student must have been enrolled in graduate school when the courses were completed, and the courses must cover similar material as those currently offered at UW-Madison or those listed in the UW-Madison catalogue.

Example Programs

1. Emphasis: *Analytical & Numerical Methods in Rock Mechanics and Hydrogeology*

Student Background: Applied mechanics or mechanical engineering.

Deficiencies: GLE 330 (Soil Mechanics), GLE 474 (Rock Mechanics), GEOL 594 (Intro to Applied Geophysics), GEOL 455 (Structural Geology), GEOL 627 (Hydrogeology)

Intended Area of Emphasis: Analytical/numerical methods for rock mechanics and hydrogeology.

Other Courses (select additional credits from the following courses):

GLE 475	Rock Mechanics Applications to Environmental Problems
GEOL 629	Contaminant Hydrogeology
GEOL 797	Tectonophysics
EMA 605	Finite Element Analysis
EMA 700	Elasticity (or EMA 622 Continuum Mechanics)
CS 713	Numerical Analysis of Differential Equations

Thesis or Independent Study: At the discretion of the student's Mentor and Evaluation Committee in consultation with the student, a thesis and/or independent study may be required.

2. Emphasis: *Rock and Soil Mechanics*

Student Background: Civil Engineering

Deficiencies: GEOL 594 (Intro to Applied Geophysics), GEOL 455 (Structural Geology), GEOL 627 (Hydrogeology)

Intended Area of Emphasis: Rock and soil mechanics.

Other Courses (select additional credits from the following courses):

GLE 475	Rock Mechanics Applications to Environmental Problems
GLE 479	Field Methods in Geological Engineering
CEE 530	Slope Stability
CEE 531	Retaining Structures
CEE 532	Foundations
GEOL 797	Tectonophysics

Thesis or Independent Study: At the discretion of the student's Mentor and Evaluation Committee in consultation with the student, a thesis and/or independent study may be required.

3. Emphasis: *Applied Geophysics*

Student Background: Geological Engineering (e.g., UW undergraduate program).

Intended Area of Emphasis: Applied Geophysics

Suggested Courses (select 18-24 credits from the following courses):

EECS 320	Electrodynamics II
EECS 330	Signals and Systems
GLE 596	Electrical and EM methods in Applied Geophysics
GLE 597	Borehole Methods in Applied Geophysics
GEOL 724	Groundwater Flow Modeling
GLE 735	Soil Dynamics
GEOL 793	Geophysical Inverse Theory
GEOL 797	Tectonophysics

Thesis or Independent Study: At the discretion of the student's Mentor and Evaluation Committee in consultation with the student, a thesis and/or independent study may be required.

4. Emphasis: *Geoenvironmental Engineering*

Student Background: Geology

Deficiencies: GLE 330 (Soil Mechanics), GLE 474 (Rock Mechanics)

Other Courses (select additional credits from the following courses):

GLE 530	Seepage, Slopes and Earth Dams
GLE 533	Waste Geotechnics
GLE 535	Remediation Geotechnics
GEOL 724	Groundwater Flow Modeling
GEOL 722	Contaminant Transport Modeling
GLE 594	Introduction to GeophysicsGLE 730 Engineering Properties of Soils
GLE 736	Unsaturated Soil Behavior

Thesis or Independent Study: At the discretion of the student's Mentor and Evaluation Committee in consultation with the student, a thesis and/or independent study may be required.

5. Emphasis: *Geotechnical Engineering*

Student Background: Geology.

Deficiencies: GLE 330 (Soil Mechanics), GLE 474 (Rock Mechanics), GEOL 627 (Hydrogeology)

Other Courses (select additional credits from the following courses):

GLE 530	Seepage, Slopes and Earth Dams
GLE 531	Retaining Structures
GLE 532	Foundations
GLE 730	Engineering Properties of Soils
GLE 731	Engineering Properties of Geosynthetics
GLE 479	Field Methods in Geological Engineering
EMA 605	Introduction to Finite Elements

Thesis or Independent Study: At the discretion of the student's Mentor and Evaluation Committee in consultation with the student, a thesis and/or independent study may be required.

6. Emphasis: *Engineering Geology*

Deficiencies: GEOL 594 (Intro to Applied Geophysics), GEOL 455 (Structural Geology), GEOL 627 (Hydrogeology)

Student Background: Civil Engineering

Other Courses (select additional credits from the following courses):

GEOL 421	Applied Surficial Geology
GEOL 456	Field Methods in Geology
GEOL 629	Contaminant Hydrogeology
GEOL 724	Groundwater Modeling
GLE 479	Field Methods in Geological Engineering

Thesis or Independent Study: At the discretion of the student's Mentor and Evaluation Committee in consultation with the student, a thesis and/or independent study may be required.

PHD IN GEOLOGICAL ENGINEERING

Curriculum

There is no specific course sequence required for the Doctor of Philosophy degree in Geological Engineering. Rather, specific courses that are especially pertinent to a student's area of interest may be recommended or required by the student's Mentor and Evaluation Committee.

Specific Requirements

The following must be satisfied to obtain the PhD in Geological Engineering:

(i) All of the general regulations of the Graduate School, including the residency requirement and minor subject requirement.

(ii) The candidate must maintain a grade point average of 3.00 (on 4.00 scale) or higher in all graduate work. Credits for a course in which the student receives a grade of less than B cannot be applied towards the degree requirements unless specifically approved by the faculty of the Geological Engineering Graduate Program.

(iii) At least 72 graduate credits beyond the Bachelor's Degree must be completed (for students who have earned a Masters Degree, credits accumulated for the M.S. can be applied towards this requirement). These credits will consist of formal course work (following the guidelines established by the student's Mentor and Evaluation Committee), independent study, minor subject study and normally 18-24 credits that are for thesis work.

(iv) A minor is required to give breadth to the Ph.D. major. The minor consists of 10 units of course work outside the students major field of study, and can either be concentrated from in one department (Option A), or distributed across two or more departments (Option B). In the case of Option A, the minor must be approved by the department in which the courses were taken, while for Option B, approval comes from the GLE Graduate Committee. For example, a student pursuing a PhD in Geological Engineering in the applied geophysics discipline might complete a minor in mathematics, electrical engineering, rock mechanics, or geology.

(v) Students must enroll in two graduate level seminars per year. GLE 900 must be taken once a year for 1 credit. The student must also take a second seminar that is approved by the student's advisor. This second seminar can also be GLE 900. In the event of unusual extenuating circumstances, students may petition the Program for a revision or waiver of this requirement.

(vi) A student must be evaluated by their mentor committee at the end of the first year of the doctoral program on whether the student is eligible to continue within the PhD path. The student's mentor committee will decide on the method of evaluation, and will provide the student with a letter stating whether or not the student is approved to continue.

PhD Exams

All PhD students must successfully pass two exams, the preliminary exam, and the dissertation defense. These exams are oral exams, are scheduled in consultation with the Mentor and Evaluation Committee, and are administered by a dissertation committee of five faculty members.

Foreign Language and Liberal Studies

There is no foreign language requirement or liberal studies requirement.

Transfer Credits

A student transferring graduate credits from another institution may count those credits towards the degree requirements with the approval of the Mentor and Evaluation Committee and provided that they complete at least half of their credits for the MS degree at UW-Madison. For graduate courses to be transferable, the student must have been enrolled in graduate school when the courses were completed, and the courses must cover similar material as those currently offered at UW-Madison or those listed in the UW-Madison catalogue.

FACULTY

David L. Alumbaugh, Assistant Professor; PhD University of California at Berkeley, 1993.
near-surface and borehole geophysics, geophysical characterization and evaluation of groundwater, mineral and petroleum resources, geophysical evaluation of hazardous waste sites, geophysical monitoring of subsurface flow processes, geophysical imaging, inversion and optimization, numerical modeling , characterization of error and uncertainty in geophysical measurements

Mary P. Anderson, Professor; PhD Stanford University, 1973.
Computer modeling of groundwater systems, geological characterization of heterogeneity, groundwater-lake systems.

Jean M. Bahr, Professor; PhD Stanford University, 1987.
Field and modeling studies of fluid flow and mass transport in groundwater systems with applications to environmental problems, water resource management and energy and mineral resource development.

Craig H. Benson, Professor; PhD University of Texas at Austin, 1989.
Geo-environmental engineering; landfill design and construction; remediation of hazardous waste sites; field testing and performance evaluation; transport of groundwater pollutants; statistical construction quality control; stochastic modeling of flow and transport; data sufficiency.

William Bleam, Professor; PhD Cornell University 1984.
Theoretical solid-state chemistry of mineral surfaces, magnetic resonance and x-ray absorption spectroscopy studies of adsorption and precipitation, colloid chemistry

Peter J. Bosscher, Professor; PhD University of Michigan, 1981.

Subsurface spatial information management; static and dynamic soil-structure interaction modeling; computer-aided engineering; geotechnical instrumentation for subsurface exploration and monitoring field performance.

Tuncer B. Edil, Professor; PhD Northwestern University, 1973.
Behavior of soils and wastes; compression of peat and soft ground construction; waste geotechnics; friction piles and anchors; soil-structure interaction; coastal slope stability.

Bezalel C. Haimson, Professor and Chair; PhD University of Minnesota, 1968.
Stresses in the Earth's crust and their measurement; site investigation and the design of structures in rock; hydraulic fracturing; mechanical behavior of solid rock, rock joints, and rock mass; cyclic fatigue in rock; borehole stability and breakouts.

King-Jau S. Kung; Professor, PhD Cornell University, 1984.
Soil physics; analytical, numerical, and experimental approaches to problems involving mass, heat, and solute transfer in unsaturated soil.

David M. Mickelson, Professor; PhD Ohio State University, 1971 (Chairman of Geological Engineering).
Geomorphology and applied geology, shoreline erosion, slope stability, hydrogeologic properties of glacial deposits, field geology.

Kenneth W. Potter, Professor; PhD John Hopkins University, 1976.
Hydrological modeling and design; storm water modeling, management and design; estimation of hydrologic risk; estimation of hydrological budgets.

Herbert F. Wang, Professor; PhD Massachusetts Institute of Technology, 1971.
Poroelastic behavior of fracture rock; numerical modeling of fluid flow, thermal history, and chemical diffusion related to geologic processes.

Chin Wu, Assistant Professor, PhD Massachusetts Institute of Technology, 1998.
Environmental fluid mechanics, air-sea interactions, surface wave dynamics, coastal processes, nearshore hydrodynamics, transport and mixing processes, groundwater and surface water interactions, experimental fluid mechanics.

FACILITIES AND EQUIPMENT

Facilities and equipment used by the Geological Engineering Program include the Rock Mechanics Laboratory (Materials Science and Engineering Dept.), Soil Mechanics Laboratory (Civil and Environmental Engineering Dept.), Environmental Geotechnics Laboratory (Civil and Environmental Engineering Dept.), Geosynthetics Laboratory (Civil and Environmental Engineering Dept.), Civil Engineering Computer Laboratory, Materials Science and Engineering Computer Laboratory, Computational Mechanics Group Computer Facility (Nuclear Engineering and Engineering Physics Dept.), and College of Engineering facilities such as the Computer Aided Engineering Center (CAE).