GEOLOGICAL ENGINEERING

Geological engineering is application of principles of geology to the solution of a wide range of problems in engineering practice, such as assessing and mitigating geologic hazards (subsidence, landslides, flooding, etc.), evaluating and improving groundwater resources, sustainably developing mineral and energy resources, selecting appropriate sites for civil and military infrastructure, and analyzing land use and environmental impacts. The graduate programs available in this multiple-industry field include:

- Graduate Certificates
- Master of Science / Master of Engineering
- Doctor of Philosophy / Doctor of Engineering

Most can be completed wholly or partially through online work. Details of these programs and their requirements are available at the departmental website and in associated sections of this catalog. GRE scores are not required. Other campus-wide rules for graduate degrees are repeated here only if modified; check the graduate studies section of this catalog for the latest updates. The catalog version in force during the semester of initial enrollment is the baseline for evaluation of graduation readiness.

Geological engineering faculty conduct research in cooperation with other MS&T departments and research centers, University of Missouri campuses, state and federal agencies, and other universities and research entities worldwide. Our laboratories and research sites are located in Missouri S&T's McNutt Hall, Rock Mechanics facility, Audubon Nature Center, and Experimental Mine, as well as the Missouri Department of Natural Resources Bohigian Conservation Area and field sites both domestic and international. Some recent research projects include:

- Designing rock and soil excavating tools for use on Earth and in space.
- Measuring the permeability of soils using satellites, drones and ground-based geophysics.
- Evaluating earthquake hazards along the New Madrid fault.
- Using satellite data to investigate aquifer depletion and land subsidence.
- Studying blasting efficiency for enhancing productivity in the mining industry.
- Predicting water pollution based on geologic and land use factors.
- Developing a rock fall hazard rating system for Missouri highways.
- Assessing the effect of water saturation on rock fragmentation.
- Using LiDAR to research the rock raveling process on natural and engineered slopes.
- Developing a virtual geotechnical database for the greater St. Louis Metropolitan Area.
- Identifying areas suitable for managed aquifer recharge in the U.S. and Iraq.
- Detection of underground mines and caverns using geophysical methods.
- Using drone data to find the locations to drill wells in fractured rock.
- Modifying mining methods for use in space.
- Designing controlled methods to reduce the size of asteroids on collision courses with Earth.
- Developing sustainable point-of-use drinking water systems in developing areas.
- Using renewable energy systems to power groundwater pumping and remediation systems.
- Characterizing the reliability of renewable energy system prediction models.

Master of Science Geological Engineering

A master's degree in geological engineering can be earned in any of several ways:

- Research Master of Science (MS), during which the student completes a research project under the direction of a graduate faculty member and writes a comprehensive thesis about the results.
- Non-thesis (also called coursework) MS. This consists of passing a selection of courses customized to serve the needs of the student.
- Master of Engineering (ME). This consists of a selective course curriculum in addition to a practice-oriented project, for which a comprehensive engineering report is written. Currently our program offers a ME degree in geotechnics that is completed online.

Research MS in Geological Engineering

The thesis MS program consists of a minimum of 30 credit hours, including at least 21 credit hours of lecture courses (at least 9 of which must be in geological engineering), 6 or more credit hours of Geo Eng 6099 (Research), and enrollment in Geo Eng 6010 (Geological Engineering Graduate Seminar) for a minimum of two semesters.

The research topic and the course schedule are selected by the student in consultation with the advisor, who is assigned during the first semester of the student's program. The research is conducted, and the thesis is written and defended, by the student. Details of departmental and campus-wide requirements for the research MS degree can be found in the GGPE Department and Graduate Studies section of this catalog, respectively.

Coursework MS in Geological Engineering

The non-thesis MS program consists of a minimum of 30 credit hours, including at least one course in each of the three core areas (first table below), plus one or more courses from each of the four emphasis areas following. No fewer than four courses of the total must be geological engineering courses. Course substitutions may be made on a case-by-case basis, especially if some of these courses have been completed as part of the undergraduate curriculum.

Core Geological Engineering Courses

Take all 3 (9 credit hours).

GEO ENG 5443	Subsurface Exploration	3
GEO ENG 5331	Subsurface Hydrology	3
or GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	
GEO ENG 5441	Engineering Geology And Geotechnics	3
or GEO ENG 6441	Geotechnical Construction Practice	
or GEO ENG 6625	Applications in Geological Engineering	

Engineering Geology and Geotechnics Emphasis Area

Choose 1-3 courses; at least one course must be in geological engineering (3 to 9 credit hours).

GEO ENG 5471	Rock Engineering	3
GEO ENG 6441	Geotechnical Construction Practice	3
GEO ENG 6477	Discontinuous Rock	3
GEO ENG 6625	Applications in Geological Engineering	3
CIV ENG 5715	Intermediate Soil Mechanics	3
CIV ENG 5716	Geotechnical Earthquake Engineering	3
CIV ENG 5729	Foundation Engineering II	3

Environmental and Hydrology Emphasis Area
Chose 1-3 courses (3 to 9 credit hours).

GEO ENG 5233	Risk Assessment In Environmental Studies	3
GEO ENG 5235	Environmental Geological Engineering	3
GEO ENG 5237	Geological Aspects Of Hazardous Waste Management	3
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
GEO ENG 6235	Advanced Concepts Of Environmental Geological Engineering	3
GEO ENG 6237	Advanced Geological & Geotechnical Design For Hazardous Waste Mgt	3
GEO ENG 6331	Advanced Subsurface Hydrology	3

Engineering Geophysics Emphasis Area
Choose 1 to 2 courses (3 to 6 credit hours).

GEO ENG 5736	Geophysical Field Methods	3
GEO ENG 5761	Transportation Applications of Geophysics	3
GEO ENG 5782	Environmental and Engineering Geophysics	3
GEO ENG 6782	Surface Waves (MASW) and Ground Penetrating Radar (GPR)	3
GEO ENG 6784	Advanced Engineering And Environmental Geophysics	3

Data Analysis Emphasis Area
Choose 1 to 2 courses (3 to 6 credit hours).

GEO ENG 5144	Remote Sensing Technology	3
GEO ENG 5146	Applications Of Geographic Information Systems	3
GEO ENG 5315	Advanced Statistical Methods in Geology and Engineering	3
GEO ENG 5556	Renewable Energy Systems	3
COMP SCI 5204	Regression Analysis	3
STAT 5260	Statistical Data Analysis Using SAS	3
STAT 5346	Regression Analysis	3
STAT 5353	Statistical Data Analysis	3
STAT 5814	Applied Time Series Analysis	3

Geological Engineering-PhD

Both the PhD and DE programs consist of 90 credit hours beyond the BS degree or 60 credit hours beyond the MS degree. If these degrees are not in geological engineering or a related field, remedial courses may be required. No course below the 5000-level may be applied to the degree requirements. The schedule of course work, research, and/or engineering design is developed by the student in consultation with, and subject to the approval of, their advising committee. There is no foreign language requirement. Details of requirements for this program not covered here can be found in the Academic Program Procedures section of this catalog.

In addition to the course requirements and regardless of other degrees held, the PhD student must prepare and defend a comprehensive dissertation based on analytical, numerical, and/or experimental research on an important problem; their solution must add constructively to the body of human knowledge. A minimum of 50% of the course work credit hours and the research credit hours completed during the PhD program must be in geological engineering. Enrollment in Geo Eng 6010 (Geological Engineering Graduate Seminar) is required for four semesters.

For a student with a MS degree, 30 credit hours from the MS program are accepted toward the PhD requirement. A student holding a BS degree and pursuing the PhD directly must complete 90 total credit hours.

For the self-motivated student with access to an appropriate research project, a geological engineering PhD can be earned online. This option is designed for working professionals who do not wish to take an extended leave of absence from their posts, such as in the military, government, and research sectors.

Geological Engineering-DE

Both the PhD and DE programs consist of 90 credit hours beyond the BS degree or 60 credit hours beyond the MS degree. If these degrees are not in geological engineering or a related field, remedial courses may be required. No course below the 5000-level may be applied to the degree requirements. The schedule of course work, research, and/or engineering design is developed by the student in consultation with, and subject to the approval of, their advising committee. There is no foreign language requirement. Details of requirements for this program not covered here can be found in the Academic Program Procedures section of this catalog.

The Doctor of Engineering (DE) program focuses on geological engineering aspects of a major engineering practice-oriented design project. A candidate for the DE must complete the equivalent of three years (six semesters) of full-time work beyond the BS degree for a total of 90 or more credit hours. In addition to formal course work, the candidate is expected to complete an internship with an industrial organization. This internship consists of a minimum of one year of planned and approved high-level engineering experience. At the end of the internship period, the student prepares an engineering design report supplemented by appropriate research, worth 18 to 25 credit hours (included in the 90 credit hour total).

We offer several graduate certificate programs. Each consists of a four-course sequence selected according to the curricula specified below. Graduate certificate programs are available to individuals holding a BS degree in an appropriate discipline, or are currently enrolled in certain graduate degree programs at Missouri S&T. Although students in a certificate program have non-degree status, if they complete the certificate curriculum with a grade of B or better in each course, the students are eligible, upon application, for admittance to selected graduate degree programs. GRE scores are not required. The certificate credits taken by students who do this would then count toward those graduate degree requirements. Alternative courses may be substituted with departmental approval, depending on the availability of the courses listed. Students who do not have all prerequisites for the courses required in these programs will be permitted to take “bridge” courses as needed.

Geoanalytics and Geointelligence

The graduate certificate in Geoanalytics and Geointelligence is designed to provide formalized education in the areas of geoanalytics, geospatial data analysis, and geointelligence.

The Geoanalytics and Geointelligence Certificate Program is open to all persons holding a B.S., M.S., or Ph.D. degree in Geology, Geophysics, Geological Engineering, Geotechnics, Civil Engineering, or similar programs or who are currently accepted into a graduate degree program

in one of these fields at Missouri S&T. Once admitted to the program, the student must take the four designated courses (provided in the curriculum section). In order to receive a Graduate Certificate, the student must have an average cumulative grade point of 3.0 or better in the certificate courses. Once admitted to the program, a student will be given three years to complete the program.

Students admitted to the Geoanalytics and Geointelligence Certificate Program will have non-degree graduate status, however, they will earn graduate credit for the courses they complete. If the student completes the four-course sequence with a grade of B or better in each of the courses taken, they, upon application, will be admitted to their choice of non-thesis M.S. degree programs in either Geological Engineering or Geology and Geophysics. The certificate credits taken by the students admitted to the M.S. degree program will count towards their master's degree. Students who do not have all of the prerequisite courses necessary to begin the courses in the Geoanalytics and Geointelligence Certificate Program will be allowed to take "bridge" courses at either the graduate or undergraduate level to prepare for the formal certificate courses.

Required Course:		
GEO ENG 5144	Remote Sensing Technology	3
Three of the following courses are required:		
POL SCI 4500	Geopolitics and International Security	3
PET ENG 4111	Fundamental Digital Applications In Petroleum Engineering	3
GEO ENG 4115	Statistical Methods in Geology and Engineering [1]	3
or GEO ENG 5315	Advanced Statistical Methods in Geology and Engineering	
GEO ENG 5146	Applications Of Geographic Information Systems	3
GEOPHYS 5261	Computational Geophysics	3
COMP SCI 5402	Introduction to Data Mining [2]	3
or COMP SCI 5400	Introduction To Artificial Intelligence	
GEO ENG 5642	Military Geology	3
GEO ENG 6146	Advanced Remote Sensing And Image Processing	3
GEOLOGY 4831	Computational Geology	3
IS&T 5535	Machine Learning Algorithms and Applications	3
SYS ENG 6213	Deep Learning	3

1. Only one of the listed courses may count toward completion of this certificate.

2. Only one of the listed courses may count toward completion of this certificate.

Geoenvironmental Science and Engineering

The graduate certificate in Geoenvironmental Science and Engineering is designed to provide graduate students with the geoscience and engineering backgrounds they will need to be successful in the geoenvironmental consulting or regulatory fields.

The Geoenvironmental Science and Engineering Certificate Program is open to all persons holding a B.S., M.S., or Ph.D. degree in Geology, Geophysics, Geological Engineering, Civil Engineering, or Biology or are currently accepted into a graduate degree program in one of these fields at Missouri S&T. Once admitted to the program, the student must take the four designated courses (provided in the curriculum section). In order to receive a Graduate Certificate, the student must have an average cumulative grade point of 3.0 or better in the certificate courses. Once admitted to the program, a student will be given three years to complete the program.

Students admitted to the Geoenvironmental Science and Engineering Certificate Program will have non-degree graduate status, however, they will earn graduate credit for the courses they complete. If the student completes the four-course sequence with a grade of B or better in each of the courses taken, they, upon application, will be admitted to the non-thesis M.S. degree program in Geology and Geophysics. The certificate credits taken by the students admitted to the M.S. degree program will count towards their master's degree. Students who do not have all of the prerequisite courses necessary to begin the courses in the Geoenvironmental Science and Engineering Certificate Program will be allowed to take "bridge" courses at either the graduate or undergraduate level to prepare for the formal certificate courses.

One of the following courses is required:		
GEOLOGY 4411	Hydrogeology	3
GEO ENG 5331	Subsurface Hydrology	3
GEO ENG 5332	Fundamentals of Groundwater Hydrology	3
Three of the following courses are required:		
GEOLOGY 4431	Methods Of Karst Hydrogeology	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEOPHYS 5782	Environmental and Engineering Geophysics	3
GEO ENG 5174	Geological Engineering Field Methods	3
GEO ENG 5233	Risk Assessment In Environmental Studies	3
GEO ENG 5235	Environmental Geological Engineering	3
GEO ENG 5237	Geological Aspects Of Hazardous Waste Management	3
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
GEO ENG 6331	Advanced Subsurface Hydrology	3
BIO SCI 6313	Environmental Microbiology	3
BIO SCI 6363	Advanced Freshwater Ecology	3
BIO SCI 6463	Bioremediation	3
ENV ENG 5605	Environmental Systems Modeling	3
ENV ENG 5635	Phytoremediation and Natural Treatment Systems: Science and Design	3
ENV ENG 6601	Biological Principles In Environmental Engineering Systems	3

Geologic Hazards

The graduate certificate in Natural and Geologic Hazards is designed to provide graduate students with formalized education in the area of geologic hazards assessment and engineering.

The Geologic Hazards Certificate Program is open to all persons holding a B.S., M.S., or Ph.D. degree in Geology, Geophysics, Geological Engineering, Geotechnics, or Civil Engineering or who are currently accepted into a graduate degree program in one of these fields at Missouri S&T. Once admitted to the program, the student must take the four designated courses (provided in the curriculum section). In order to receive a Graduate Certificate, the student must have an average cumulative grade point of 3.0 or better in the certificate courses. Once admitted to the program, a student will be given three years to complete the program.

Students admitted to the Geologic Hazards Certificate Program will have non-degree graduate status, however, they will earn graduate credit for the courses they complete. If the student completes the four-course sequence with a grade of B or better in each of the courses taken, they, upon application, will be admitted to their choice of non-thesis M.S. degree programs in either Geological Engineering or Geotechnics. The certificate credits taken by the students admitted to the M.S. degree program will count towards their master's degree. Students who do not have all of the prerequisite courses necessary to begin the courses in the Geologic Hazards Certificate Program will be allowed to take "bridge"

courses at either the graduate or undergraduate level to prepare for the formal certificate courses.

Required Course:		
GEO ENG 5441	Engineering Geology And Geotechnics	3
One of the following courses are required:		
GEO ENG 6441	Geotechnical Construction Practice	3
GEO ENG 6625	Applications in Geological Engineering	3
Two of the following courses are required:		
GEO ENG 5144	Remote Sensing Technology	3
GEO ENG 5146	Applications Of Geographic Information Systems	3
CIV ENG 5337	River Mechanics And Sediment Transport	3
GEO ENG 5471	Rock Engineering	3
CIV ENG 5716	Geotechnical Earthquake Engineering	3
GEO ENG 5782	Environmental and Engineering Geophysics	3
or GEO ENG 6784	Advanced Engineering And Environmental Geophysics	
or GEO ENG 5761	Transportation Applications of Geophysics	
GEO ENG 6146	Advanced Remote Sensing And Image Processing	3
CIV ENG 6205	Structural Dynamics and Earthquake Engineering	3
GEO ENG 6477	Discontinuous Rock	3
CIV ENG 6717	Earth Dams And Related Problems	3

Space Resources

The graduate certificate program in Space Resources is designed to provide a pathway for non-aerospace engineering professionals to enter the emerging field of space-based resource discovery and production.

The Space Resources Certificate Program is open to all persons holding a B.S., M.S., or Ph.D. degree in, Geological Engineering, Geotechnics, Civil Engineering, Mining Engineering, Ceramic Engineering, Chemical Engineering, Metallurgical Engineering or Aerospace Engineering or who are currently accepted into a graduate degree program in one of these fields at Missouri S&T. Once admitted to the program, the student must take the four designated courses (provided in the curriculum section). In order to receive a Graduate Certificate, the student must have an average cumulative grade point of 3.0 or better in the certificate courses. Once admitted to the program, a student will be given three years to complete the program.

Students admitted to the Space Resources Certificate Program will have non-degree graduate status, however, they will earn graduate credit for the courses they complete. If the student completes the four-course sequence with a grade of B or better in each of the courses taken, they, upon application, will be admitted to their choice of graduate degree programs in either Geological Engineering or Geotechnics. Admission to other engineering programs will be at the discretion of those programs. The certificate credits taken by the students admitted to the graduate degree program will count towards their degree. Students who do not have all of the prerequisite courses necessary to begin the courses in the Space Resources Certificate Program will be allowed to take "bridge" courses at either the graduate or undergraduate level to prepare for the formal certificate courses.

The following course is required:		
GEO ENG 5810	Fundamentals of Space Resources	3
One of the following Space Mechanics courses is required:		
AERO ENG 3613	Aerospace Mechanics I	3
AERO ENG 5313	Intermediate Dynamics of Mechanical and Aerospace Systems	3
AERO ENG 5614	Spaceflight Mechanics	3
One of the following Exploration courses is required:		
GEO ENG 5144	Remote Sensing Technology	3
GEO ENG 5443	Subsurface Exploration	3
One of the following Processing courses is required:		
CHEM ENG 4110	Chemical Engineering Process Dynamics And Control	3
CHEM ENG 5110	Intermediate Chemical Reactor Design	3
CHEM ENG 5190	Plantwide Process Control	3
MS&E 6120	Thermodynamics and Phase Equilibria	3

Subsurface Water Resources

The graduate certificate in Subsurface Water Resources is designed to provide formalized education in the area of subsurface water resource engineering, with emphasis on groundwater extraction, protection, and remediation

The Subsurface Water Resources Certificate Program is open to all persons holding a B.S., M.S., or Ph.D. degree in Geology, Geophysics, Geological Engineering, Geotechnics, or Civil Engineering or who are currently accepted into a graduate degree program in one of these fields at Missouri S&T. Once admitted to the program, the student must take the four designated courses (provided in the curriculum section). In order to receive a Graduate Certificate, the student must have an average cumulative grade point of 3.0 or better in the certificate courses. Once admitted to the program, a student will be given three years to complete the program.

Students admitted to the Subsurface Water Resources Certificate Program will have non-degree graduate status, however, they will earn graduate credit for the courses they complete. If the student completes the four-course sequence with a grade of B or better in each of the courses taken, they, upon application, will be admitted to their choice of non-thesis M.S. degree programs in either Geological Engineering or Geotechnics. The certificate credits taken by the students admitted to the M.S. degree program will count towards their master's degree. Students who do not have all of the prerequisite courses necessary to begin the courses in the Subsurface Water Resources Certificate Program will be allowed to take "bridge" courses at either the graduate or undergraduate level to prepare for the formal certificate courses.

Required Courses:		
GEO ENG 5331	Subsurface Hydrology	3
or GEO ENG 5332	Fundamentals of Groundwater Hydrology	
or GEOLOGY 4411	Hydrogeology	
And		
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3
Two of the following courses are required:		
GEOLOGY 4431	Methods Of Karst Hydrogeology	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEO ENG 5233	Risk Assessment In Environmental Studies	3
GEO ENG 5443	Subsurface Exploration	3
CIV ENG 5630	Remediation of Contaminated Groundwater and Soil	3
CIV ENG 5635	Phytoremediation and Natural Treatment Systems: Science and Design	3
CIV ENG 5640	Environmental Law And Regulations	3
GEO ENG 5782	Environmental and Engineering Geophysics	3
or GEO ENG 6784	Advanced Engineering And Environmental Geophysics	
GEO ENG 6331	Advanced Subsurface Hydrology	3
GEO ENG 5235	Environmental Geological Engineering	3

Jeffrey D Cawlfield, Professor[1,2]
PHD University of California-Berkeley
Probabilistic modeling and geo-statistics, ground-water and contaminant transport analysis, and computer applications in geological engineering.

Leslie Sour Gertsch, Associate Professor
PHD Colorado School of Mines
Rock mechanics, mechanical mining and excavating, mine design and rock fragmentation.

Weibing Gong, Assistant Professor
PHD University of California-Berkeley

Katherine R Grote, Associate Professor[2]
PHD University of California-Berkeley
Application of geophysical techniques for hydrological site characterization with emphasis on vadose zone processes, investigation of agriculture practices for improved water management.

Jeremy Maurer, Assistant Professor
PHD Stanford University
Geophysics, earthquakes, induced seismicity, remote sensing, big Earth data.

J David Rogers, Professor Emeritus[2,1]
PHD University of California-Berkeley
Seismic hazards, geotechnical engineering, dam safety and earth structures.

Taghi Sherizadeh, Assistant Professor
PHD University of Arizona

GEO ENG 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor is required.

GEO ENG 5001 Special Topics (LAB 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

GEO ENG 5085 Internship (IND 0.0-15)
Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

GEO ENG 5090 Geological Engineering Design (LAB 1.0 and LEC 2.0)
Geological engineering design is an open-ended project course requiring the collection of data, analysis and synthesis of that data and design of a socially acceptable, economical solution to the selected problem. Oral and written reports are required. Prerequisite: To be taken in the semester before graduation.

GEO ENG 5092 International Engineering and Design (LEC 3.0)
A multi-disciplinary engineering course focused on sustainable design and technology transfer to developing countries. Course includes elements of traditional capstone design classes. Experiential learning through competitions and/or field work is a major component of the class. Prerequisites: Senior standing, instructor approval, Geo Eng 5211, Geo Eng 5247. (Co-listed with Met Eng 4510 and Cer Eng 4510).

GEO ENG 5099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

GEO ENG 5144 Remote Sensing Technology (LAB 1.0 and LEC 2.0)
Principles of digital image processing including image enhancement and multispectral classification. Emphasis upon design and implementation of remote sensing systems and analysis of remotely sensed data for geotechnical and environmental investigations. Prerequisite: Geology 1110. (Co-listed with Geology 4310).

GEO ENG 5146 Applications Of Geographic Information Systems (LAB 1.0 and LEC 2.0)
Applications of Geographical Information Systems and remote sensing to environmental monitoring, mineral resource exploration, and geotechnical site evaluation. Prerequisite: Geo Eng 3175 or consent of instructor. (Co-listed with Geology 4821).

GEO ENG 5153 Regional Geological Engineering Problems In North America (LEC 3.0)
A physiographic approach to engineering materials and problems. Course emphasizes the distribution and engineering characteristics of soil and rock to construction and site problems and includes aggregates, foundations, excavations, surface and ground water, slope stability and arctic conditions.

GEO ENG 5172 Soil Science In Engineering Practice (LEC 3.0)
A study of the ways in which soils and geologic conditions influence engineered projects. Soil formation, soil chemistry and properties to include composition, organic component, ion exchange and water relationships as well as erosion control and revegetation will be covered. Prerequisite: Geo Eng 3175.

GEO ENG 5173 Geologic Field Methods (LAB 3.0)
Field practice in geologic mapping and interpretation in the Western United States using topographic base maps and aerial photos. Emphasizes the description and interpretation of stratigraphic sections, sedimentary and tectonic structures. Prerequisite: Two courses in either Geology or Geological Engineering.

GEO ENG 5174 Geological Engineering Field Methods (LAB 3.0)
Instruction in methods of field investigation required for geological engineering studies. Course will include procedures for qualitative and quantitative data collection for characterizing surficial geologic conditions, groundwater and surface water investigations, and other engineering activities. Written reports and field trip required.

GEO ENG 5211 Introduction to International Engineering and Design Lab (LAB 1.0)
The lab for multi-disciplinary design will be as follows: Students will develop a work plan to address design objectives and other considerations including scheduling, budgeting, environmental impacts, and life cycle design. Prerequisites: Senior standing, instructor approval, accompanied by GEO ENG 5247.

GEO ENG 5233 Risk Assessment In Environmental Studies (LEC 3.0)
This course will present the concepts required to assess the human health and environmental risks resulting from contaminants in soil and groundwater. Course topics include evaluation of data sets, exposure calculation, chemical fate and transport, and development of conceptual site models.

GEO ENG 5235 Environmental Geological Engineering (LEC 3.0)
Introduction to engineering geologic mapping for site selection for solid waste disposal facilities; landfill site selection, design, permitting, construction, operation, and closeout/reclamation. Prerequisites: Geo Eng 3175, accompanied or preceded by Civ Eng 3715.

GEO ENG 5237 Geological Aspects Of Hazardous Waste Management (LEC 3.0)
Nature and classification of hazardous wastes; federal and state regulation for treatment and disposal; geological characterization of facility sites; design of impoundments, storage and containment facilities; ground water monitoring and protection; site permitting and licensing planning. Prerequisite: Geo Eng 3175.

GEO ENG 5239 Groundwater Remediation (LEC 3.0)
A survey of conventional and innovative techniques for remediation of contaminated groundwater. Topics include groundwater cleanup standards, physico-chemical properties of groundwater and contaminants, fate and transport of contaminants in the subsurface, hydrogeologic site characterization, and selection process of a remedial technology. Various computer programs developed to assist in preliminary selection and design of remediation technologies will be used. Prerequisite: Geo Eng 5331.

GEO ENG 5247 Introduction to International Engineering and Design (LEC 2.0)
A multi-disciplinary design course focused on sustainable design and technology transfer to developing countries. Students will develop a work plan to address design objectives and other considerations including scheduling, budgeting, environmental impacts, and life cycle design. Prerequisites: Senior standing, instructor approval, accompanied by Geo Eng 5211.

GEO ENG 5276 Advanced Environmental Aspects Of Mining (LEC 3.0)
Applied and fundamental research issues pertaining to: permitting -- the legal environment of reclamation and environmental impact assessment; post-mining land-use selection and mine planning for optimum reclamation of all mines: metal, nonmetal, and coal; unit operations of reclamation: drainage, backfill, soil replacement, revegetation, maintenance, etc. Course project. (Co-listed with Min Eng 5742).

GEO ENG 5315 Advanced Statistical Methods in Geology and Engineering (LEC 3.0)
Application of statistical methods to study of geologic materials and practices, with emphasis on reliable interpretation of laboratory and field data for water, hydrocarbon, and mineral exploration, research, and engineering as well as other aspects of geological engineering. Prerequisites: Geo Eng 4115 or Stat 3111 or Stat 3113 or Stat 3115 or Stat 3117.

GEO ENG 5320 Groundwater Modeling (LEC 3.0)
This course is an introduction to advanced modeling techniques for understanding flow and transport in porous media under different hydrologic conditions. Emphasis is placed on both theoretical and practical modeling considerations. Computer demonstrations are incorporated. Practical applications are emphasized. Prerequisite: Civ Eng 3330 or Geo Eng 5331.

GEO ENG 5331 Subsurface Hydrology (LAB 1.0 and LEC 2.0)
Introduction to the theory and engineering concepts of the movement of subsurface fluids. Hydraulic characteristics of earth materials, aquifer characterization, and flow prediction. Engineering problems related to subsurface fluids. Prerequisites: Geo Eng 1150; Math 1215 or Math 1221.

GEO ENG 5332 Fundamentals of Groundwater Hydrology (LEC 3.0)
Focus on fundamental analysis and survey of groundwater hydrology with emphasis on practical geo-environmental and subsurface hydrology issues of interest to working professionals. Topics will include general hydrology, surface and subsurface intercconnection, basic groundwater flow and well test analysis, and a brief intro to contaminant transport. Prerequisites: Graduate standing.

GEO ENG 5381 Intermediate Subsurface Hydrology And Contaminant Transport Mechs (LAB 1.0 and LEC 2.0)
A study of the physical/chemical properties of rocks and sediments in the subsurface environment. Emphasis is put on waterrock properties such as permeability, capillarity, and mechanical dispersion. Both microscopic and macroscopic approaches are used. Prerequisites: Geo Eng 5331, Geo Eng 5332, or Geol 4411.

GEO ENG 5415 Soil Mechanics for Geoprofessionals (LEC 3.0)
The basic principles of soil mechanics necessary for professionals to practice in the field of geoconstruction. Topics related to the practical aspects of engineering include: soil classification, index properties, water flow through soils, compaction, compressibility, and shear strength. These basic principles will be applied to real world problems.

GEO ENG 5441 Engineering Geology And Geotechnics (LEC 3.0)
Study of procedures and techniques used to evaluate geologic factors for site selection and the design of engineered structures. Prerequisite: Geo Eng 3175.

GEO ENG 5443 Subsurface Exploration (LAB 1.0 and LEC 2.0)
Lectures and field and laboratory exercises in the use of geologic and geophysical techniques for evaluation of subsurface geology and resources. Prerequisite: Geo Eng 1150.

GEO ENG 5471 Rock Engineering (LEC 3.0)
Data requirements for design; engineering properties of rock; characterization of fractures and rock masses; stereonet analysis of discontinuities; graphic analysis of failure; ground stress distribution; tunnel construction methods; ground support principles; selection of tunneling equipment; and specifications for underground construction. Prerequisite: Geo Eng 3175.

GEO ENG 5556 Renewable Energy Systems (LEC 3.0)
Introduction to the theory and performance prediction of typical renewable energy systems such as, but not limited to, those based on energy from the sun, wind and water, and geothermal. The use of environmental data, including stochastic modeling, for renewable energy system (including wind turbine, photovoltaic, and geothermal) design is addressed. Prerequisites: Math 3304, Physics 2135, and preceded or accompanied by Geo Eng 4115 or any Probability and Statistics class. Junior or senior standing is required.

GEO ENG 5575 Aggregates And Quarrying (LEC 3.0)
Properties and uses of aggregates. Finding aggregate deposits and methods of extraction. Aggregate processing. Aggregate testing. Economics and politics of aggregates. Special topics in aggregates and quarrying. Prerequisites: Geo Eng 1150, Geo Eng 3175.

GEO ENG 5642 Military Geology (LEC 3.0)
This course will familiarize geologists, geophysicists, civil and geological engineers with the fundamental principles of physical geology, geohydrology and geomorphology as applied to military problems, such as development of fortitications, core infrastructure, water resources and combat engineering requirements. Prerequisite: Geo Eng 3175 or graduate standing.

GEO ENG 5736 Geophysical Field Methods (LAB 1.0 and LEC 2.0)
Imaging of selected subsurface features and engineering structures using various geophysical tools. Special emphasis is placed on ground penetrating radar and surface wave techniques. One field trip at student expense required. Prerequisite: Junior level standing or higher. (Co-listed with Geophys 5736).

GEO ENG 5761 Transportation Applications of Geophysics (LAB 1.0 and LEC 2.0)
Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geophys 5761 and Civ Eng 5750).

GEO ENG 5782 Environmental and Engineering Geophysics (LAB 1.0 and LEC 2.0)
An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential, induced polarization and electromagnetic methods as applied to the solution of engineering and environmental problems. Prerequisite: Math 2222. (Co-listed with Geophys 5782).

GEO ENG 5810 Fundamentals of Space Resources (LEC 3.0)
Introduction to the science of the mineral resources of space, and to the engineering of extracting them for human use.

GEO ENG 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

GEO ENG 6001 Special Topics (LAB 0.0 and LEC 0.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

GEO ENG 6010 Seminar (RSD 1.0)
Discussion of current topics. Prerequisite: Graduate student.

GEO ENG 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

GEO ENG 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

GEO ENG 6085 Internship (IND 0.0-15)
Students working toward a doctor of engineering degree will select, with the advice of their committees, appropriate problems for preparation of a dissertation. The problem selected and internship plan must conform to the purpose of providing a high level engineering experience consistent with the intent of the doctor of engineering degree.

GEO ENG 6099 Research (IND 0.0-15)
Investigations of an advanced nature leading to the preparation of a thesis or dissertation.

GEO ENG 6146 Advanced Remote Sensing And Image Processing (LAB 1.0 and LEC 2.0)
Quantitative methods of utilizing remote sensing technology for terrain analysis. Digital image processing of landsat and/or aircraft scanner data for mineral resource studies and geological engineering applications. Prerequisite: Geo Eng 5146. (Co-listed with Geology 6341).

GEO ENG 6235 Advanced Concepts Of Environmental Geological Engineering (LEC 3.0)
Application of the principles of geology to the solution of engineering problems in environmental protection and remediation. Topics will include the study of geologic processes and the evaluation of geologic materials as they affect the potential for groundwater contamination, susceptibility of soils to erosion, characterization of the geologic environment for site suitability and the analysis of the criteria necessary for the selection of technologies for minimizing environmental impact. Prerequisite: Graduate level course in environmental geologic studies.

GEO ENG 6237 Advanced Geological & Geotechnical Design For Hazardous Waste Mgt (LEC 3.0)
Geological and geotechnical design factors for hazardous waste management facilities and remedial actions (cleanup) of uncontrolled hazardous waste sites. Prerequisite: Geo Eng 5237 or consent of instructor.

GEO ENG 6331 Advanced Subsurface Hydrology (LEC 3.0)
Advanced treatment of selected topics in subsurface hydrology, including groundwater contamination, contaminant transport, land disposal of wastes, aquifer test analysis, injection well technology, etc. Applied hydrogeologic site analysis and flow and transport modeling through solution of selected case examples. Prerequisite: Geo Eng 5331 or equivalent.

GEO ENG 6332 Numerical Methods In Subsurface Flow (LEC 3.0)
Development of governing balance equations, constitutive laws and mathematical models of groundwater flow and contaminant transport in porous media. Solution of mathematical models by finite difference and finite element methods for various boundary and initial conditions. Prerequisites: Geo Eng 5331, Comp Sci 1970.

GEO ENG 6400 Practice Oriented Project (IND 3.0)
This class will consist of a single term project. Students will, in consultation with the instructor, pick a topic relevant to their studies, and produce a comprehensive, in depth, professionally written report, including a literature review on the state of the practice on that topic. Prerequisites: Limited to students enrolled in the Masters of Engineering (M.E.) in Geotechnics Program.

GEO ENG 6407 Inca Civilization Geotechnical Engineering Practices (LEC 3.0)
An in-depth study of geotechnical engineering practices in the mountains of Peru, including the Cuzco-Machu Picchu corridor, with emphasis on the inter-relationships between tectonics, geology, geomorphology, climate, hydrology, agriculture, quarrying, construction practices, irrigation, culture and history. A week-long field trip to Peru during Spring Break is required at student's expense. Prerequisite: Geo Eng 1150 or Civ Eng 3715 or Geo Eng 5471 or equivalent; Graduate standing. (Co-listed with Civ Eng 6760).

GEO ENG 6441 Geotechnical Construction Practice (LEC 3.0)
Advanced level lecture topics on procedures used for site characterization, standards for earthquake grading and construction, including embankments, building pads, retention structures, roads, levees, and earthen dams. Specific emphasis on preparation of documents involved in such work and engineer's responsibilities. Prerequisite: Geo Eng 5441.

GEO ENG 6477 Discontinuous Rock (LEC 3.0)
Nature and properties of discontinuous rock masses, genesis and properties of joints, role of joints in rock shear strength, slope of stability of jointed rock, fracture flow hydrogeology. Modeling of the mechanical behavior of fractured rock. Prerequisite: Min Eng 4823 or Geo Eng 5471.

GEO ENG 6625 Applications in Geological Engineering (LEC 3.0)
Content is focused on practical aspects of geological engineering. Geotechnical, environmental and geohydrologic case studies are presented to illustrate concepts and relate theory to applications.

GEO ENG 6736 Advanced Geophysical Methods (LAB 2.0 and LEC 1.0)
Geophysical field data will be acquired at selected study sites with the objective of imagine the shallow subsurface and/or built structures. Registrants will process and interpret the acquired non-invasive imaging data using ground truth as a constraint. Prerequisite: Graduate Standing.

GEO ENG 6782 Surface Waves (MASW) and Ground Penetrating Radar (GPR) (LAB 1.0 and LEC 2.0)
Geological engineering applications of surface wave and ground penetrating radar methods are emphasized. Field data will be acquired, processed and interpreted. Prerequisites: Geo Eng 1150 or Civ Eng 3715 or equivalent, and graduate standing.

GEO ENG 6784 Advanced Engineering And Environmental Geophysics (LEC 3.0)
An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential induced polarization, seismic, electromagnetic and GPR methods as applied to the solution of engineering and environmental problems. Prerequisite: Admittance into USAES-S&T Co-operative Degree Program. (Co-listed with Geophys 5251).
