

GEOLOGY AND GEOPHYSICS

Emphasis areas at the bachelor of science level in geochemistry, geology, geophysics, groundwater and environmental geochemistry, and petroleum geology.

The geology and geophysics program is offered under the department of Earth Sciences and Engineering.

Geologists, geochemists, and geophysicists study the history, composition, and structure of Earth and other planetary bodies. The expertise and activities in the geology and geophysics program help make the Missouri University of Science and Technology one of the leading U.S. research universities. Faculty and students are investigating areas such as exploration for strategic minerals to help power green energy initiatives, water resources and water security issues, paleoclimate studies using cores from lake sediments, palynostratigraphy (microfossils), geophysical characterization of geological hazards (e.g., earthquakes, reflection and theoretical seismology, computational geophysics, petroleum exploration, the genesis of ore deposits, magmatism, and global tectonics). We provide the only program in Missouri in geophysics and geochemistry with an emphasis on exploration and environmental applications.

Students are drawn to geology and geophysics by a desire to explore a topic that is for many a personal passion. As a student in the geology and geophysics program, you may become involved in a wide range of studies. We have students investigating their world and beyond in areas as diverse as planetary geology, fossils and evolution, volcanology, structure and dynamics of Earth's deep interior, development of cave systems, exploration for oil and gas, adsorption of pollutants by soils, ore mineralization, and the creation of mountain systems to name but a few. Many courses involve work outdoors and in the laboratory. You may even find yourself hiking in the Grand Canyon, snorkeling over a coral reef in the Caribbean Sea, working in the rifted valleys in Africa or examining the evolution of the desert lakes in the Outback of Australia.

In the first two years of study, students develop a strong foundation in geology through the core curriculum. This foundation is strengthened by course work in chemistry, physics, mathematics, computer science, and the humanities and social sciences. Students begin to take more specialized courses pertaining to their particular area of geological interest in their junior and senior years. The numerous elective courses offered by the geology and geophysics program, as well as courses outside the department, provide our majors with the flexibility to custom design an emphasis area of their choice, focusing in on aspects of Earth Science that are of most interest to them. In this way, our majors develop a broad understanding of the fundamentals of the geosciences while preserving the opportunity to develop their own passion within a broad field of science and engineering disciplines.

The Earth sciences have been an integral part of Missouri S&T since its founding in 1870. Our student organizations in geology and geophysics are among the oldest in the nation and include the Dake Society, American Association of Petroleum Geologists, Society of Exploration Geophysicists, and the Sigma Gamma Epsilon (Eta Chapter) honor society. These organizations provide numerous opportunities for social and scientific interaction among students, professionals, and faculty.

The geology and geophysics program is located in McNutt Hall and it is especially well endowed with modern, state-of-the-art equipment for teaching and research in most areas of the Earth sciences. The

availability of such equipment provides our students with an excellent laboratory and field educational experience. In addition, cooperative studies with the Missouri Geological Survey and the U.S. Geological Survey provide students with opportunities for part time employment and on-the-job experience while they pursue their degree.

Geological scientists enjoy their work. As a geologist or geophysicist you may explore for oil, gas, and coal to provide for our nation's energy needs. You may search for minerals critical to industry. You may become involved in minimizing environmental pollutants and geologic hazards. In all cases, you will have the opportunity to work outdoors, in the lab, and with cutting edge technology. You do not need a license to be employed as a geologist or geophysicist but the curriculum prepares students for future professional licensing. Students may take the ASBOG National License Exam, a necessary requirement in the process of becoming a Licensed Professional Geologist. Additional requirements vary by state.

Mission Statement

1. Provide the highest quality education to students leading to the B.S., M.S., and Ph.D. degrees in geology and geophysics. Prepare students for professional careers in five emphasis areas: geology, geochemistry, geophysics, groundwater and environmental geochemistry, and petroleum geology. Provide service courses for students in related programs (including geological engineering, mining engineering, petroleum engineering, environmental engineering, ceramic engineering, civil engineering, physics, biology and chemistry) as well as many of the programs in the humanities and liberal arts.
2. The program has both the opportunity and the mission to engage in basic and applied research that contributes to the solution of problems related to mankind and the environment. To meet this goal, the program collaborates on projects that transcend the traditional boundaries between scientific and engineering disciplines. Faculty and students commonly conduct research with geologists in the Rolla offices of the United States Geological Survey and the Missouri Geological Survey, with scientists and engineers from various disciplines at Missouri S&T and other campuses of the University of Missouri system, as well as with other Earth scientists in universities within the United States and abroad (e.g., Ireland, Republic of South Africa).
3. Provide graduates to the mining, petroleum, groundwater, and environmental industries; to the Missouri Geological Survey, the U.S. Geological Survey and other educational research institutions.
4. Provide professional service in the fields of geology, geophysics, geochemistry, groundwater and environmental geology. Such service includes the identification of minerals, rocks, and fossils that are sent to the department, the assessment of geologic hazards, contributing to the development and operation of professional organizations, and when called upon, assisting local and state agencies with the evaluation of geological problems.
5. Provide a strong foundation in fundamental principles of geology and geophysics for undergraduate students who desire to pursue opportunities for advanced research in the top graduate schools across the United States. Our graduates have continued their education in prestigious programs, including Arizona State, California-Berkeley, Colorado, Colorado School of Mines, Delaware, MIT, Michigan, Michigan State, Oklahoma, Stanford, Texas, Virginia

Tech, Washington, University of Missouri-St. Louis and the Missouri University of Science and Technology.

Bachelor of Science Geology and Geophysics

A minimum of 127 credit hours is required for a Bachelor of Science degree in Geology and Geophysics. Students must average at least two grade points per credit hour and must obtain a letter grade of "C" or better in all Geology and Geophysics courses.

The Geology and Geophysics curriculum must include ENGLISH 1120 and ENGLISH 1160, ECON 1100 or ECON 1200, either HISTORY 1200, HISTORY 1300, HISTORY 1310 or POL SCI 1200, and nine elective hours in humanities/social sciences. Specific requirements for the bachelor degree program are outlined in the sample program below

Freshman Year

First Semester	Credits	Second Semester	Credits
GEOLOGY 1110 or GEO ENG 1150	3	GEOLOGY 1120 ¹	3
ENGLISH 1120	3	GEOLOGY 1129 ¹	1
CHEM 1310	4	Elective (Science & Eng) ²	3
CHEM 1319	1	Humanities/ Social Science Elective	3
CHEM 1100	1	MATH 1214 or 1211 ³	4
Humanities/ Social Science Elective	3		
15		14	

Sophomore Year

First Semester	Credits	Second Semester	Credits	Summer Semester	Credits
GEOLOGY 2610	4	GEOLOGY 2620 ¹	4	GEOLOGY 2096	3
GEOPHYS 3210	3	GEOLOGY 3410	3		
MATH 1215 ³	4	ENGLISH 1160 or 3560	3		
COMP SCI 1500 or GEO ENG 3249	3	ECON 1100 or 1200	3		
		HISTORY 1200, or 1300, or 1310, or POL SCI 1200	3		
14		16		3	

Junior Year

First Semester	Credits	Second Semester	Credits	Summer Semester	Credits
GEOLOGY 3310	3	GEOLOGY 3620	3	GEOLOGY 4097	3
GEOLOGY 3319	1	GEOLOGY 3629	1		
PHYSICS 1135 ⁴	4	PHYSICS 2135 ⁴	4		
STAT 3113, or 3115, or 3117, or GEO ENG 4115	3	Elective (Geo & Geop) ⁵	6		
Elective (Geo & Geop) ⁵	3	Humanities/ Social Sciences Elective	3		
14		17		3	

Senior Year

First Semester	Credits	Second Semester	Credits
GEOLOGY 4010	0.5	GEOPHYS 5096	3
Elective (Science & Eng) ²	6	Elective (Science & Eng) ²	9
Elective (Geo & Geop) ⁵	9	Free Elective ⁶	3
GEOLOGY 4010		.5	
15.5		15.5	

Total Credits: 127

¹ Communications Emphasized (CE) courses

² All Geology/Geophysics students must complete at least 15 hours of elective course work in science (which may include additional Geology/Geophysics courses), mathematics, and/or engineering, courses required for the basic program. 12 hours of this course work must be numbered 2000 or above.

³ MATH 1208 or MATH 1211 may be substituted for MATH 1214. MATH 1221 may be substituted for MATH 1215.

⁴ Students may substitute PHYSICS 1111 and PHYSICS 1119 for PHYSICS 1135; PHYSICS 2111 and PHYSICS 2119 for PHYSICS 2135.

⁵ All Geology and Geophysics students must complete at least 18 hours of elective course work numbered 2000 or above in the Department of Geology and Geophysics, in addition to the required core curriculum.

⁶ Free elective hours may be taken in any combination of credit hours (1, 2, 3, etc.) and can include any course offerings at the University.

Core Curriculum

Taken by all students in Geology & Geophysics.

GEOLOGY 1110	Physical and Environmental Geology	3
GEOLOGY 1120	Evolution Of The Earth	3
GEOLOGY 1129	Evolution of the Earth Laboratory ⁵	1
GEOLOGY 2610	Mineralogy And Crystallography	4
GEOLOGY 2620	Igneous And Metamorphic Petrology	4
GEOLOGY 3310	Structural Geology	3
GEOLOGY 3319	Structural Geology Lab	1
GEOLOGY 3410	Introduction To Geochemistry	3
GEOLOGY 3620	Stratigraphy And Sedimentation	3
GEOLOGY 3629	Stratigraphy Lab	1
GEOLOGY 4010	Seminar	0.5
GEOLOGY 2096	Field Geology	3
GEOLOGY 4097	Advanced Field Geology	3
GEOPHYS 3210	Introduction to Geophysics	3
GEOPHYS 5096	Global Tectonics	3
Total Credits		38.5

Geology and Geophysics Focus Areas Geochemistry

Students should complete at least 5 courses (15 hours minimum) from the list.

Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 3511	Introduction to Mineral Deposits	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEOLOGY 4461	Isotope Geochemistry	3
GEOLOGY 4631	Advanced Igneous and Metamorphic Petrology	4
GEOLOGY 4841	Geological Field Studies	3
GEOLOGY 5611	Granites And Rhyolites	4
GEOLOGY 5671	Clay Mineralogy	3

CER ENG 2110	Atomic Structure Of Crystalline Ceramics	3
CER ENG 3220	Phase Equilibria	3

General Geology

Students should complete at least 5 courses (15 hours minimum) from the list. Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 3511	Introduction to Mineral Deposits	3
GEOLOGY 4630	Systematic Paleontology	3
GEOLOGY 3811	Fundamentals Of Geographic Information Systems	3
or GEO ENG 3148	Fundamentals Of Geographic Information Systems	
GEOLOGY 4631	Advanced Igneous and Metamorphic Petrology	4
GEOLOGY 4711	Paleoclimatology and Paleoecology	3
GEOLOGY 4841	Geological Field Studies	3
GEOLOGY 5513	Petroleum Geology	3
GEOLOGY 5611	Granites And Rhyolites	4
GEOLOGY 5741	Micropaleontology	3
GEOLOGY 6311	Advanced Structural Geology	3
GEO ENG 3175	Geomorphology And Terrain Analysis	3

Geophysics

Students must choose 1 math and 3 geophysics courses from the list. Students should also choose at least one additional course to be selected from an approved list and with guidance from student's advisor.

MATH 2222	Calculus III	4
MATH 3304	Elementary Differential Equations	3
MATH 3108	Linear Algebra I	3
MATH 5325	Partial Differential Equations	3
GEOPHYS 4231	Seismic Interpretation	3
GEOPHYS 5202	Exploration and Development Seismology	3
GEOPHYS 5231	Seismic Data Processing	3
GEOPHYS 5261	Computational Geophysics	3
GEOPHYS 5736	Geophysical Field Methods	3
or GEO ENG 5736	Geophysical Field Methods	
GEOLOGY 4310	Remote Sensing Technology	3

Groundwater and Environmental Geochemistry

Students should complete at least 5 courses (15 hours minimum) from the list. Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 4431	Methods Of Karst Hydrogeology	3
GEOLOGY 4451	Aqueous Geochemistry	3
GEOLOGY 4711	Paleoclimatology and Paleoecology	3
GEOPHYS 5782	Environmental and Engineering Geophysics	3
or GEO ENG 5782	Environmental and Engineering Geophysics	
BIO SCI 1173	Introduction to Environmental Sciences	3
ENV ENG 2601	Fundamentals of Environmental Engineering and Science	3
ENV ENG 5640	Environmental Law And Regulations	3
GEO ENG 5237	Geological Aspects Of Hazardous Waste Management	3
GEO ENG 5331	Subsurface Hydrology	3
GEO ENG 5381	Intermediate Subsurface Hydrology And Contaminant Transport Mechs	3

Petroleum Geology

Students should complete at least 5 courses (15 hours minimum) from the list. Students may also choose additional courses to be selected from an approval list and with guidance from student's advisor.

GEOLOGY 4630	Systematic Paleontology	3
GEOLOGY 5311	Depositional Systems	3
GEOLOGY 5513	Petroleum Geology	3

GEOLOGY 5661	Advanced Stratigraphy and Basin Evolution	3
GEOLOGY 5741	Micropaleontology	3
GEOPHYS 5202	Exploration and Development Seismology	3
PET ENG 3330	Formation Evaluation	3
GEOLOGY 4310	Remote Sensing Technology	3

Accelerated BS/MS Program Option for Geology and Geophysics Majors

Geology and Geophysics undergraduates in G&G at Missouri S&T may opt to apply for an accelerated BS/MS G&G program where a student can achieve both the BS and MS degrees in G&G faster than if pursuing the degrees separately. The degrees awarded will be a BS & MS (non-thesis or thesis) in Geology and Geophysics.

The benefits for undergraduate students admitted to the program are:

- Undergraduate and graduate courses may be chosen with greater flexibility,
- Up to nine hours of 5000-level or above G&G coursework may apply to both the BS and MS requirements,
- The classes taken for shared BS/MS credit may be taken at the lower undergraduate tuition rate,
- The GRE is not required for admission,
- Other graduate courses can be taken any time after entering the program as a dual enrolled student,
- Work on a thesis project may begin before the BS requirements are completed.

To be eligible for the accelerated BS/MS G&G program, a G&G undergraduate must be at or beyond the junior level standing with a minimum of 48 credit hours. They must have successfully completed the Chemistry and Math requirements and have completed 21 credit hours of G&G courses at Missouri S&T with at least a 3.2 GPA in the G&G courses.

To be admitted, the student must complete the program application and non-thesis MS students must have the recommendation of a G&G faculty member, while thesis MS students must have the recommendation of a G&G faculty member who agrees to serve as the graduate thesis advisor.

All other MS degree requirements remain the same. The program may be combined with existing honors research, emphasis areas, and certificate options.

The Accelerated Program application must be completed within one semester after shared-credit courses are completed. Courses taken for shared credit will be identified on the application form. These courses will also be listed on the student's Graduate Form 1 to be submitted after the student enters the graduate program. The nine hours of shared-credit coursework, to be taken as undergraduate credit, must be approved by the academic advisor, and may not be undergraduate research, special problems, or transfer courses. An additional six credit hours of coursework for graduate credit (beyond the shared BS/MS credits) can be taken while in the undergraduate program by applying for dual undergraduate/graduate enrollment. Taking additional courses for graduate credit as a dual enrolled student will require formal application to the graduate program. Upon application, acceptance to the G&G MS degree from the Accelerated Program is automatic so long as the student remains in good standing (GPA above 3.0 and B's or better in all graduate courses) within the program. To remain in the Accelerated Program, the student must maintain good standing within the undergraduate G&G program and must maintain continuous enrollment at Missouri S&T.

If the student exits the program before completion of the MS degree requirements, or fails to maintain continuous enrollment at Missouri S&T,

the shared-credit courses may not apply toward graduate requirements in the event of future readmission.

It is the student's responsibility to check on how dual-enrollment status and graduate coursework affects scholarships and other financial aid. As a graduate student, you **are not** eligible for Federal Pell Grants. You are still eligible for Federal Financial Aid. You may be eligible for fellowships and teaching/research assistantships. It is the International student's responsibility to check with international affairs during completion of an accelerated BS/MS to ensure immigration status will be maintained throughout the program.

Minor in Geology

The minor will consist of 18 hours of geology related course work and must include GEOLOGY 2611 and one of GEOLOGY 1110 or GEO ENG 1150 or GEOLOGY 1120. Six additional hours of course work must come from any combination of 1000, 2000, 3000 geology courses. The remaining 6 hours of course work can be from any combination of geology related courses approved by the geology and geophysics program. Approved geology related course work:

BIO SCI 1113	General Biology	3
BIO SCI 1213	Principles of Biology	3
BIO SCI 2263	Ecology	3
BIO SCI 3233	Evolution	3
ENV ENG 3603	Chemical Fundamentals Of Environmental Engineering	3
ENV ENG 5630	Remediation of Contaminated Groundwater And Soil	3
ENV ENG 5605	Environmental Systems Modeling	3
GEO ENG 3175	Geomorphology And Terrain Analysis	3
GEO ENG 4115	Statistical Methods in Geology and Engineering	3
MIN ENG 3913	Mineral Identification and Exploration	3
MIN ENG 5522	Ore Reserve Analysis and Geostatistics	3
MIN ENG 5823	Rock Mechanics	3
PET ENG 3330	Formation Evaluation	3
PET ENG 4311	Reservoir Characterization	3
PET ENG 4720	Reservoir Geomechanics	3

David M. Borrok, Gulf Oil Foundation Professor and Dean for College of Engineering and Computing
PHD University of Notre Dame

Andreas Eckert, Associate Professor
PHD University of Karlsruhe

Stephen Shangxing Gao, Professor and Department Chair
PHD University of California-Los Angeles

John Patrick Hogan, Associate Professor
PHD Virginia Polytechnic Institute

Kelly Hong Liu, Professor
PHD University of California-Los Angeles

Marek Locmelis, Associate Professor
PHD Macquarie University, Sydney

Jeremy Maurer, Assistant Professor
PHD Stanford University

Francisca Oboh Ikenobe, Professor and Associate Dean for Academic Affairs for College of Engineering & Computing²
PHD Cambridge University

Jonathan Obrist Farner, Associate Professor
PHD Missouri University of Science and Technology

Wan Yang, Professor
PHD University of Texas at Austin

GEOLOGY 1001 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.

GEOLOGY 1110 Physical And Environmental Geology (LAB 1.0 and LEC 2.0)

Materials, structure, and surface features of the Earth and planets are studied in the context of the processes that continuously transform the Earth and affect management of Earth resources, hazards, engineering problems, and environmental challenges. Prerequisite: Entrance requirements. (Co-listed with Geo Eng 1150).
GEOLOGY 1110 - MOTR GEOL 100: Geology

GEOLOGY 1111 Introduction to Physical Geology (LAB 1.0 and LEC 2.0)

A study of Earth materials, surface features, internal structures and processes. Particular attention is paid to Earth resources, geological hazards, engineering and environmental problems. Prerequisite: Entrance requirements.
GEOLOGY 1111 - MOTR GEOL 100L: Geology with Lab

GEOLOGY 1120 Evolution Of The Earth (LEC 3.0)

A survey of the Earth history from the coalescence of the solar system to the present and the events that have profoundly transformed the planet in the context of the dynamic feedback between physical and biological systems. A one day field trip is required. Prerequisites: Recommend Geo Eng 1150 or Geology 1110 or Bio Sci 1113 but not required.

GEOLOGY 1129 Evolution of the Earth Laboratory (LAB 1.0)

Geology 1129 is designed to accompany Geology 1120 and consists of laboratory explorations of fundamental concepts in geology and the diversity of the fossil record. Prerequisite: Preceded or accompanied by Geology 1120.

GEOLOGY 1141 Physical Oceanography (LEC 3.0)

An introduction to the study of the physical and geological processes in the world's oceans including the importance of the oceans to the environment and to life on Earth. Prerequisites: Entrance requirements.

GEOLOGY 2001 Special Topics (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

GEOLOGY 2096 Field Geology (LEC 3.0)

Theory and practice in the qualitative and quantitative description of spatial relationships of major rock types, contacts, and structures through construction of geologic maps. Emphasis on developing fundamental field skills, including logistical planning, navigation, data collection and documentation, and professional protocol during site visits. Students will be charged a fee to cover the cost of field trip expenses. Prerequisites: GEOLOGY 1111, 1110, 1119, & 1129.

GEOLOGY 2610 Mineralogy And Crystallography (LAB 1.0 and LEC 3.0)

An introduction to the study of minerals, including their systematic classification, crystallography, morphology, chemistry, societal use, geologic occurrence, environmental application and impact, and identification by means of their physical and chemical properties. Prerequisites: Chem 1310.

GEOLOGY 2611 Physical Mineralogy And Petrology (LAB 1.0 and LEC 2.0)

An introduction to the study of physical mineralogy and petrology, overviewing systematic determination of minerals and rocks by means of their physical properties. Includes the recognition of crystal forms and field relationships of rocks. Course designed for non-geology majors, credit will not count towards a geology-geophysics degree. Prerequisites: Chem 1310 and Chem 1319 or Chem 1351; Geo Eng 1150 or Geology 1110.

GEOLOGY 2620 Igneous And Metamorphic Petrology (LAB 1.0 and LEC 3.0)

A comprehensive study of megascopic and microscopic characteristics of igneous and metamorphic rocks. Fundamental theories for their origin are presented. The class includes a trip to examine these rock types in the field. Prerequisite: Geology 2610.

GEOLOGY 2731 Introduction to Planetary Science (LEC 3.0)

Basic principles of astronomy, the origin and evolution of the universe, stellar evolution, and the origin, composition, and processes operating on the planetary bodies in the solar system.

GEOLOGY 3000 Special Problems (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

GEOLOGY 3001 Special Topics (IND 0.0-6.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

GEOLOGY 3310 Structural Geology (LEC 3.0)

Students will develop an appreciation for the geometrical beauty of geologic structures through an understanding of crustal deformation at scales from mineral lattices to tectonic plates. Field trip fee required. Prerequisites: GEOLOGY 1110 or GEO ENG 1111.

GEOLOGY 3319 Structural Geology Lab (LAB 1.0)

This course reinforces the principles of Structural Geology through detailed analysis of rock deformation. Techniques will include using a geologic compass, preparing rock descriptions, stereographic analysis, interpretation of geologic maps, construction of cross-sections, and orthographic projections to solve scientific and engineering problems. Prerequisites: Preceded or accompanied by GEOLOGY 3310.

GEOLOGY 3410 Introduction To Geochemistry (LEC 3.0)

Application of basic chemical principals towards investigations of element distributions in geologic systems. Emphasis on origin of elements in our Solar System, element distribution during planetary formation, phase equilibria, rock-water interactions, thermodynamic principles, environmental and isotope geochemistry. Prerequisite: Chem 1310.

GEOLOGY 3511 Introduction to Mineral Deposits (LEC 3.0)

Basic processes involved in the formation of metallic and industrial mineral deposits illustrated by typical examples of deposits from throughout the world. Exploration and economic factors in mineral exploration and development are reviewed. Prerequisites: Geology 1110 and Geology 2610.

GEOLOGY 3620 Stratigraphy And Sedimentation (LEC 3.0)

Principles of physical stratigraphy, bio-stratigraphy and introductory sedimentation. Introduction to depositional systems, facies, unconformities, stratigraphic nomenclature and correlation. One field trip at student expense is required. Prerequisite: Geology 2620 or Geology 2611.

GEOLOGY 3629 Stratigraphy Lab (LAB 1.0)

This course re-enforces the principles of stratigraphy and sedimentation through the use of "hands-on" laboratory procedures such as seive and pipette analyses, correlation problems, fence diagrams and stratigraphic maps. One field trip at student expense is required. Prerequisite: Concurrent with Geology 3620.

GEOLOGY 3811 Fundamentals Of Geographic Information Systems (LAB 1.0 and LEC 2.0)

Introduction to the fundamental concepts and components of Geographic Information Systems. Techniques for acquiring, manipulating and analyzing digital terrain data for geological and geotechnical applications. (Co-listed with Geo Eng 3148).

GEOLOGY 4000 Special Problems (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

GEOLOGY 4001 Special Topics (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

GEOLOGY 4010 Seminar (LEC 0.50)

Discussion of current topics. Required for two semesters during senior year. (Course cannot be used for graduate credit). Prerequisite: Senior standing.

GEOLOGY 4085 Internship (IND 3.0)

Students will select, with the advice of their advisor, appropriate problems for investigation through practical application of fundamental geoscience principles. The problems selected must provide higher level experiential learning. Assessment is based upon the quality of written and oral presentations and supervisor's evaluation. Prerequisite: Advisor's approval.

GEOLOGY 4097 Advanced Field Geology (LEC 3.0)

Advanced instruction in theory and practice of qualitative and quantitative description of spatial relationships of rock types in areas exhibiting complex deformation. Emphasis on experiential learning where students plan, implement, and reflect on outcomes for several scientific field campaigns in a manner consistent with professional scientific practices. Students will be charged a fee to cover the cost of field trip expenses. Prerequisites: GEOLOGY 2610, 2620, 3310, 3620, 3629, and 2096.

GEOLOGY 4099 Undergraduate Research (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

GEOLOGY 4211 Electrical Methods In Geophysics (LEC 3.0)

The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 5325 and Geophysics 3221.

GEOLOGY 4310 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 Geo Eng 5144).

GEOLOGY 4411 Hydrogeology (LAB 1.0 and LEC 2.0)

This course discusses geologic aspects of major surface and subsurface hydrologic systems of North America. Chemical and physical relationships between groundwater and fractures, faults, karst, subsurface pressures, mineral deposits plus both contaminant and hydrocarbon migration are discussed. Prerequisites: Geo Eng 1150 or Geology 1110, Geology 3620 recommended.

GEOLOGY 4421 Radioactive Waste Management And Remediation (LEC 3.0)

Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal options, regulatory control, materials issues, site selection and geologic characterization, containment, design and monitoring requirements, domestic and foreign waste disposal programs, economic and environmental issues; history of disposal actions, and conduct of remedial actions and cleanup. Prerequisite: Math 3304. (Co-listed with Nuc Eng 4367).

GEOLOGY 4431 Methods Of Karst Hydrogeology (LEC 3.0)

Familiarize geoscientists with the origin and identification of karst features, discuss groundwater movement, engineering problems, water quality and supply in karst areas, and teach investigative techniques including fluorescent dye tracing. Several field trips at student expense will be required. Prerequisite: Geology 1110 or Geo Eng 1150; Geology 3620.

GEOLOGY 4441 Applied Geochemistry (LAB 1.0 and LEC 2.0)

Application of the principles of geochemistry and techniques of geochemical analysis in a student research project investigating geochemical processes (mineral deposits, environmental geochemistry, trace element migration, or water-rock interaction). Field trip fee required. Prerequisites: Geology 2610 and Geology 3410.

GEOLOGY 4451 Aqueous Geochemistry (LEC 3.0)

Studies of the interaction of water with minerals and organic materials at low temperatures; including processes affecting the migration of elements (alteration, precipitation, and adsorption), the influence of geochemical processes on water composition, weathering, soil formation, and pollution. Field trip fee required. Prerequisite: Geology 3410.

GEOLOGY 4461 Isotope Geochemistry (LAB 1.0 and LEC 2.0)

Introduction to the fundamentals of radiogenic and stable isotopes as used to understand geologic processes. The use of selected isotopic systems in petrology, ore petrogenesis, paleontology, and the global climate systems will be discussed. Prerequisites: Geology 2620, 3620, 3410.

GEOLOGY 4521 Ore Microscopy (LAB 2.0 and LEC 1.0)

A study of polished sections of minerals and ores under reflected light. Includes the preparation of polished sections, the identification of ore minerals, and the study of the textures, associations, and alterations of ore minerals. Prerequisite: Geology 2610 and Geology 3511.

GEOLOGY 4630 Systematic Paleontology (LAB 1.0 and LEC 2.0)

Provide understanding of paleontological principles, morphological concepts, evolution of life, and applications/uses of fossils. Chronicles evolution and classification of microfossils, invertebrates, plants and palynomorphs. Emphasis on communication skills and team work. A compulsory field trip to The Field Museum (Chicago) may be at student expense. Prerequisite: Geology 1110 or Geology 1120 or Bio Sci 1113.

GEOLOGY 4631 Advanced Igneous and Metamorphic Petrology (LAB 1.0 and LEC 3.0)

Processes governing the formation of igneous and metamorphic rocks as constrained by geochemical, isotopic, and thermodynamic data, with particular reference to the relationship between rock suites and tectonic setting. The laboratory will emphasize the description of rock suites in hand sample and thin section. A field trip at the student's expense is required. Prerequisite: Geology 2620.

GEOLOGY 4711 Paleoclimatology and Paleocology (LEC 3.0)

This course will introduce students to the elements of climate, evidence of climate changes, proxy measurements and paleoclimate models. There is a review of Holocene climates and Archean to Pleistocene paleoclimates. Prerequisite: Geology 1110 or Geology 1120 or Geo Eng 1150.

GEOLOGY 4721 Meteorology and Climatology (LEC 3.0)

An introduction to the atmospheric and climatic systems of the Earth including weather, paleoclimatology, and global climate change. Prerequisites: GEOLOGY 1110 or GEOLOGY 1120 or equivalent.

GEOLOGY 4821 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 31+D151275 or consent of instructor. (Co-listed with Geo Eng 5146).

GEOLOGY 4831 Computational Geology (LAB 1.0 and LEC 2.0)

This course introduces the technology used for both surface and subsurface geologic mapping. It utilizes common systems and programs such as UNIX, Windows and industry-standard mapping applications. The goal of the course is to fully prepare students for their first professional assignment. Prerequisites: Geology 1110 or Geology 1120 or Geo Eng 1150.

GEOLOGY 4841 Geological Field Studies (LEC 3.0)

Intensive review of the scientific literature corresponding to a selected geographical region of geologic interest; followed by a 7 to 10 day long field trip to be held over spring break or after the end of the semester. Students will be expected to bear a portion of the field trip expenses. Repeatable for credit. Prerequisites: Geology 1110 or Geo Eng 1150.

GEOLOGY 5000 Special Problems (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

GEOLOGY 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.

GEOLOGY 5010 Seminar (LEC 0.50)

Discussion of current topics.

GEOLOGY 5040 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.

GEOLOGY 5085 Internship (IND 3.0)

Students will select, with their committee's advice, problems for investigation and preparation of a graduate research proposal. Problems must provide higher level experiential learning consistent with a graduate degree in geology. Assessment is based upon the quality of written and oral presentations and supervisor's evaluation. Repeatable for credit. Prerequisite: Graduate Standing.

GEOLOGY 5099 Research (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation.

GEOLOGY 5100 Professional Geoscience Skills (LEC 3.0)

Development and communication of complex topics in the geosciences is required for successful post-MS career advancement. Best practices for developing these skills in the geosciences will be critiqued weekly, culminating with poster and oral presentations. Assessment by peer-review and self-evaluation. Topics selected from geosciences careers. Prerequisites: Graduate Standing.

GEOLOGY 5111 Advanced Physical Geology (LEC 3.0)

Examination of topics concerned with the physical properties of earth materials, processes affecting change of the surface and interior of the earth, and the driving forces causing these changes. Weekly critical assessment of literature, and an oral presentation and term paper required. Prerequisite: Consent of instructor.

GEOLOGY 5121 Advanced Historical Geology (LAB 1.0 and LEC 2.0)

Study of the physical and biological history of the Earth beginning with the origin of the solar system up to the present. Emphasis will be placed on processes that shaped the Earth and its ecosystems. Prerequisite: Entrance requirements for the MST program in Earth Science.

GEOLOGY 5311 Depositional Systems (LEC 3.0)

Development of three dimensional depositional models using Walther's Law, Walther's Warning and seismic stratigraphy. Emphasis on overall geometries and internal porosity and permeability characteristics of aquifers and hydrocarbon reservoirs. Includes 3-D models for clastic, carbonate and evaporate sequences. Prerequisites: Geology 1110 or Geo Eng 1150; accompanied or preceded by both Geology 3310 and Geology 3620.

GEOLOGY 5510 Organic Geochemistry (LEC 3.0)

This course explores the carbon cycle, the history and inventory of organic matter on Earth, the transport of organic matter in aqueous systems, the burial of organic matter, the maturation of organic matter to become petroleum, and organic contaminants in the environment. Prerequisites: Graduate standing or consent of instructor.

GEOLOGY 5511 Applied Petroleum Geology (LAB 2.0 and LEC 1.0)

The principles of petroleum geology are applied in solving hydrocarbon exploration and developmental problems. Geological and economical techniques for evaluating hydrocarbonbearing reservoirs are presented, with methods for decisionmaking under conditions of extreme uncertainty. Prerequisite: Consent of instructor.

GEOLOGY 5513 Petroleum Geology (LAB 1.0 and LEC 2.0)

Principles of origin, migration, and accumulation of oil and gas. The laboratory introduces the procedures used for exploration, and development of hydrocarbon resources. Prerequisites: Geology 1110 or Geo Eng 1150; accompanied or preceded by both Geology 3310 and Geology 3620.

GEOLOGY 5521 Coal Petrology (LEC 3.0)

Formation, composition, and properties of coals. Discussion of the geology of selected coal deposits, the analysis of coal, and the optical identification of coal minerals. Prerequisite: Permission of instructor.

GEOLOGY 5611 Granites And Rhyolites (LAB 1.0 and LEC 3.0)

Processes governing the generation and crystallization of felsic magma will be covered, with specific reference to: 1) crust vs mantle sources, 2) melt migration and emplacement, 3) magma chamber dynamics, 4) the volcanic-plutonic connection, and 5) the relationship to tectonic setting. A field trip at the student's expense is required. Prerequisite: Geology 2620.

GEOLOGY 5631 Carbonate Petrology (LAB 1.0 and LEC 2.0)

Petrology, chemistry and sedimentology of carbonates and other associated chemical sedimentary rocks. Prerequisites: GEOLOGY 2620, 3620 and CHEM 1320 or equivalent; GEOLOGY 3410 recommended.

GEOLOGY 5641 Advanced Igneous Petrology (LAB 1.0 and LEC 2.0)

The genesis of eruptive rocks as evidenced by the physico-chemical conditions of formation of their constituent minerals. A critical examination of various magmatic processes. Use of advanced petrographic techniques. Prerequisites: GEOLOGY 4631.

GEOLOGY 5661 Advanced Stratigraphy and Basin Evolution (LEC 3.0)

Advanced topics in sedimentary geology including: tectonic controls on sedimentary basin development, global sequence stratigraphy, regional facies and diagenetic patterns, basin hydrogeology, thermal evolution of basins and distribution of economic resources. This course should be preceded or accompanied by Geology 3410. Prerequisites: Geology 3620 and Geology 3310.

GEOLOGY 5671 Clay Mineralogy (LAB 1.0 and LEC 2.0)

Mineral structure, geochemical properties, occurrence, environment, and uses of clays. Determination of physical properties, optics, x-ray diffraction, and thermal features of clays. Field trip fee required. Prerequisites: Geology 2610 and 3410, or Chem 2310, or Civ Eng 5715, or Geo Eng 5172.

GEOLOGY 5679 Field and Laboratory Studies in Earth Science (LAB 3.0)

Hands-on laboratory and field experiences in the Earth Sciences. This course is designed to be taught in an intensive three week session during the summer on the S&T campus. Prerequisites: GEOLOGY 2096 or 5121 or equivalents.

GEOLOGY 5681 Lidar Principles and Application (LEC 3.0)

Provides a comprehensive understanding of light detection and ranging (lidar) technology as it has been developed for commercial use; various methods of deploying technology for collection of data for mapping, engineering and science, and application of the data using specialized software for editing and processing point cloud data. Assumes GIS experience. Prerequisite: Senior or graduate standing.

GEOLOGY 5741 Micropaleontology (LAB 1.0 and LEC 2.0)

This course studies the fossil and soft-body characteristics of bacteria, protists, microinvertebrates and organic-walled microfossils (palynomorphs). Focused discussions on systematics, evolutionary histories, paleoecology, and geologic applications of the microfossil groups. Extraction of foraminifera and palynomorphs from rocks in lab. Prerequisite: Geology 4630.

GEOPHYS 2211 Geophysical Imaging (LAB 1.0 and LEC 2.0)

A study of the major geophysical methods applicable to shallow engineering and environmental geoscience. Topics include the background theory and practical application of gravity, magnetics, radiometrics, resistivity, induced polarization, spontaneous potential, reflection and refraction seismics, ground penetrating radar, electromagnetics, and borehole logging methods. Prerequisites: Physics 2135; Geo Eng 1150 or Geology 1110.

GEOPHYS 3001 Special Topics (LEC 0.0-6.0)

This course is designed to give the department an opportunity to test a new course.

GEOPHYS 3210 Introduction to Geophysics (LEC 3.0)

An introduction to a broad area of solid earth geophysics and exploration geophysics. Topics include plate tectonics, earthquake study, structure and dynamics of the Earth's deep interior, gravity, magnetism, heat flow, and geophysical exploration for natural resources. Prerequisites: Geology 1110.

GEOPHYS 3211 Introduction To Geophysical Data Analysis (LEC 3.0)

The application of time series and spatial series analysis techniques to geophysical data. Topics covered include digitization and aliasing of geophysical signals, frequency and wavenumber spectra, digital filtering and linear systems theory. Prerequisites: Math 2222 and Comp Sci 1570, 1970 & 1980, or 1971 & 1981.

GEOPHYS 3221 Potential Field Theory (LEC 3.0)

The mathematics and physics of gravitational, magnetic, and electrical fields of the earth as derived from potential functions, with applications to practical problems. The theorems of Laplace, Poisson, Gauss, and Green and their applications to geophysics are presented. Prerequisite: Accompanied or preceded by Math 5325.

GEOPHYS 4000 Special Problems (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

GEOPHYS 4001 Special Topics (LAB 1.0 and LEC 2.0)

This course is designed to give the department an opportunity to test a new course. Variable title.

GEOPHYS 4099 Undergraduate Research (IND 0.0-6.0)

Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

GEOPHYS 4231 Seismic Interpretation (LAB 1.0 and LEC 2.0)

An introduction to 2-D/3-D seismic structural interpretation, stratigraphic interpretation, reservoir identification and evaluation, and horizon and formation attributes. The students are expected to master interactive 2-D/3-D seismic interpretation software packages that are routinely used in the petroleum industry. Prerequisites: Math 1208, Math 1211, or Math 1214; Geology 1110 or Geo Eng 1150.

GEOPHYS 4241 Electrical Methods In Geophysics (LAB 1.0 and LEC 2.0)

The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 5325 and Geophysics 2211 or Geophysics 3251.

GEOPHYS 4261 Geophysical Instrumentation (LAB 1.0)

Field and laboratory practice in the use of geophysical instrumentation. Techniques of geophysical data reduction and interpretation are also covered. May be taken more than once for credit with Geophysics 4241 and Geophysics 384. Prerequisite: Concurrent registration in Geophysics 3251, 283 or 384.

GEOPHYS 5000 Special Problems (IND 0.0-6.0)

Problems or readings on specific subjects or projects in the department. Consent of instructor required.

GEOPHYS 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.

GEOPHYS 5010 Seminar (LEC 0.50)

Discussion of current topics.

GEOPHYS 5040 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.

GEOPHYS 5096 Global Tectonics (LEC 3.0)

An integrated view of the Earth's structure and dynamics with an emphasis on information gained through geophysical methods. Topics include seismology, heat flow, gravity, rheological and compositional structure, plate motions and intermotions, and mantle driving mechanisms for plate tectonics. Prerequisite: Geology 3310.

GEOPHYS 5099 Research (IND 0.0-15)

Investigations of an advanced nature leading to the preparation of a thesis or dissertation. Consent of instructor required.

GEOPHYS 5202 Exploration and Development Seismology (LAB 1.0 and LEC 2.0)

Principles of reflection seismology as applied to the delineation of geologic structures and the determination of stratigraphy and lithology. Emphasis on both the capabilities and limitations of the seismic method. The laboratory utilizes both modeled and actual seismic data. Prerequisites: Math 1208, Math 1211, or Math 1214; Geology 1110 or Geo Eng 1150.

GEOPHYS 5211 Seismic Stratigraphy (LAB 1.0 and LEC 2.0)

A study of the seismic expression of depositional models. Reflection patterns and reflection amplitudes are interpreted to determine bed thicknesses, fluid content, depositional environment, and lithology. Special data acquisition and processing techniques are examined. Prerequisites: Geophys 4521, Geology 3310, 3620.

GEOPHYS 5221 Wave Propagation (LEC 3.0)

A study of Hamilton's principle and energy theorems, fundamentals of plane wave theory, waves in stratified fluids, elastic waves in solids, electromagnetic and hydromagnetic radiation, and Allen's functions and point sources. Prerequisites: Geophys 281, 3221.

GEOPHYS 5231 Seismic Data Processing (LAB 1.0 and LEC 2.0)

Introduction to seismic data processing. Topics to be covered include statics corrections, filtering, velocity analysis, deconvolution, stacking and migration. The course has a field component to record seismic data. If this is offered in the summer, an off-campus trip may be needed. Extra fee may be charged to cover the field expenses. Prerequisites: Geophys 3210 or Geophys 5202.

GEOPHYS 5241 Advanced Electrical And Electromagnetic Methods In Geophysical Exp (LAB 1.0 and LEC 2.0)

Theory of the electrical geophysical methods as applied to subsurface investigations addressing geologic, engineering, groundwater and contaminant transport problems. Course content includes both passive and active methods and recent advances in the application of these methods. Course will include a field component illustrating application of techniques to local problems. Prerequisites: Geophys 3251, Math 2222.

GEOPHYS 5261 Computational Geophysics (LAB 2.0 and LEC 1.0)

Scientific programming in a UNIX/Linux environment, with emphasis on solving geophysical problems such as linear and nonlinear inversion, spectral analysis, seismicity, seismic wave attenuation, shear-wave splitting, and seismic tomography. Prerequisite: Geophys 3210.

GEOPHYS 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 Geo Eng 5736).

GEOPHYS 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 Geo Eng 5761 and Civ Eng 5750).

GEOPHYS 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 Geo Eng 5782).
