Geology and Geological Engineering

Program Description

A Bachelor of Science degree in Geological Engineering is the basis for careers concentrating on the interaction of humans and the earth. Geological Engineers deal with a wide variety of the resource and environmental problems that come with accommodating more and more people on a finite planet. Geologic hazards and conditions must be recognized and considered in the location and design of foundations for buildings, roads, and other structures; waste disposal facilities must be properly located, designed, and constructed; contaminated sites and groundwater must be accurately characterized before cleanup can be accomplished; water supplies must be located, developed, and protected; and new mineral and energy resources must be located and developed in an environmentally sound manner. Geological Engineers are the professionals trained to meet these challenges.

The Geological Engineering curriculum provides a strong foundation in the basic sciences, mathematics, geological science, and basic engineering along with specialized upper-level instruction in integrated applications to real problems. Engineering design is integrated throughout the four-year program, beginning in Design I (Freshman year) and ending with the capstone design courses in the senior year.

Students have the background to take the Fundamentals of Engineering Exam, the first step in becoming a registered Professional Engineer, as well as the Fundamentals of Geology Exam, the first steps towards registration as a Professional Geologist.

Graduates follow five general career paths:

Engineering Geology and Geotechnics. Careers in site investigation, design and stabilization of foundations and slopes; site characterization, design, construction and remediation of waste disposal sites or contaminated sites; and assessment of geologic hazards for civil, mining or environmental engineering projects.

Groundwater Engineering. Careers in assessment and remediation of groundwater contamination, design of groundwater control facilities for geotechnical projects and exploration for and development of groundwater supplies.

Petroleum Exploration and Development Engineering. Careers in the search for and development of oil and gas and their efficient extraction.

Mineral Exploration and Development Engineering. Careers in the search for and development of natural deposits of metals, industrial materials and rock aggregate.

Geological Science. Students are also well prepared to pursue careers in basic geoscience. Graduates have become experts in fields as divergent as global climate change, the early history of the Earth, planetary science, fractal representation of groundwater flow, and simulation of sedimentary rock sequences, to name a few. Careers are available in research and education.

The curriculum may be followed along three concentration paths with slightly different upper-division requirements. The concentrations are identical in the first two years as students study basic science, mathematics, engineering science, and geological science. In the junior year, those students pursuing careers in environmental geoscience or groundwater engineering follow the Environmental Geosciences concentration. Students pursuing careers in engineering geology, geotechnical engineering and geotechnics follow the Engineering Geology and Geotechnics concentration. Students anticipating careers in resource exploration and development or who expect to pursue graduate studies in geological sciences follow the Mineral and Energy Resources Exploration concentration.

At all levels the Geological Engineering Program emphasizes laboratory and field experience. All courses have a laboratory session, and after the junior year students participate in a field course, which is five weeks of geologic and engineering mapping and direct observation. The course involves considerable time outdoors in the mountains and canyons of Utah and Colorado.

At the senior level, students begin to focus on a career path by taking course sequences in at least two areas of geological engineering specialization. The course sequences begin with a 4-unit course in the fundamentals of a field of geological engineering which is followed by a 3-unit design-oriented course that emphasizes experience in direct application of principles through design projects.

Program Educational Objectives (Bachelor of Science in Geological Engineering)

In addition to contributing toward achieving the educational objectives described in the CSM Graduate Profile and the ABET accreditation criteria, the Geological Engineering program at CSM has established the following program educational objectives, which students are expected to attain within a few years of graduation:

1. Demonstrate a high level of technical competence
2. Demonstrate prowess in written, oral and graphical communication
3. Experience good teamwork and leadership practices

Student Learning Outcomes

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

ABET Accreditation Status

The Bachelor of Science in Geological Engineering is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org/, under the commission's General Criteria and Program Criteria for Geological and Similarly Named Engineering Programs.

Program Requirements

In order to achieve the program goals listed above, every student working toward the Bachelor of Science Degree in Geological Engineering must complete the following requirements:

Program Requirements

In order to achieve the program goals listed above, every student working toward the Bachelor of Science Degree in Geological Engineering must complete the following requirements:

Degree Requirements (Geological Engineering)

Following the sophomore year, Geological Engineering students choose from one of three tracks:

1. Environmental Geosciences
2. Engineering Geology and Geotechnics
3. Mineral and Energy Resources Exploration

ENVIRONMENTAL GEOSCIENCES TRACK

Recommended for students intending careers in environmental geoscience or groundwater engineering.

Freshman

Fall		lec	lab	sem.hrs
GEGN101	EARTH AND ENVIRONMENTAL SYSTEMS			4.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
				16.0

Total Semester Hrs: 16.0

Freshman

Spring		lec	lab	sem.hrs
PHGN100	PHYSICS I - MECHANICS			4.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II	4.0		4.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
HASS100	NATURE AND HUMAN VALUES			3.0
SUCCESS AND WELLNESS				1.0
				15.0

Total Semester Hrs: 15.0

Sophomore

Fall		lec	lab	sem.hrs
GEGN203	ENGINEERING TERRAIN ANALYSIS			3.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
CEEN241	STATICS			3.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
HASS215	FUTURES			3.0
				17.0

Total Semester Hrs: 17.0

Sophomore

Spring		lec	lab	sem.hrs
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CEEN311	MECHANICS OF MATERIALS			3.0
GEGN212	THE ROCK CYCLE			4.0
GEGN217	GEOLOGIC FIELD METHODS			2.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
ELECTIVE (CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective				3.0
				17.0

Total Semester Hrs: 17.0

Junior

Fall		lec	lab	sem.hrs
FREE Free Elective				3.0
GEOL309	STRUCTURAL GEOLOGY AND TECTONICS			4.0
EBGN201	PRINCIPLES OF ECONOMICS			3.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
				13.0

Total Semester Hrs: 13.0

Junior

Spring		lec	lab	sem.hrs
CEEN312	SOIL MECHANICS			3.0
CEEN312L	SOIL MECHANICS LABORATORY			1.0
GEGN432	GEOLOGICAL DATA MANAGEMENT			3.0
GEOL314	STRATIGRAPHY			4.0
GEGN317	GEOLOGIC FIELD SKILLS			1.0
GEGN351	GEOLOGICAL FLUID MECHANICS			3.0
				15.0

Total Semester Hrs: 15.0

Junior

Summer		**lec**	**lab**	**sem.hrs**
GEGN316	FIELD GEOLOGY			5.0
				5.0

Total Semester Hrs: 5.0

Senior

Fall		**lec**	**lab**	**sem.hrs**
CHGN406	INTRODUCTION TO GEOCHEMISTRY	3.0	3.0	3.0
CHGN499L - Lab will be added in CIM as CHGN406L			1.0	1.0
GEGN466	GROUNDWATER ENGINEERING			3.0
GEGN466L	GROUNDWATER ENGINEERING			1.0
GEGN4XX RESTRICTED ELECTIVE 1				3.0
ELECTIVE CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective		3.0		3.0
FREE Free Elective		3.0		3.0
				17.0

Total Semester Hrs: 17.0

Senior

Spring		**lec**	**lab**	**sem.hrs**
GEGN4XX ENVIRONMENTAL GEOSCIENCES DESIGN				3.0
GEGN470	GROUND-WATER ENGINEERING DESIGN			3.0
GEGN475	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS			3.0
REST4XX RESTRICTED ELECTIVE 2				3.0
ELECTIVE CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective		3.0		3.0
				15.0

Total Semester Hrs: 15.0

Degree Total 130.0
RESTRICTED ELECTIVE 1 must be selected from GEGN 473 GE Site Investigation, GEOL 4XX Paleoclimate, or GEGN 4XX Surface Water Hydrology
RESTRICTED ELECTIVE 2 must be a 400- or 500-level GEGN, GEOL or GPGN course

Engineering Geology and Geotechnics Track

Recommended for students intending careers in engineering geology, geotechnics or geotechnical engineering careers.

Freshman

Fall		**lec**	**lab**	**sem.hrs**
GEGN101	EARTH AND ENVIRONMENTAL SYSTEMS			4.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
				16.0

Total Semester Hrs: 16.0

Freshman

Spring		**lec**	**lab**	**sem.hrs**
PHGN100	PHYSICS I - MECHANICS			4.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II	4.0		4.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
HASS100	NATURE AND HUMAN VALUES			3.0
S&W SUCCESS AND WELLNESS				1.0
				15.0

Total Semester Hrs: 15.0

Sophomore

Fall		**lec**	**lab**	**sem.hrs**
GEGN203	ENGINEERING TERRAIN ANALYSIS			3.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
CEEN241	STATICS			3.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
HASS215	FUTURES			3.0
				17.0

Total Semester Hrs: 17.0

Sophomore

Spring		**lec**	**lab**	**sem.hrs**
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CEEN311	MECHANICS OF MATERIALS			3.0
GEGN212	THE ROCK CYCLE			4.0
GEGN217	GEOLOGIC FIELD METHODS			2.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0
ELECTIVE CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective				3.0
				17.0

Total Semester Hrs: 17.0

Junior

Fall		**lec**	**lab**	**sem.hrs**
MNGN321	INTRODUCTION TO ROCK MECHANICS			3.0
GEOL309	STRUCTURAL GEOLOGY AND TECTONICS			4.0
EBGN201	PRINCIPLES OF ECONOMICS			3.0

MATH225	DIFFERENTIAL EQUATIONS	3.0
		13.0

Total Semester Hrs: 13.0

Junior

Spring		**lec**	**lab**	**sem.hrs**
CEEN312	SOIL MECHANICS			3.0
CEEN312L	SOIL MECHANICS LABORATORY			1.0
GEGN432	GEOLOGICAL DATA MANAGEMENT			3.0
GEOL314	STRATIGRAPHY			4.0
GEGN317	GEOLOGIC FIELD SKILLS			1.0
GEGN351	GEOLOGICAL FLUID MECHANICS			3.0
				15.0

Total Semester Hrs: 15.0

Junior

Summer		**lec**	**lab**	**sem.hrs**
GEGN316	FIELD GEOLOGY			5.0
				5.0

Total Semester Hrs: 5.0

Senior

Fall		**lec**	**lab**	**sem.hrs**
GEGN468	ENGINEERING GEOLOGY AND GEOTECHNICS	3.0	3.0	4.0
GEGN466	GROUNDWATER ENGINEERING			3.0
GEGN466L	GROUNDWATER ENGINEERING			1.0
GEGN473	GEOLOGICAL ENGINEERING SITE INVESTIGATION			3.0
ELECTIVE CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective		3.0		3.0
FREE Free Elective		3.0		3.0
				17.0

Total Semester Hrs: 17.0

Senior

Spring		**lec**	**lab**	**sem.hrs**
GEGN469	ENGINEERING GEOLOGY DESIGN			3.0
GEGN470	GROUND-WATER ENGINEERING DESIGN			3.0
GEGN475	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS			3.0
FREE Free Elective				3.0
ELECTIVE CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective		3.0		3.0
				15.0

Total Semester Hrs: 15.0

Degree Total 130.0

Students in the Engineering Geology and Geotechnics track may further specialize by utilizing their free elective courses to emphasize a specific specialty. Suggested courses are presented below and should be selected in consultation with the student's advisor. The emphasis area is an informal designation only and it will not appear on the transcript.

MINERAL AND ENERGY RESOURCES Track

Recommended for students intending careers in exploration and development of mineral and energy resources or intending careers in geoscience research and education.

Freshman

Fall		**lec**	**lab**	**sem.hrs**
GEGN101	EARTH AND ENVIRONMENTAL SYSTEMS			4.0
MATH111	CALCULUS FOR SCIENTISTS AND ENGINEERS I			4.0
CHGN121	PRINCIPLES OF CHEMISTRY I			4.0
EDNS151	CORNERSTONE - DESIGN I			3.0
CSM101	FRESHMAN SUCCESS SEMINAR			1.0
				16.0

Spring		**lec**	**lab**	**sem.hrs**
PHGN100	PHYSICS I - MECHANICS			4.0
MATH112	CALCULUS FOR SCIENTISTS AND ENGINEERS II			4.0
CSCI128	COMPUTER SCIENCE FOR STEM			3.0
HASS100	NATURE AND HUMAN VALUES			3.0
S&W	SUCCESS AND WELLNESS			1.0
				15.0

Sophomore

Fall		**lec**	**lab**	**sem.hrs**
GEGN203	ENGINEERING TERRAIN ANALYSIS			3.0
CHGN122	PRINCIPLES OF CHEMISTRY II (SC1)			4.0
CEEN241	STATICS			3.0
MATH213	CALCULUS FOR SCIENTISTS AND ENGINEERS III			4.0
HASS215	FUTURES			3.0
				17.0

Spring		**lec**	**lab**	**sem.hrs**
PHGN200	PHYSICS II-ELECTROMAGNETISM AND OPTICS			4.0
CEEN311	MECHANICS OF MATERIALS			3.0
GEGN212	THE ROCK CYCLE			4.0
GEGN217	GEOLOGIC FIELD METHODS (GEOLOGIC FIELD METHODS)	1.0	8.0	2.0
CSM202	INTRODUCTION TO STUDENT WELL-BEING AT MINES			1.0

ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
				17.0
Junior				
Fall		**lec**	**lab**	**sem.hrs**
GEOL309	STRUCTURAL GEOLOGY AND TECTONICS			4.0
GEOL321	MINERALOGY AND MINERAL CHARACTERIZATION			3.0
MATH225	DIFFERENTIAL EQUATIONS			3.0
EBGN321	ENGINEERING ECONOMICS*For the 2023 Catalog EBGN321 replaced EBGN201 as a Core requirement. EBGN321 was added to the core, but has a prerequisite of 60 credit hours. Students whose programs that required EBGN201 the sophomore year may need to wait to take EBGN321 until their junior year. For complete details, please visit: https://www.mines.edu/registrar/core-curriculum/			3.0
				13.0
Spring		**lec**	**lab**	**sem.hrs**
GEGN432	GEOLOGICAL DATA MANAGEMENT			3.0
GEGN307	PETROLOGY			4.0
GEOL314	STRATIGRAPHY	3.0	3.0	4.0
GEGN317	GEOLOGIC FIELD SKILLS (GEOLOGIC FIELD SKILLS)	1.0	4.0	1.0
ELECTIVE	CULTURE AND SOCIETY (CAS) Mid-Level Restricted Elective			3.0
				15.0
Summer		**lec**	**lab**	**sem.hrs**
GEGN316	FIELD GEOLOGY			5.0
				5.0
Senior				
Fall		**lec**	**lab**	**sem.hrs**
GEGN401	MINERAL DEPOSITS			4.0
GEGN438	PETROLEUM GEOLOGY			4.0
CEEN312	SOIL MECHANICS or MNGN 321 (RESTRICTED ELECTIVE)			3.0
ELECTIVE	CULTURE AND SOCIETY (CAS) 400-Level Restricted Elective	3.0		3.0
FREE	Free Elective			3.0
				17.0
Spring		**lec**	**lab**	**sem.hrs**
GEGN403	MINERAL EXPLORATION DESIGN			3.0
GEGN439	PETROLEUM EXPLORATION DESIGN			3.0
GEGN475	APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS			3.0
RESTRICTED ELECTIVE	Choose from list below.			3.0
FREE	Free Elective			3.0
				15.0

Total Semester Hrs: 130.0

The Mines guidelines for Minor/ASI can be found in the Undergraduate Information section of the Mines Catalog.

Geological Engineering Minor and Area of Special Interest

To receive a minor or ASI, a student must take at least 12 (ASI) or 18 (minor) credits of a logical sequence of courses. This may include GEGN101 (4 credits) and up to 4 credits at the 200-level.

Students must consult with the department to have their sequence of courses approved before embarking on a minor program.

Courses

GEGN101. EARTH AND ENVIRONMENTAL SYSTEMS. 4.0 Semester Hrs.
Equivalent with SYGN101,
(I, II, S) Fundamental concepts concerning the nature, composition and evolution of the lithosphere, hydrosphere, atmosphere and biosphere of the earth integrating the basic sciences of chemistry, physics, biology and mathematics. Understanding of anthropological interactions with the natural systems, and related discussions on cycling of energy and mass, global warming, natural hazards, land use, mitigation of environmental problems such as toxic waste disposal, exploitation and conservation of energy, mineral and agricultural resources, proper use of water resources, biodiversity and construction. 3 hours lecture, 3 hours lab; 4 semester hours.

GEGN198. SPECIAL TOPICS. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEGN199. INDEPENDENT STUDY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEGN203. ENGINEERING TERRAIN ANALYSIS. 3.0 Semester Hrs.
Geomorphology of landscapes and the physical processes that shape them. Landform morphology, evolution and complex connections to climatic, tectonic, geologic, biotic, anthropogenic and geomorphic processes. Theoretical and practical introduction to weathering, hillslopes, drainage systems, rivers and glaciers. Collection, analysis and interpretation of geomorphic data and maps. Applications of geomorphic information to solve geological engineering problems with emphasis on ethical and environmental considerations. Course will include fieldwork in Colorado, with analysis of landforms and geomorphic processes. 2 hours lecture, 3 hours lab; 3 semester hours. Prerequisite: GEGN101, MATH111.

GEGN212. THE ROCK CYCLE. 4.0 Semester Hrs.
Introduction to Earth materials. This course will teach foundations of mineralogy and petrology in lecture, including an introduction to crystal chemistry and mineral classification schemes and the concepts of rock forming processes as a basis for rock classification. Students will be able to link chemistry, mineralogy, and tectonic processes to rock forming processes and the associated rock classification. The associated laboratory will focus on practical skills used to identify minerals and rocks in hand sample. Prerequisite: CHGN122 or CHGN125. Co-requisite: GEGN217.
Course Learning Outcomes

- Students will be able to: 1. Analyze physical properties of minerals for identification and recall chemical information based on mineral ID.
- Students will be able to: 2. Classify minerals based on crystallographic structures and relate mineral structure to physical properties.
- Students will be able to: 3. Describe igneous, metamorphic, and sedimentary rocks and classify them according to standard classification schemes.
- Students will be able to: 4. Construct conceptual models of tectonic environments and compare temperature and pressure gradients between different environments.
- Students will be able to: 5. Relate rock composition and texture to tectonic environments and construct rock history from observations.

GEGN217. GEOLOGIC FIELD METHODS. 2.0 Semester Hrs.
Methods and techniques of geologic field observations and interpretations. Lectures in field techniques and local geology. Laboratory and field project in diverse sedimentary, igneous, metamorphic, structural, and surficial terrains using aerial photographs and topographic maps. Geologic cross sections, maps, and reports. Weekend exercises required. Prerequisite: GEGN101.
Course Learning Outcomes

- Students will be able to: 1. Systematically describe sedimentary, igneous and metamorphic rocks in the field
- Students will be able to: 2. Read and interpret topographic maps and construct topographic profiles
- Students will be able to: 3. Measure and record structural data and plot data on a map
- Students will be able to: 4. Interpret the nature of geological contacts in the field (conformable, unconformable, fault and intrusive contacts) and map locations on a base map
- Students will be able to: 5. Construct 1:1 scale geological cross sections
- Students will be able to: 6. Interpret geological histories from geological maps and cross sections

GEGN298. SPECIAL TOPICS. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEGN299. INDEPENDENT STUDY IN ENGINEERING GEOLOGY OR ENGINEERING HYDROGEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEGN307. PETROLOGY. 4.0 Semester Hrs.
Equivalent with GEOL307,
An introduction to igneous, sedimentary and metamorphic processes, stressing the application of chemical and physical mechanisms to study the origin, occurrence, and association of rock types. Emphasis on the megascopic and microscopic classification, description, and interpretation of rocks. Analysis of the fabric and physical properties. Prerequisite: GEOL321.
Course Learning Outcomes

- No change

GEGN316. FIELD GEOLOGY. 5.0 Semester Hrs.
Six weeks of field work, stressing geology of the Southern Rocky Mountain Province. Mapping of igneous, metamorphic, and sedimentary terrain using air photos, topographic maps, and other methods. Diversified individual problems in petroleum geology, mining geology, engineering geology, structural geology, and stratigraphy. Formal reports submitted on several problems. Frequent evening lectures and discussion sessions. Field trips emphasize regional geology as well as mining, petroleum, and engineering projects. Prerequisite: GEGN203, GEGN212 or GEOL314, GEGN317.
Course Learning Outcomes

- No changes

GEGN317. GEOLOGIC FIELD SKILLS. 1.0 Semester Hr.
Advanced methods and techniques of geologic field observations and interpretations. Field mapping projects in diverse sedimentary, igneous, metamorphic, structural, and surficial terrains using aerial photographs and topographic maps. Geologic cross sections, maps, and reports. Weekend exercises required. Course includes an introduction to camping skills and working in remote field locations. Prerequisite: GEGN217, GEGN212, GEOL309. Co-requisite: GEOL314.
Course Learning Outcomes

- Students will be able to: 1. Describe, name and interpret sedimentary, igneous and metamorphic rocks in the field and use their interpretations to develop geological models.
- Students will be able to: 2. Measure and record complex structural data and plot data both on a map and stereonet. Use a stereonet to interpret structural domains and kinematics.
- Students will be able to: 3. Interpret complex geological contacts and juxtapositions in the field and map these contacts carefully and accurately on a base map.
- Students will be able to: 4. Construct 1:1 scale geological cross sections of deformed terrains from map and notebook data.
- Students will be able to: 5. Interpret geological histories from geological maps and cross sections and relate these interpretations to regional tectonic processes.

GEGN330. GEOSCIENTISTS THERMODYNAMICS. 3.0 Semester Hrs.
Introduction to fundamental principles of thermodynamics applied to geosciences and geoengineering. Thermodynamics are used as a tool for evaluating the stability and chemical transformation of minerals and rocks, evolution of vapors and liquids and their reaction paths when subjected to different P-T geological regimes. The course will focus on basic principles of thermodynamics and make use of examples relevant to geoscientists encompassing: i) calculation of thermodynamic properties (volume, heat capacity, enthalpy and entropy) as a function of

pressure, temperature and composition, ii) the study of heat transfer and volume change associated to chemical reactions and iii) evaluation of phase stabilities using Gibbs energy minimization and law of mass action. Introduction to pure phase properties, ideal and non-ideal solutions, activities, equilibrium constants, chemical potential, electrolytes, phase rule and Gibbs energy function. May not also receive credit for CHGN209 or CBEN210. Prerequisite: CHGN121, CHGN122 or CHGN125, MATH111, MATH112.

Course Learning Outcomes

- - Introduce basic principles of thermodynamics and their application to geological systems.
- - Predict the stability of minerals, liquids and vapors as a function of pressure and temperature.
- - Link thermodynamic predictions and basic principles with geological processes.
- - Learn to use the GEM-selektor software for calculation of thermodynamic properties as a function of pressure and temperature.

GEGN340. COOPERATIVE EDUCATION. 1-3 Semester Hr.
(I, II, S) Supervised, full-time, engineering-related employment for a continuous
six-month period (or its equivalent) in which specific educational objectives are achieved. Prerequisite: Second semester sophomore status and a cumulative grade-point average of at least 2.00. 1 to 3 semester hours. Cooperative
Education credit does not count toward graduation except under special conditions. Repeatable.

GEGN342. ENGINEERING GEOMORPHOLOGY. 3.0 Semester Hrs.
Study of interrelationships between internal and external earth processes, geologic materials, time, and resulting landforms on the Earth's surface. Influences of geomorphic processes on design of natural resource exploration programs and siting and design of geotechnical and geohydrologic projects. Laboratory analysis of geomorphic and geologic features utilizing maps, photo interpretation and field observations. 2 hours lecture, 3 hours lab; 3 semester hours. Prerequisite: GEGN101.

GEGN351. GEOLOGICAL FLUID MECHANICS. 3.0 Semester Hrs.
Properties of fluids; Bernoulli's energy equation, the momentum and mass equations; laminar and turbulent flow in pipes, channels, machinery, and earth materials; subcritical and supercritical flow in channels; Darcy's Law; the Coriolis effect and geostrophic flow in the oceans and atmosphere; sediment transport. 3 hours lecture; 3 semester hours. Prerequisite: CEEN241.

GEGN398. SEMINAR IN GEOLOGY OR GEOLOGICAL ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEGN399. INDEPENDENT STUDY IN ENGINEERING GEOLOGY OR ENGINEERING HYDROGEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEGN399. INDEPENDENT STUDY. 1-6 Semester Hr.

GEGN401. MINERAL DEPOSITS. 4.0 Semester Hrs.
Introductory presentation of magmatic, hydrothermal, and sedimentary metallic ore deposits. Chemical, petrologic, structural, and sedimentological processes that contribute to ore formation. Description of classic deposits representing individual deposit types. Review of exploration sequences. Laboratory consists of hand specimen study of host rock-ore mineral suites and mineral deposit evaluation problems. Prerequisite: GEGN307, GEGN316.

Course Learning Outcomes

- Understand what economic geologists do (exploration and mining geologists)
- Understand the interface between geology and mining engineering, metallurgy, and environmental science) .
- Understand the basic types of metallic mineral deposits through lectures, readings, and laboratory examination of samples.
- Enhance student’s reading and writing skills.
- Enhance student’s ability to solve mineral exploration problems utilizing geologic maps and cross sections.

GEGN403. MINERAL EXPLORATION DESIGN. 3.0 Semester Hrs.
(WI) Exploration project design: commodity selection, target selection, genetic models, alternative exploration approaches and associated costs, exploration models, property acquisition, and preliminary economic evaluation. Lectures and laboratory exercises to simulate the entire exploration sequence from inception and planning through implementation to discovery, with initial ore reserve calculations and preliminary economic evaluation. Prerequisite: GEGN401, GEGN475 (or concurrent enrollment).

Course Learning Outcomes

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GEGN404. ORE MICROSCOPY. 3.0 Semester Hrs.
Identification of ore minerals using reflected light microscopy, micro-hardness,
and reflectivity techniques. Interpretation of common ore mineral textures, including those produced by magmatic segregation, open space filling, replacement, exsolution, and recrystallization. Guided research on the ore mineralogy and ore textures of classical ore deposits. Prerequisite: GEOL321, GEGN401. 6 hours lab; 3 semester hours.

GEGN432. GEOLOGICAL DATA MANAGEMENT. 3.0 Semester Hrs.
(I, II, S) Techniques for managing and analyzing geological data, including statistical analysis procedures and computer programming. Topics addressed include elementary probability, populations and distributions, estimation, hypothesis testing, analysis of data sequences, mapping, sampling and sample representativity, linear regression, and overview of univariate and multivariate statistical methods. Practical experience with principles of software programming and statistical analysis for geological applications via suppled software and data sets from geological case histories. Prerequisites: Junior standing in Geological Engineering. 2 hours lecture; 3 hours lab; 3 semester hours.

Course Learning Outcomes

- 1. This course is intended to produce “computationally and statistically literate” geological engineers.
- 2. It combines experiences in computer programming with basic statistical methods useful to geologists and geological engineers.

- 3. Students will be exposed to “hands-on” data analysis and management issues with data sets representing various areas of geological study.

GEGN438. PETROLEUM GEOLOGY. 0-4 Semester Hr.
Source rocks, reservoir rocks, types of traps, temperature and pressure conditions of the reservoir, theories of origin and accumulation of petroleum, geology of major petroleum fields and provinces of the world, and methods of exploration for petroleum. Term report required. Laboratory consists of study of well log analysis, stratigraphic correlation, production mapping, hydrodynamics and exploration exercises. Prerequisite: GEOL308 or GEOL309 and GEOL314 or GEOL315; and GEGN316 or GPGN486 or PEGN316. 3 hours lecture, 3 hours lab; 4 semester hours.

GEGN439. PETROLEUM EXPLORATION DESIGN. 3.0 Semester Hrs.
Equivalent with PEGN439,
(WI) This is a multi-disciplinary design course that integrates fundamentals and design concepts in geology, geophysics, and petroleum exploration. Students work both individually and in teams on multiple open-ended design problems in oil and gas exploration, including integration of well and seismic reflection databases, seismic interpretation in different tectonostratigraphic settings, and the development of a prospects in a variety of exploration plays. Several detailed written and oral presentations are made throughout the semester. 2 hours lecture, 3 hours lab; 3 semester hours. Prerequisite: GEOL309, GEOL314, GEGN438.
Course Learning Outcomes

- Make internally consistent interpretations of a complex 3D dataset.
- Develop a strong skill set in seismic interpretation using Petrel.
- Develop integrated geological (structural and stratigraphic) interpretations of 3D seismic data.
- Integrate geological interpretations with geophysics and petroleum engineering sections in a design project to assess the petroleum potential of an area through presentations and reports.

GEGN466. GROUNDWATER ENGINEERING. 3.0 Semester Hrs.
Theory of groundwater occurrence and flow. Relation of groundwater to surface water; hydraulic head distribution and flow; theory of aquifer tests; water chemistry, water quality, and contaminant transport. Prerequisites:MATH213 or MATH223, MATH225 or MATH235.
Course Learning Outcomes

- No changes to current class outcomes

GEGN466L. GROUNDWATER ENGINEERING. 1.0 Semester Hr.
Laboratory and field methods for groundwater hydrology, including groundwater occurrence and flow and contaminant transport. Prerequisite: MATH213 or MATH223, MATH225 or MATH235. Co-requisite: GEGN466.

GEGN468. ENGINEERING GEOLOGY AND GEOTECHNICS. 4.0 Semester Hrs.
Application of geology to evaluation of construction, mining, and environmental projects such as dams, water ways, tunnels, highways, bridges, buildings, mine design, and land-based waste disposal facilities. Design projects including field, laboratory, and computer analysis are an important part of the course. Prerequisite: MNGN321 and CEEN312/ CEEN312L. 3 hours lecture, 3 hours lab, 4 semester hours.

GEGN469. ENGINEERING GEOLOGY DESIGN. 3.0 Semester Hrs.
(WI) This is a capstone design course that emphasizes realistic engineering geologic/geotechnics projects. Lecture time is used to introduce projects and discussions of methods and procedures for project work. Several major projects will be assigned and one to two field trips will be required. Students work as individual investigators and in teams. Final written design reports and oral presentations are required. 2 hours lecture, 3 hours lab; 3 semester hours. Prerequisite: GEGN468.

GEGN470. GROUND-WATER ENGINEERING DESIGN. 3.0 Semester Hrs.
(WI) Application of the principles of hydrogeology and ground-water engineering to water supply, geotechnical, or water quality problems involving the design of well fields, drilling programs, and/or pump tests. Engineering reports, complete with specifications, analysis, and results, will be required. 2 hours lecture, 3 hours lab; 3 semester hours. Prerequisite: GEGN 466 and 466L or equivalent, and GEGN351 or CEEN 310 or MEGN 351.
Course Learning Outcomes

- No change

GEGN473. GEOLOGICAL ENGINEERING SITE INVESTIGATION. 3.0 Semester Hrs.
Methods of field investigation, testing, and monitoring for geotechnical and hazardous waste sites, including: drilling and sampling methods, sample logging, field testing methods, instrumentation, trench logging, foundation inspection, engineering stratigraphic column and engineering soils map construction. Projects will include technical writing for investigations (reports, memos, proposals, workplans). Class will culminate in practice conducting simulated investigations (using a computer simulator).
Course Learning Outcomes

- No changes

GEGN475. APPLICATIONS OF GEOGRAPHIC INFORMATION SYSTEMS. 0-3 Semester Hr.
An introduction to Geographic Information Systems (GIS) and their applications to all areas of geology and geological engineering. Lecture topics include: principles of GIS, data structures, digital elevation models, data input and verification, data analysis and spatial modeling, data quality and error propagation, methods of GIS projects, as well as video presentations. Prerequisite: GEGN101. 2 hours lecture, 3 hours lab; 3 semester hours.

GEGN481. ANALYTICAL HYDROLOGY. 3.0 Semester Hrs.
Equivalent with GEGN581,
Introduction to the theory, and hydrological application of, probability, statistics, linear algebra, differential equations, numerical analysis, and integral transforms. Prerequisites: GEGN466. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- To introduce the student to the analysis of many types of hydrologic data using the tools from several mathematics courses, including basic probability and statistics, linear algebra, differential equations, and numerical. The course is also designed to develop the analytic skills necessary to understand and quantify hydrologic processes and problems.
- The class is designed to meet the Hydrologic Science and Engineering admission prerequisite of one semester each of Differential Equations and Probability/ Statistics.

GEGN483. MATHEMATICAL MODELING OF GROUNDWATER SYSTEMS. 3.0 Semester Hrs.
Lectures, assigned readings, and direct computer experience concerning the fundamentals and applications of analytical and finite-difference solutions to ground water flow problems as well as an introduction to inverse modeling. Design of computer models to solve ground water problems. Prerequisites: Familiarity with
computers, mathematics through differential and integral calculus, and GEGN466. 3 hours lecture; 3 semester hours.

GEGN497. SUMMER PROGRAMS. 0-15 Semester Hr.

GEGN498. SEMINAR IN GEOLOGY OR GEOLOGICAL ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEGN498. SPECIAL TOPICS. 1-6 Semester Hr.

GEGN498. SPECIAL TOPICS. 1-6 Semester Hr.

GEGN499. INDEPENDENT STUDY IN ENGINEERING GEOLOGY OR ENGINEERING HYDROGEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEGN499. INDEPENDENT STUDY. 1-6 Semester Hr.

GEOC407. ATMOSPHERE, WEATHER AND CLIMATE. 3.0 Semester Hrs.
(II) An introduction to the Earth’s atmosphere and its role in weather patterns and long term climate. Provides basic understanding of origin and evolution of the atmosphere, Earth’s heat budget, global atmospheric circulation and modern climatic zones. Long- and short-term climate change including paleoclimatology, the causes of glacial periods and global warming, and the depletion of the ozone layer. Causes and effects of volcanic eruptions on climate, El Nino, acid rain, severe thunderstorms, tornadoes, hurricanes, and avalanches are also discussed. Microclimates and weather patterns common in Colorado. Prerequisite: Completion of CSM freshman technical core, or equivalent. 3 hours lecture; 3 semester hours. Offered alternate years.

GEOC408. INTRODUCTION TO OCEANOGRAPHY. 3.0 Semester Hrs.
(II) An introduction to the scientific study of the oceans, including chemistry, physics, geology, biology, geophysics, and mineral resources of the marine environment. Lectures from pertinent disciplines are included. Recommended background: basic college courses in chemistry, geology, mathematics, and physics. 3 hours lecture; 3 semester hours. Offered alternate years.

GEOL102. INTRODUCTION TO GEOLOGICAL ENGINEERING. 1.0 Semester Hr.
Presentations by faculty members and outside professionals of case studies to provide a comprehensive overview of the fields of Geology and Geological Engineering and the preparation necessary to pursue careers in those fields. A short paper on an academic professional path will be required. 1 hour lecture; 1 semester hour. Prerequisite: GEGN101 or concurrent enrollment.

GEOL198. SEMINAR IN GEOLOGY OR GEOLOGICAL ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEOL199. INDEPENDENT STUDY IN GEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEOL199. INDEPENDENT STUDY. 1-6 Semester Hr.

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GEOL298. SPECIAL TOPICS. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEOL299. INDEPENDENT STUDY. 1-6 Semester Hr.

GEOL308. INTRODUCTORY APPLIED STRUCTURAL GEOLOGY. 3.0 Semester Hrs.
Nature and origin of structural features of Earth's crust emphasizing structural controls on oil and gas entrapment. Structural patterns and associations are discussed in context of plate tectonic theories, using examples from across the globe. In class exercises and field projects in structural geometry, mapping and cross section construction and seismic reflection data interpretation. Course required of all PEGN students. Prerequisite: GEGN101.
Course Learning Outcomes

- • Apply the tools and methods of structural analysis, which are the basis for structural seismic interpretation and structural analysis of reservoirs.
- • Evaluate approaches and conclusions reached in geologic studies applied to petroleum and geophysical engineering projects.

GEOL309. STRUCTURAL GEOLOGY AND TECTONICS. 4.0 Semester Hrs.
(WI) Recognition, habitat, and origin of deformational structures related to stresses and strains (rock mechanics and microstructures) and plate tectonics. Structural development of mountain belts, rift, strike-slip and salt systems. Comprehensive field and laboratory projects use descriptive geometry, stereographic projection, structural contours, map and cross section construction, air photo interpretation, and seismic reflection data analysis. Required of Geological Engineers. 3 hours lecture, 3 hours lab; 4 semester hours. Prerequisite: GEGN217.
Course Learning Outcomes

- No change

GEOL310. EARTH MATERIALS. 3.0 Semester Hrs.
Introduction to Earth Materials, emphasizing the structure, formation, distribution and engineering behavior of minerals and rocks. Structural features and processes are related to stress/strain theory and rock mechanics principles. Laboratories and field exercises emphasize the recognition, description and engineering evaluation of natural materials. Lectures and case study exercises present the knowledge of natural

materials and processes necessary for mining engineering careers. 2 hours lecture; 3 hours lab; 3 semester hours. Prerequisite: GEGN101.
Course Learning Outcomes

- see attached document

GEOL311. MINING GEOLOGY. 3.0 Semester Hrs.
Introduction to Mining Geology, emphasizing the formation, distribution, engineering behavior, exploration for and geological aspects of development of ore materials. Laboratories emphasize the recognition, description and engineering evaluation of ores and their hosts. Lectures and case study exercises present the knowledge of ores and ore-forming processes necessary for mining engineering careers. 2 hours lecture; 3 hours lab; 3 semester hours. Prerequisite: GEGN101 and GEOL310 or MNGN310.
Course Learning Outcomes

- see attached document

GEOL314. STRATIGRAPHY. 0-4 Semester Hr.
Lectures and laboratory and field exercises in concepts of stratigraphy and biostratigraphy, facies associations in various depositional environments, sedimentary rock sequences and geometries in sedimentary basins, and geohistory analysis of sedimentary basins. 3 hours lecture, 3 hours lab; 4 semester hours. Prerequisite: GEGN101, GEGN212, GEGN217.
Course Learning Outcomes

- Understanding stratigraphy, biostratigraphy, facies associations, sedimentary rock sequences, and sedimentary basins.

GEOL315. SEDIMENTOLOGY AND STRATIGRAPHY. 3.0 Semester Hrs.
Integrated lecture, laboratory and field exercises on the genesis of sedimentary rocks as related to subsurface porosity and permeability development and distribution for non-geology majors. Emphasis is placed on siliciclastic systems of varying degrees of heterogeneity. Topics include diagenesis, facies analysis, correlation techniques, and sequence and seismic stratigraphy. Application to hydrocarbon exploitation stressed throughout the course. Required of all PEGN students. Prerequisite: GEGN101, PEGN308. 2 hours lecture, 3 hours lab; 3 semester hours.

GEOL321. MINERALOGY AND MINERAL CHARACTERIZATION. 3.0 Semester Hrs.
Principles of mineralogy and mineral characterization. Crystallography of naturally occurring materials. Principles of crystal chemistry. Interrelationships among mineral structure, external shape, chemical composition, and physical properties. Introduction to mineral stability. Laboratories emphasize analytical methods, including X-ray diffraction, scanning electron microscopy, and optical microscopy. 2 hours lecture, 3 hours lab: 3 semester hours. Prerequisite: GEGN101, GEGN212, CHGN122 or CHGN125.
Course Learning Outcomes

- No change

GEOL398. SPECIAL TOPICS. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEOL399. INDEPENDENT STUDY IN GEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEOL399. INDEPENDENT STUDY IN GEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

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(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEOL399. INDEPENDENT STUDY IN GEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

GEOL410. PLANETARY GEOLOGY. 3.0 Semester Hrs.
Introduction to the geology of planets, moons, and other bodies within and beyond our solar system. Focusing on topics such as (a) the origin and composition of our solar system and its constituent materials, (b) geologic processes occurring on planetary surfaces (e.g. cratering) and shallow and deep interiors (e.g. volcanism, mantle convection), (c) methods of solar system exploration, and potential for resource discovery and utilization on near-neighbors and asteroids, and (d) comparative planetology (thermal histories, evidence for plate tectonics, origin and retention of atmospheres, exobiology).
Course Learning Outcomes

- Students will learn geological processes of the solar system.

GEOL440. PLATE TECTONICS. 3.0 Semester Hrs.
Introduction to the theory of plate tectonics as a first-order framework with which the evolution of the Earth’s lithosphere in space and time may be described and understood. Key topics include plate boundaries, the mechanisms of mountain building, crustal growth and destruction, volcanism and seismicity in intraplate and plate-margin settings, and secular changes in plate tectonic processes and products over geological time. Formation of all rock types (igneous, sedimentary, metamorphic) will be discussed in the context of plate tectonics. Other planets and planetary processes will be discussed and compared to Earth. Prerequisite: Basic geology knowledge; Consent from instructor.
Course Learning Outcomes

GEOL443. UNDERGRADUATE FIELD SEMINAR. 1-3 Semester Hr.
Special advanced classroom and field programs emphasizing detailed study of some aspects of the geology of an area or region. Field studies normally conducted away from the Golden campus. Classroom course

content dependent on area of study. Fees assessed for field and living expenses and transportation. 1 to 3 semester hours; may be repeated for credit.

GEOL444. INVERTEBRATE PALEONTOLOGY. 3.0 Semester Hrs.
Fossils are the basis for establishing global correlation among Phanerozoic sedimentary rocks, and thus are critical to the reconstruction of the past 550 million years of Earth history. This is a lecture elective course that will aid in rounding out undergraduate Earth science/engineering geological knowledge. Fossil preservation, taphonomy, evolution, mass extinctions, biostratigraphy, graphic correlation, invertebrate phyla and their geologic history and evolution. Prerequisites: GEGN203. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- At the conclusion of the class students will be able to... Recognize the characteristics of the major phyla and classes of invertebrate fossils/animals; Explain how fossils are used in establishing geologic age of rocks and correlation; Explain how a fossil species is recognized, formally described, and classified into higher taxonomic categories; Explain the components of current evolutionary theory and how the fossil record supports it. These relate to the desired outcome of students being scientifically curious and to feeding their wonder over the beauty and complexity of the natural world.

GEOL470. APPLICATIONS OF SATELLITE REMOTE SENSING. 3.0 Semester Hrs.
Students are introduced to geoscience applications of satellite remote sensing. Introductory lectures provide background on satellites, sensors, methodology, and diverse applications. One or more areas of application are presented from a systems perspective. Guest lecturers from academia, industry, and government agencies present case studies focusing on applications, which vary from semester to semester. Students do independent term projects, under the supervision of a faculty member or guest lecturer, that are presented both written and orally at the end of the term. Prerequisites: PHGN200 and MATH225. 3 hours lecture; 3 semester hours.

GEOL497. SPECIAL SUMMER COURSE. 0-15 Semester Hr.

GEOL497. SPECIAL SUMMER COURSE. 0-15 Semester Hr.

GEOL498. SEMINAR IN GEOLOGY OR GEOLOGICAL ENGINEERING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.

GEOL498. SPECIAL TOPICS. 1-6 Semester Hr.

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GEOL499. INDEPENDENT STUDY IN GEOLOGY. 1-6 Semester Hr.
(I, II) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: “Independent Study” form must be completed and submitted to the Registrar. Variable credit; 1 to 6 credit hours. Repeatable for credit.

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Professor and Department Head

Alexis Navarre-Sitchler

Professors

David A. Benson

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Zhaoshan Chang, Charles F. Fogarty Endowed Chair

Thomas Monecke, Director of Center for Advanced Subsurface Earth Resource Models and Co-Director of Center for Mineral Resources Science

Piret Plink-Bjorklund

Eric Roberts, Director, Potential Gas Agency

Paul M. Santi, Director of the Institute for Initiatives in Latin America

Kamini Singha, Associate Dean of Earth and Society Programs

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