

GEOLOGY (GEO)

NOTE: All prerequisites required for Geology (GEO) courses or courses counted toward major or minor requirements in geology must be completed with a grade of "C-" or better.

Geology (GEO) Courses

GEO 1013. The Third Planet. (3-0) 3 Credit Hours. (TCCN = GEOL 1301)
Evolution of ideas concerning the earth's origin, structure, and age; social impact of recognizing the antiquity of the planet and humankind's brief presence; examination of how the distribution of planetary resources and climate change influenced the rise and clash of civilizations. May be applied toward the Core Curriculum requirement in Life and Physical Sciences. May not be applied to a major in geosciences. Generally offered: Fall, Spring, Summer. Course Fee: DL01 \$75; LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

GEO 1033. Geology of North American National Parks. (3-0) 3 Credit Hours. (TCCN = GEOL 1302)

Explores the geology of the national parks of North America, including evaluation of the relationships between plate tectonics, the rock cycle, and landscapes preserved within our national parks. This course highlights the formation of the North American continent through examination of the iconic formations of the North American national parks including The Grand Canyon, Yellowstone, Yosemite, and others, with a special look at the geology of the two national parks in Texas. May be applied toward the Core Curriculum requirement in Life and Physical Sciences. May not be applied to a major in geology. Generally offered: Fall, Spring, Summer. Course Fees: LRS1 \$46.2; STSI \$21.6; LRC1 \$12.

GEO 1103. Physical Geology. (3-0) 3 Credit Hours. (TCCN = GEOL 1303)

Prerequisite: Concurrent enrollment in GEO 1111. This course is intended for geosciences majors and minors as well as others interested in the geologic sciences. It constitutes an introduction to the geosciences major and skillsets needed by the practicing geologist including; mineral and rock identification, deep time, outcrop descriptions, and mapping. The course includes an introduction to the theory of plate tectonics and its relation to the Earth's internal structure, surface features, hydrosphere, earthquakes, and volcanism. One or more field trips may be required. Generally offered: Fall, Spring. Course Fee: LRS1 \$46.20; STSI \$21.60.

GEO 1111. Physical Geology Laboratory. (1-3) 1 Credit Hour. (TCCN = GEOL 1103)

Prerequisite: Completion of or concurrent enrollment in GEO 1103. Relation of the earth's present processes to its resources, structure, and internal composition. Field and laboratory study of minerals, rocks, maps, and aerial and satellite photos. Field trips may be required. (Formerly titled "Introduction to Earth Systems Laboratory.") Generally offered: Fall, Spring. Course Fees: IUE1 \$15; LRS1 \$15.40; STSI \$7.20.

GEO 1123. Life Through Time. (3-0) 3 Credit Hours. (TCCN = GEOL 1304)

Prerequisite: Concurrent enrollment in GEO 1131 recommended. A study of the origin and evolution of life on Earth including major events from the beginning of the Earth and solar system to the present, as well as the interaction of life with the lithosphere, atmosphere, and hydrosphere. This course will explore the fossil record, sedimentary rocks, plate tectonics, evolution, and climate change. May apply toward the Core Curriculum requirement in Life and Physical Sciences. Generally offered: Fall, Spring. Course Fees: LRC1 \$12; LRS1 \$46.20; STSI \$21.60; DL01 \$75.

GEO 1131. Life Through Time Laboratory. (1-3) 1 Credit Hour. (TCCN = GEOL 1104)

Prerequisite: GEO 1111, completion of or concurrent enrollment in GEO 1123. Laboratory and field study of minerals, rocks, fossils, sequences of rocks, and mapping for the interpretation of life through time and the interpretation of Earth's history. This course is intended and required for Geological Science majors and minors and will introduce students to many concepts covered in upper-level courses. Field trips may be required. Generally offered: Fall, Spring. Course Fee: IUE1 \$15; LRS1 \$15.40; STSI \$7.20.

GEO 2003. Mineralogy. (3-0) 3 Credit Hours.

Prerequisites: CHE 1103, CHE 1121, GEO 1103, GEO 1111, MAT 1093 or higher, or satisfactory performance on placement exam, and completion of or concurrent enrollment in GEO 2011. Crystallography, crystal chemistry, and the physical and optical properties of minerals. Principles of optical mineralogy and the microscopic determination of nonopaque minerals. Field trips may be required. Generally offered: Fall. Course Fees: LRS1 \$46.20; STSI \$21.60.

GEO 2011. Mineralogy Laboratory. (1-3) 1 Credit Hour.

Prerequisite: Completion of or concurrent enrollment in GEO 2003. Laboratory study of crystal models, crystals, and minerals. Use of physical properties and the petrographic microscope for mineral identification. Field trips may be required. (Formerly GEO 2012. Credit cannot be earned for both GEO 2011 and GEO 2012.) Generally offered: Fall. Course Fee: IUE1 \$15; LRS1 \$15.40; STSI \$7.20.

GEO 2043. Scientific Methods in Geosciences. (3-0) 3 Credit Hours.

The goal of this class is to apply fundamental scientific methods in Earth Sciences. Students will learn mathematics using Geosciences' examples. Fundamental theories and principles on the physics and chemistry of the Earth System will be introduced and applied using scientific methods. This course aims to improve students' knowledge and skills of scientific approaches involved in Geosciences. After successfully completing this course, students will be prepared for advanced level courses requiring college level mathematics, chemistry, and physics in Earth Sciences. Generally offered: Fall, Spring. Course Fees: LRS1 \$46.2; STSI \$21.6.

GEO 2113. Fundamentals of Geographic Information Systems (GIS). (2-3) 3 Credit Hours.

This course will serve as a basic introduction to the concepts and techniques of utilizing a Geographic Information System (GIS) to study and model environmental issues. In lecture and laboratory, students will study methods of querying, analyzing, creating, and displaying GIS data utilizing industry-standard software. Students will also be introduced to using the Global Positioning System (GPS) as a means for creating GIS data. (Same as ES 2113. Credit cannot be earned for both GEO 2113 and ES 2113.) Generally offered: Fall, Spring. Course Fee: LRS1 \$46.20; STSI \$21.60; IUE1 \$15.

GEO 3001. Preparation for the Geoscience Workforce. (1-0) 1 Credit Hour.

Prerequisite: GEO 1103, GEO 1123, and at least junior standing. This course provides the opportunity to engage in professional development activities in preparation for a career in the geosciences and aligned fields. Activities will include workshops, seminars, and assignments. This course has Differential Tuition.

GEO 3003. Atmospheric Science. (3-0) 3 Credit Hours.

Introduction to atmospheric sciences and the dynamic world of weather using real-world current environmental data. The course covers the composition and structure of the atmosphere, the flow of energy into, through, and out of the atmosphere, and the resulting motions from local to global scales. The impact of weather on humans, particularly severe weather, is studied, emphasizing basic physical principles of atmospheric phenomena. Analysis methods are introduced as the students study current meteorological data delivered via the Internet. Generally offered: Fall (online). This course has Differential Tuition. Course Fee: DL01 \$75.

GEO 3004. Rocks, Fossils, and Global Tectonics. (2-6) 4 Credit Hours.

Prerequisite: GEO 1103 and GEO 1111. An investigation of the major rock forming minerals, petrogenesis of the major rock types, and their plate tectonic context. Study of major trends in fauna and flora through time and their application to interpreting plate tectonics, paleoenvironments, and paleoclimate. Credit may not be applied to a B.S. or B.A. in Geosciences degrees. This course has Differential Tuition. Course Fee: DL01 \$100.

GEO 3013. Fundamentals of Plate Tectonics. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, GEO 1111, GEO 2003, GEO 2011, and MAT 1093. This course introduces the student to the mechanics of lithospheric plate motion and the physical phenomena driving the motion. The relationships between plate tectonics, mantle convection, and geomagnetism are explored, as well as common structures associated with plate boundaries. Mathematical models are introduced and used to describe plate motion on a sphere. Historical development of plate tectonic theory is also covered. Generally offered spring. This course has Differential Tuition. Course Fee: STSI \$21.60; LRS1 \$46.20.

GEO 3043. Petrology. (3-0) 3 Credit Hours.

Prerequisite: GEO 2003, GEO 2011, and MAT 1213 (or MAT 1214 in previous catalogs). Description, classification, occurrence, and origin of igneous and metamorphic rocks. Field trips may be required. Generally offered: Spring. This course has Differential Tuition.

GEO 3051. Petrology Laboratory. (1-3) 1 Credit Hour.

Prerequisite: GEO 2003, GEO 2011, and completion of or concurrent enrollment in GEO 3043. Laboratory study of igneous and metamorphic rocks in hand specimen and thin section. Field trips may be required. Generally offered: Spring. This course has Differential Tuition.

GEO 3063. Paleontology. (3-0) 3 Credit Hours.

Prerequisite: GEO 1123, GEO 1131, or consent of instructor, and concurrent enrollment in GEO 3071. Study of fossil animals and plants. Emphasis on invertebrate animals. Systematics, biostratigraphy, paleoecology, and evolution of fossil organisms. Field trips may be required. Generally offered: Fall. This course has Differential Tuition.

GEO 3071. Paleontology Laboratory. (1-3) 1 Credit Hour.

Prerequisite: GEO 1123, GEO 1131, and concurrent enrollment in GEO 3063. Study of fossil specimens, collections, and preparation techniques. Field trips may be required. Generally offered: Fall. This course has Differential Tuition. Course Fee: IUE1 \$15.

GEO 3103. Structural Geology. (3-0) 3 Credit Hours.

Prerequisite: GEO 3113, and completion of or concurrent enrollment in GEO 3111. Description and origin of geologic structures at the microscopic, hand specimen and mountain scales with emphasis on the response of Earth materials to stress and the role of rheology. Relationships between structure and tectonics will be explored. Field trip required. Generally offered: Spring. This course has Differential Tuition.

GEO 3111. Structural Geology Laboratory. (1-3) 1 Credit Hour.

Prerequisite: Completion of or concurrent enrollment in GEO 3103. Laboratory study of structural features and concepts using maps, cross-sections, photographs, and descriptive geometric and stereographic methods. Field trips may be required. Generally offered: Spring. This course has Differential Tuition.

GEO 3113. Geologic Field Investigations. (1-6) 3 Credit Hours.

Prerequisite: GEO 1103 and GEO 1111. Introduction to techniques for studying geologic features and processes in the field, including rock identification, measuring stratigraphic sections, and construction of geological maps and cross sections. Some half-day and Saturday field trips may be required. Generally offered: Fall, Spring. This course has Differential Tuition.

GEO 3123. Sedimentation and Stratigraphy. (3-0) 3 Credit Hours.

Prerequisite: GEO 2003, GEO 2011, and completion of or concurrent enrollment in GEO 3131. Processes of erosion, transportation, and deposition that form bodies of sedimentary rock. Depositional systems and modeling are a significant area of study. Stratigraphic principles and temporal and spatial facies relationships at various scales. Field trips may be required. Generally offered: Spring. This course has Differential Tuition.

GEO 3131. Sedimentation and Stratigraphy Laboratory. (1-3) 1 Credit Hour.

Prerequisite: GEO 2003, GEO 2011, and completion of or concurrent enrollment in GEO 3123. Laboratory studies of sedimentary processes and their products. Hand specimens, thin sections, sedimentary structures, and interpretation of depositional environments. Stratigraphic case studies, including surface, subsurface, and sequence stratigraphic analysis. Field trips may be required. Generally offered: Spring. This course has Differential Tuition. Course Fee: IUE1 \$15.

GEO 3163. Oceanography. (3-0) 3 Credit Hours.

An introduction to the role of the ocean in the Earth system by using real-world oceanographic data. Topics covered include the flow of energy into and out of the ocean and the motions that result; physical and chemical properties of ocean water; ocean circulation; marine life and habitats; and the interaction of the ocean with the other components of the Earth system (hydrosphere, atmosphere, geosphere, and biosphere). It provides the scientific basis for understanding the world ocean. An optional field trip may be offered. (Same as ES 3133. Credit cannot be earned for both GEO 3163 and ES 3133.) Generally offered: Fall (online only, some set time), Spring (online). This course has Differential Tuition. Course Fee: DL01 \$75.

GEO 3173. The Cryosphere. (3-0) 3 Credit Hours.

This course covers properties, areal distribution, seasonal change and climatic change of the major constituents of the cryosphere: the large ice sheets of Greenland and Antarctica; seasonal snow cover in the high and mid latitudes; sea ice covers in the Arctic, Southern Ocean, and other seas; mountain glaciers from the tropics to the polar regions; and permafrost in the high latitude land areas of the Northern Hemisphere. Methods of cryospheric research will be introduced such as remote sensing and in situ field investigations. Generally offered: Spring. This course has Differential Tuition.

GEO 3343. Introduction to Geospatial Technologies. (3-0) 3 Credit Hours.

This course introduces several aspects of geospatial technologies, not only what they are but how they are used in hands-on applications, all based on free internet resources not commercial software packages. This course provides a solid foundation on which further knowledge in more specialized classes, such as Geographic Information Systems, Global Positioning Systems, and Remote Sensing, can be built on. This course has Differential Tuition.

GEO 3373. Geochemistry. (2-3) 3 Credit Hours.

Prerequisite: CHE 1103 and CHE 1121. A survey of geochemical processes and the distribution of elements in the earth. Application of geochemical methods and data to the solution of geologic problems. Includes geochemical laboratory experiments and use of analytical equipment. Incorporates use of standard computer software for analysis of geochemical data and graphing of results. Students taking this class will learn to describe the role that modern geochemistry plays in all aspects of Earth Sciences, solve geochemical problems using geochemical data sets, and explain geochemical processes that take place at depth and at the surface of our planet. Generally offered Fall. This course has Differential Tuition. Course Fee: IUE1 \$15.

GEO 3383. General Geophysics. (3-0) 3 Credit Hours.

Prerequisite: Completion of or concurrent enrollment in MAT 1223 and PHY 1963. This course examines the interrelated geology and physics of the Earth's interior as deduced from earthquake seismology, gravity and magnetic fields, and the introduction of geophysical survey methods to the exploration of near-surface cultural and natural resources. Topics in archaeological, environmental, geological, and engineering geophysics will be explored. Generally offered: Fall. This course has Differential Tuition.

GEO 3393. Introduction to Isotope Geochemistry. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, GEO 1111, CHE 1103, CHE 1121, and MAT 1213. The course includes a review of theories of nuclear structure, stability of nucleus, nucleosynthesis and origin of elements, and introduces both radiogenic and stable isotope geochemistry. Topics include radioactive decay schemes for tritium-helium, U-Pb, Rb-Sr, Sm-Nd, K-Ar, and U-Th-Pb-He systems; isotopic fractionations of stable isotopes of C, H, O, N, and S; and application of radiogenic and stable isotopes to petrology, evolution of the crust and mantle, geochronology, geothermometry, archaeology, ecology, hydrology, and paleoclimatic interpretation. Generally offered: Fall. This course has Differential Tuition. Course Fee: LRS1 \$46.20; STSI \$21.60.

GEO 3403. Biogeochemistry. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, GEO 1111, CHE 1103, CHE 1121, and MAT 1093, or consent of instructor. This course will provide theoretical and conceptual knowledge regarding important topics in biogeochemistry, including how elements are cycled in lithosphere, hydrosphere, and atmosphere, as well as discussing the impact of water and energy associated with these cycles. We follow the elements most necessary for life on earth from their origins in the universe through the present day and consider their future in a warming climate. Basic metabolic pathways of life and mechanisms of biogeochemical transformations of carbon, nitrogen, phosphorus, sulfur, and other weathering-derived elements are discussed. Biogeochemical processes associated with natural water chemistry (surface, groundwater, ocean water, and atmospheric waters - specifically wetlands, oceans, estuaries, soils, and sediments), will be covered with theory, case studies, and numerical calculations. A portion of class will also focus on interactions between natural organic matter and microbial processes that catalyze the cycling of elements of human health concern. Simple calculations using spreadsheet programs will be used to understand some of the biogeochemical processes in a quantitative manner. These Earth systems and processes are innately complex in nature. This course aims to support students' understanding of these systems through lecture, literature, and group assignments. Generally offered: Spring. This course has Differential Tuition.

GEO 3413. Introduction to Earth System Science and Remote Sensing. (3-0) 3 Credit Hours.

This course is designed for students in sciences or engineering to get basic knowledge about the Earth system and some compelling science problems related to ice, snow, water, atmosphere, and ocean. The second part of the course will include some basic knowledge of remote sensing and how different remote sensing technology can be used to sense these different types of earth environments. Generally offered: Fall. This course has Differential Tuition.

GEO 4001. Experiential Learning Internship. (0-0) 1 Credit Hour.

The opportunity to apply geological principles and skills during a semester-long internship in an organization that utilizes geoscience to accomplish its mission. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). This course has Differential Tuition.

GEO 4002. Experiential Learning Internship. (0-0) 2 Credit Hours.

The opportunity to apply geological principles and skills during a semester-long internship in an organization that utilizes geoscience to accomplish its mission. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

GEO 4003. Experiential Learning Internship. (0-0) 3 Credit Hours.

The opportunity to apply geological principles and skills during a semester-long internship in an organization that utilizes geoscience to accomplish its mission. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

GEO 4013. Volcanology. (3-0) 3 Credit Hours.

Prerequisites: GEO 3043 and either PHY 1623 or PHY 1943, or consent of instructor. A survey of volcanoes and volcanic processes, including historically important volcanic eruptions and the prediction and mitigation of volcanic hazards. Field trips may be required. Generally offered: Spring. This course has Differential Tuition.

GEO 4023. Engineering Geology. (3-0) 3 Credit Hours.

Prerequisite: PHY 1963 (engineering majors only) or PHY 1603 or PHY 1943, and MAT 1213 (or MAT 1214 in previous catalogs); or consent of instructor. Geologic factors in siting, design, and construction of structures. Geotechnical properties of rocks and soils. Case studies. May not be applied to a major in Geosciences. Generally offered: Fall and Spring. This course has Differential Tuition.

GEO 4033. Profession of Geology. (3-0) 3 Credit Hours.

Prerequisite: GEO 2113, GEO 3123, GEO 3131, GEO 3113. This course is designed to provide the basic knowledge required by the ASBOG National Geologist Examination (Fundamentals) for licensure as a Professional Geologist, and introduces the geoscience student to the fundamentals of professional practice that impact, health, safety, and well-being of the public. The emphasis will be on principles and practices of geoscience that affect the economy, feasibility and design of engineering works, siting criteria, site selection and investigation, human-land interactions, site assessment, liability, responsibility, professional report writing, and licensure. This course has Differential Tuition.

GEO 4043. Big Data Analysis for Extreme Environments. (3-0) 3 Credit Hours.

This course will touch on three basic aspects of data science and technology: geospatial data, data assimilation and modeling, and cloud computation and big data analytics. Generally offered: Spring. This course has Differential Tuition.

GEO 4053. Climate Change. (3-0) 3 Credit Hours.

An introduction to the Earth's climate system using real-world environmental data. Climate change is investigated with proxy records of the past, direct observations of the present, and climate model simulations of the future to understand both natural and human effects. The course also addresses how energy use and policy impacts climate change as well as how society is affected by it. Generally offered: Spring (online). This course has Differential Tuition. Course fee: DL01 \$75.

GEO 4063. Advanced Environmental Geology. (3-0) 3 Credit Hours.

Prerequisites: GEO 1103 and GEO 1111. An analysis of human interaction with geologic systems; the risks and effects of natural geologic hazards such as volcanic eruptions, earthquakes, and floods. Topics will include the effects of human activity on natural systems such as groundwater quality and recharge, river systems, coastal hazards, energy resources, and climate change. The meaning of "sustainability" as a long-term concept and tools to assess and work with Earth systems to avoid endangering human life and property are also topics that are applied and addressed. This course has Differential Tuition.

GEO 4073. Web GIS. (2-3) 3 Credit Hours.

Prerequisite: ES 2113 or GEO 2113 or GEO 3343, or consent of instructor. This course will focus upon developing GIS applications to be served out via the Internet or a Local Area Network (LAN). Additional topics include the use of Web authoring software. The course presents and introductory level skill set for the creation and publishing of web mapping applications using the ESRI ArcGIS Online resources and available tools. The technical focus of the course includes computer lab tutorials and case studies. This course has Differential Tuition. Course Fee: DL01 \$75.

GEO 4083. Computer Application for Geoscience. (2-3) 3 Credit Hours.

In this course, Geosciences students will be introduced to means to input their valuable field and lab measurements into computer systems for further processing and analysis. Students will learn the principles and fundamentals of computer programming from the Project Management point of view. By visualizing and implementing the Program Development Cycle and introducing a few programming environments (Visual Basic for Applications, Python, UNIX shell programming) students will learn how to define a problem, devise a computational solution and implement it. This course has Differential Tuition.

GEO 4093. Principles of Remote Sensing. (2-3) 3 Credit Hours.

Prerequisite: MAT 1213 (or MAT 1214 in previous catalogs) or higher and PHY 1943. This course will provide a thorough introduction to remote sensing theory, technology, and application. The emphasis in this course is on understanding the underlying principles of acquiring, interpreting, and applying data from imaging systems covering the electromagnetic spectrum from the ultraviolet through the microwave. Generally offered: Fall. This course has Differential Tuition.

GEO 4103. Programming and Statistics for GIS. (2-3) 3 Credit Hours.

Prerequisites: ES 2113 or GEO 2113 or GEO 3343, or consent of instructor. This course provides students with the basics of Python programming language and how GIS uses it as a scripting language to perform sophisticated statistical, map, and analysis calculations. They will be able to understand the desired outcomes of a project and organize tasks and processes to achieve said goal. Students will learn and master powerful Python tools that automate procedures, and carry out integration with data from many applications. As a result, they will have the ability to transform or create robust GIS datasets, and provide with in depth analysis leading to solid decision making. This course has Differential Tuition.

GEO 4113. Geomorphology. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103 or GES 2613, or consent of instructor, and junior or senior standing. In-depth study of processes that erode and deposit sediment on the Earth's surface. Sediment supply and transport capacity driving sediment transfers that change landscapes. Case studies illustrate role of geomorphic knowledge in addressing environmental problems. Field trips may be required. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 \$75.

GEO 4121. Geomorphology Laboratory. (1-3) 1 Credit Hour.

Prerequisite: GEO 1103 or GES 2613, completion of or enrollment in GEO 4113, and junior or senior standing, or consent of instructor. Geomorphic concepts applied to solve specified problems. Emphasis on geomorphic data, analysis techniques, and interpretation to gain understanding and address environmental problems. Field trips may be required. Generally offered: Fall. This course has Differential Tuition.

GEO 4133. River Science. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103 or GES 2613, or consent of instructor, and junior or senior standing. An in-depth examination of river sediment transport principles. Topics include water and sediment supply, sediment dynamics, river morphology, and channel instability. Field trips may be required. This course has Differential Tuition.

GEO 4203. Aqueous Geochemistry. (3-0) 3 Credit Hours.

Prerequisites: GEO 3373, or consent of instructor. This course will facilitate to understand in detail the fundamental (primarily thermodynamic) controls on the composition of natural waters and the response of natural waters to variations in various physico-chemical parameters. Characterization of dissolved organic matter in natural waters will be introduced. This course will explore applications to environmental problems like contaminants migration in waters (ground waters, surface waters), weathering, etc., learn to solve numerical problems related to the behavior of chemical components in natural waters, and gain familiarity with simple analytical techniques for the characterization of natural waters. This course has Differential Tuition.

GEO 4213. Chemical Hydrology. (3-0) 3 Credit Hours.

Prerequisite: GEO 3373 or GEO 4623, or consent of instructor. Discussion of the basic chemical principles of the water cycle, as well as environmentally relevant applications based on case studies. Detailed Groundwater Hydrogeochemistry, Surface Water Hydrogeochemistry, Surface water and Groundwater Interaction - Geochemical Principles governing, Quantitative and Modeling analysis and geologic effects on quality and flow of groundwater. Coverage of contemporary global issues related to water resources, including pollution control, environmental rehabilitation, sustainable development, and global warming exploration of anthropogenic. Topics include land-atmosphere interactions, movement of water and water rock interaction, contaminant transport in groundwater systems. ASBOG Test Syllabus and web-based teaching are followed. (Formerly GEO 4204. Credit cannot be earned for both GEO 4204 and GEO 4213.) This course has Differential Tuition.

GEO 4303. Geomicrobiology. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, GEO 1111, CHE 1103, CHE 1121, and MAT 1093, or consent of instructor. The overall objective of this course is to give you an understanding of how microorganisms impact geological environments and how geological environments, in turn, influence microbial activity. The course is divided into three units: (1) Fundamentals of geomicrobiology. Here you will learn about the basic properties of microbes, how we characterize them, and how they function. We will also discuss the major biogeochemical cycles. This portion of the course will lay the foundation for learning about microbial interactions with geological environments. (2) Influence of geological environments on microorganisms. This portion of the course examines environmental controls that influence who exist within microbial communities and what kinds of reactions they carry out. We will emphasize use of thermodynamic calculations to analyze microbial communities and predict behavior. (3) Impacts of microbial activity on geological environments. We will begin this portion of the course with an overview of ways microbes impact their environments and then focus our discussion on impacts of microbial activity on water resources. Generally offered: Fall. This course has Differential Tuition.

GEO 4313. Biogeochemical Modeling. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, GEO 1111, CHE 1103, CHE 1121, and MAT 1093, or consent of instructor. Students taking this course will learn how to quantitatively analyze biogeochemical reaction systems using popular geochemical modeling software, The Geochemists Workbench®. Along the way students will develop employable skills, enrich their understanding of biogeochemical reaction systems. The course will be based on a series of active learning computer exercises. Student will use the software to determine species distributions in natural waters, calculate redox pH diagrams, model the kinetics of microbial reactions, simulate rates of mineral dissolution/precipitation, create reaction path models and transport models, and determine rates of reactions and more. Generally offered: Spring. This course has Differential Tuition.

GEO 4453. Natural Hazards. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, and PHY 1623 or PHY 1943. Natural hazards include tectonic (e.g. earthquakes and tsunamis, volcanoes), weather and climate (e.g. floods, hurricanes, wildfires), and extra-terrestrial (e.g. meteorite impacts, gamma ray bursts). Focus on understanding hazard vs risk, recurrence intervals and probabilistic forecasting, and local vs. regional vs. global scale catastrophic events. Generally offered: Fall. This course has Differential Tuition.

GEO 4503. Hydrogeophysics. (3-0) 3 Credit Hours.

Prerequisite: MAT 1213 or higher, PHY 1963, and completion of or concurrent enrollment in GEO 4511. The presence of water and other fluids in subsurface formations, from the macro aquifer level to the micro pore level, are ultimately detected and observed through the application of geophysical principles and survey methods. This course will explore the fundamental science of hydrological geophysics, through the examination of the fundamental petrophysics and the various geophysical surface and borehole methods, such as seismic refraction, electrical resistivity and induced polarization, electromagnetic induction, microgravimetry, and geo-radar as applied to hydrogeologic investigations. This course has Differential Tuition.

GEO 4511. Hydrogeophysics Laboratory. (1-3) 1 Credit Hour.

Prerequisite: Completion of or concurrent enrollment in GEO 4503. Laboratory and field-based course exploring geophysical survey systems, survey planning, data collection and analysis. This course has Differential Tuition.

GEO 4623. Groundwater Hydrogeology. (3-0) 3 Credit Hours.

Prerequisite: GEO 1103, GEO 1111, PHY 1943, and MAT 1213 (or MAT 1214 in previous catalogs). Hydrologic cycle and the occurrence and movement of groundwater. Recharge and discharge of aquifers; water quality; exploration and development of groundwater supplies. Field trips may be required. Generally offered: Spring. This course has Differential Tuition.

GEO 4813. Planetary Geology. (3-0) 3 Credit Hours.

Prerequisite: PHY 1963, or consent of instructor. This course is designed for students in the Sciences or Engineering and no prior Geological knowledge is assumed, although Earth will be our point of reference. Survey of the interior and surface geology of solid bodies in our Solar System and beyond (planets, moons, asteroids, comets, Kuiper Belt Objects and exoplanets). Topics will include bulk composition and differentiation of planetary interiors, surface processes such as (cryo-) volcanism and meteorite impacts, erosion and sedimentation by fluids and wind, and heat transfer styles. There will be an emphasis on how we know things and what we don't know, quantifying uncertainties in measurements and models, and the nature of planetary scientific enquiry. This course has Differential Tuition.

GEO 4823. Geochronology and Tectonics. (3-0) 3 Credit Hours.

Prerequisite: GEO 2003 and GEO 2011. Study of traditional and recently developed techniques (U-Pb, Ar-Ar, [U-Th]/He, fission track, cosmogenic nuclides, and paleo-altimetry) used to date earth materials and events. Course starts with a history of geochronology as a science utilizing lectures and literature reviews, followed by hands-on experience modeling ages of tectonic events and interpreting the results using published datasets. This course has Differential Tuition.

GEO 4883. Petroleum Geology. (3-0) 3 Credit Hours.

Prerequisite: Completion of or concurrent enrollment in GEO 3103 and GEO 3123, or consent of instructor. Integrated study of the generation, migration, and entrapment of hydrocarbons in conventional and unconventional petroleum systems. Survey of surface and subsurface geological and geophysical techniques for exploration, development, and production using professional software. Case studies of petroleum systems including economic aspects of the petroleum industry. Generally offered: Spring. This course has Differential Tuition.

GEO 4911. Independent Study. (0-0) 1 Credit Hour.

Prerequisite: Approval from the instructor, the Department Chair, and the Associate Dean of Undergraduate Studies in the College for which this course is offered; registration Form available on UTSA OneStop website. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree in geosciences. This course has Differential Tuition.

GEO 4912. Independent Study. (0-0) 2 Credit Hours.

Prerequisite: Approval from the instructor, the Department Chair, and the Associate Dean of Undergraduate Studies in the College for which this course is offered; registration form available on UTSA OneStop website. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

GEO 4913. Independent Study. (0-0) 3 Credit Hours.

Prerequisite: Approval from the instructor, the Department Chair, and the Associate Dean of Undergraduate Studies in the College for which this course is offered; registration form available on UTSA OneStop website. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

GEO 4933. Field Geology Part I. (1-6) 3 Credit Hours.

Prerequisite: GEO 3103, GEO 3111, GEO 3123, and GEO 3131 or consent of instructor. Geologic mapping and structural analysis of data collected in the field. Taught for three weeks only in the summer session. Special fee covers cost of transportation, room, and board while in the field. Generally offered: Summer. This course has Differential Tuition.

GEO 4943. Field Geology Part II. (1-6) 3 Credit Hours.

Prerequisite: GEO 4933 or consent of instructor. Part II: In this course, students will conduct a laboratory analysis of samples collected during the first half to determine continent-scale environmental change across North America. Students will gain hands-on experience with x-ray fluorescence analysis and making thin sections. In addition, to the lab work, they will perform a structural analysis of maps and cross-sections they made during the first half. This analysis will use ArcGIS and Move software packages. Generally offered: Summer. This course has Differential Tuition.

GEO 4951. Special Studies in Geology. (1-0) 1 Credit Hour.

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition. Course Fee: LRS1 \$15.40; STSI \$7.20.

GEO 4952. Special Studies in Geology. (2-0) 2 Credit Hours.

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: Fall, Spring. This course has Differential Tuition.

GEO 4953. Special Studies in Geology. (3-0) 3 Credit Hours.

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 \$75.

GEO 4961. Special Studies in Geology Laboratory. (1-3) 1 Credit Hour.

Prerequisite: Consent of instructor. An organized laboratory course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but not more than 6 semester credit hours, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

GEO 4963. Internship. (0-0) 3 Credit Hours.

Prerequisite: Junior or Seniors in Academic Good Standing and approval from the employer, the instructor, the Department Chair, and the Associate Dean for Undergraduate Studies; registration form available on the College of Sciences website. The opportunity for a semester-long work experience in a private business or public agency in a position related to the student's field of study. This course has Differential Tuition.

GEO 4993. Directed Research. (0-0) 3 Credit Hours.

Prerequisite: Approval from the instructor, the Department Chair, and the Associate Dean of Undergraduate Studies in the College for which this course is offered; form available on the College of Sciences website. Supervised research mentored by a faculty member engaged in active research within the student's designated area of concentration. Students may produce a thesis in addition to active research. May be repeated. This course can also be used for students pursuing the COS Undergraduate Thesis Option. This course has Differential Tuition.