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Bachelor of Arts Degree in Earth Systems Science (ESYS)

The Bachelor of Arts program prepares students interested in careers or disciplines (e.g., environmental science, secondary education, law, geography) that require a fundamental understanding of earth systems. This program offers flexibility, allowing students to pursue intensive study in other disciplines. The requirements for the degree of Bachelor of Arts with a major in Earth Systems Science are:

I. Departmental requirements:

   A. At least 30 credit hours in geosciences, including:

   1. One of GEOS 1303, GEOS 1304, GEOS 1405, GEOS 1307, or GEOS 1409.

   2. GEOS 2400.

   3. GEOS 2401, 2304, and 3400.

   4. Participation in GEOS 3120 is required for junior majors. Trip expenses, including transportation,
must be paid by each student.

5. At least eleven additional upper division hours in geosciences; no more than three hours of Directed Studies or Thesis may be applied to this upper division hour requirement.

6. GEOS 4001.

B. 18 additional credit hours from the following courses:

1. At least 9 credit hours from ANTH 2310; BIOL 1311, 1111, 2412, 2305, 3434; BAT/ECON 2301; CHEM 1318, 1118, 2319, 2119; MATH 1311, 1312, 1320, 2308; CSCI 1312, 1320; PHYS 1303, 1309, 1311, 1111, 1310, 1312, 1112; PSYC 2401.

2. At least 6 credit hours from CMLT 2301, 2350; ECON/URBS 3330; ANTH 2310, 2357; PHIL 2350, 2356; PLSI 3313; SOCI 1316, 2314; URBS 3340.

II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

Bachelor of Science Degree in Geosciences

The Bachelor of Science program prepares students for graduate work in geosciences or for entry-level positions in geosciences or related fields. The program serves the student interested in a broad-based introduction to geosciences and provides the opportunity for research in the field or laboratory setting for students at the upper division level.

The requirements for the degree of Bachelor of Science with a major in geosciences are:

I. Departmental Requirements

A. At least 36 credit hours in geosciences, including:

1. One of GEOS 1303, GEOS 1304, GEOS 1307, GEOS 1405, GEOS 1406, or GEOS 1409.

2. GEOS 2400.

3. GEOS 2304, 3400, 3401; either GEOS 3309 or GEOS 3412; plus 10 additional upper division hours in geosciences; no more than 3 hours of Directed Studies or Thesis may be applied to this upper division hour requirement.

4. Participation in GEOS 3120 is required for junior majors. Trip expenses, including transportation, must be paid by each student.

5. GEOS 4001.

B. MATH 1311 and one of the MATH 1312, 1320 or 2308; CHEM 1318 and 1118; PHYS 1309 or 1311, PHYS 1310 or 1312; PHYS 1111 and 1112.
II. University requirements: completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

It is recommended that students planning to attend graduate school or enter directly into a field-oriented aspect of the discipline take an accredited and departmentally approved summer field geology course.

Guidelines for Acceptance of Majors

I. Full acceptance is granted if the following requirements are met at the time of application:

A. Completion of GEOS 2400, and one of GEOS 2401, 2304, or 3400 with an average grade of C or better.
B. A cumulative grade point average of at least 2.0.

II. Provisional Acceptance

Provisional acceptance may be granted to students who have not yet met the above requirements if there is a reasonable expectation that they can complete the major.

The Minor

This course of study is designed for students who desire to study geosciences in some depth although their major is in another field.

Honors in Geosciences

A student in Geosciences may work toward Departmental Honors by satisfying the University guidelines for Departmental Honors published in this bulletin, including the minimum 3.33 cumulative grade point average and 3.33 grade point average or better in the major.

Application and Procedures

Students planning to write a thesis in geosciences must discuss research plans with at least two department faculty members and secure the support of the thesis director and second reader by the end of the Junior year. Normally the student will initiate research during the Junior year or the summer following the Junior year.

Requirements

Six hours of Thesis credit, GEOS 4395 and 4396, must be completed over two semesters. Students may enroll for thesis credit only with the permission of the thesis director. A formal written thesis proposal must be submitted to
the geosciences faculty before the end of the fourth week of classes during the first semester of enrollment for thesis credit. The student may become a formal candidate for Departmental Honors by addressing a written request for consideration, accompanied by a letter of support from the student’s thesis director, to the Chair of the department. Achievement of Department Honors will be determined by the quality of the thesis research, the written and oral presentations, and satisfaction of University requirements.

Requirements

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The Major

Departmental requirements: Bachelor of Arts Degree in Earth Science (ESYS)

The requirements for the degree of Bachelor of Arts with a major in Earth Systems Science are:

A. At least 30 credit hours in geosciences, including:

1. One of GEOS 1303, GEOS 1304, GEOS 1405, or GEOS 1406.
2. GEOS 2400.
3. GEOS 2401, 2304, and 3400.
4. Participation in GEOS 3120 is required for junior majors. Trip expenses, including transportation, must be paid by each student.
5. At least eleven additional upper division hours in geosciences; no more than three hours of Directed Studies or Thesis may be applied to this upper division hour requirement.
6. GEOS 4001.

B. 18 additional credit hours from the following courses:

1. At least 9 credit hours from ANTH 2310; BIOL 1311, 1111, 2412, 2305, 3434; BUSN/ECON 2301; CHEM 1318, 1118, 2319, 2119; MATH 1307, 1308, 1311, 1312, 1320; CSCI 1320; PHYS 1303, 1309, 1311, 1111, 1310, 1312, 1112; PSYC 2401.
2. At least 6 credit hours from CMLT 2301, 2350; ECON/URBS 3330; ANTH 2310, 2357; PHIL 2350, 2356; PLSI 3313; SOCI 1316, 2314; URBS 3340.

C. University requirements:
Completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

Departmental requirements: Bachelor of Science Degree in Geosciences

The requirements for the degree of Bachelor of Science with a major in geosciences are:

A. At least 35 credit hours in geosciences, including:

1. One of GEOS 1303, GEOS 1304, GEOS 1405, or GEOS 1406.
2. GEOS 2400.
3. GEOS 2401, 2304, 3400, 3309, and 3401; plus 10 additional upper division hours in geosciences; no more than 3 hours of Directed Studies or Thesis may be applied to this upper division hour requirement.
4. Participation in GEOS 3120 is required for junior majors. Trip expenses, including transportation, must be paid by each student.
5. GEOS 4001.

B. MATH 1307 or 1311 and one of MATH 1308, 1312, or 1320; CHEM 1318 and 1118; PHYS 1309 or 1311, PHYS 1310 or 1312; PHYS 1111 and 1112.

C. University requirements: Completion of all other required elements of the Pathways curriculum and at least 124 credit hours.

It is recommended that students planning to attend graduate school or enter directly into a field-oriented aspect of the discipline take an accredited and departmentally approved summer field geology course.

The Minor

Requirements

The requirements are at least 18 hours of geoscience courses including GEOS 2400 and at least 9 hours of upper-division geoscience courses.

Honors in Geosciences
Requirements

Six hours of Thesis credit, GEOS 4395 and 4396, must be completed over two semesters. Students may enroll for thesis credit only with the permission of the thesis director. A formal written thesis proposal must be submitted to the geosciences faculty before the end of the fourth week of classes during the first semester of enrollment for thesis credit. The student may become a formal candidate for Departmental Honors by addressing a written request for consideration, accompanied by a letter of support from the student's thesis director, to the Chair of the department. Achievement of Department Honors will be determined by the quality of the thesis research, the written and oral presentations, and satisfaction of University requirements.

Courses

GEOS-1303 Volcanology
The study of volcanoes with emphasis on volcanic morphology, eruptive mechanisms, rock types, and magmatic properties and processes. Volcanoes will be examined in the context of plate tectonic theory. Natural resources produced by volcanic processes and geologic hazards associated with volcanism will be discussed. Field trip may be required; field trip costs must be paid by each student.

GEOS-1405 Oceanography
A inquiry-based introduction to the geologic, chemical, physical and biologic aspects of the Earth’s oceans. Topics include plate tectonics, seawater composition, waves, tides, currents, marine habitats and ecosystems and global climate change. Approximately one half of the course meeting times will be data analysis, laboratory or field activities. Field trip required; field trip costs must be paid by each student. (Offered every year.)

GEOS-1406 History and Evolution of Life
An inquiry-based study of major events in the history and evolution of life. Topics include fundamentals of earth systems, the origin of life, mechanics of evolution, diversification of life, the invasion of land, innovation of flight, mass extinctions, evolution of mammals, primates and hominids, and how human activity may affect the future of life. Three class hours each week, three full-day field trips, and out of class projects including analysis and synthesis of data gathered on field trips. Field trips are required; field trip costs must be paid by each student. (Offered every Spring)

GEOS-1304 Environmental Geology
A study of the environment that humans inhabit on Earth. Topics include geologic hazards such as volcanism, earthquakes, mass wasting and flooding; geologic resources such as soils, groundwater, mineral resources and fossil fuels; and the interaction of human activities with the geologic environment including urban development, flood control, agriculture, and climate change. Field trip is required; field trip costs must be paid by each student.

GEOS-1307 Geology, Resources, and Environmental Issues of China and Southeast Asia
A survey of the basic geology, natural resources and environmental issues of China and southeast Asia. The
fundamental geologic context of China and southeast Asia will be presented in the context of plate tectonics, Earth system process and Earth history. A large part of the course will be in seminar format. Discussion topics will focus on the unique geological features of China and southeast Asia, the geology of hydrocarbon, metallic and non-metallic resources, and the unique environmental challenges China and southeast Asia face as a result of rapid economic development.

GEOS-1409 Earth's Environmental Systems
An inquiry-based examination of the interaction of the Earth's natural systems and the role that humans play in determining the evolution of those systems. Topics include plate tectonics, solid earth processes and resources, surficial physical and chemical processes, energy resources, and global climate change. Field trips required; field trip costs must be paid by each student. Only one of GEOS 1409 and GEOS 1304 may be taken for credit. (Offered every year.)

GEOS-2400 Dynamic Earth
An intermediate-level, inquiry-based study of the fundamental geological materials and processes of the Earth. Topics include plate tectonics, geophysical studies of the subsurface, mineral properties and formation, rock properties and formation, volcanic processes and landforms, earthquake processes, geologic map interpretation, cross section construction, and relative and absolute age dating. Three class hours and three laboratory hours each week. Field trips are required; field trip costs must be paid by each student. (Offered every year).
Prerequisites: One lower division GEOS Course or fulfillment of the Natural Sciences Approach of the Pathways curriculum.

GEOS-2401 Earth History
A study of the significance of time as reflected in the rock and fossil record, with emphasis on understanding geological processes within a time framework. An analysis of time concepts, stratigraphic principles, and the fundamentals of sedimentary geology including the historical development of geological concepts and the recognition and reconstruction of ancient environments. Laboratory: study of minerals, rocks, and fossils; interpretation of surface features and time relationships through the use of topographic and geologic maps, cross sections, correlation diagrams, and aerial photos. Three class hours and three laboratory hours a week. Field trips are required; field trip costs must be paid by each student. Prerequisites: GEOS 2400

GEOS-2304 Earth Surface Processes
A survey of the important processes that create landforms on the Earth's surface. Emphasis will be on chemical and physical weathering, running water, wind, ice, and the resulting erosional and depositional landforms. The laboratory component will emphasize data collection and analysis techniques, including topographic maps, surveying and field trips. Two class hours and three laboratory hours per week for one semester. Field trips required; field trip costs must be paid by each student. Prerequisite: GEOS 2400

GEOS-3400 Earth Materials
An introduction to the origin, classification, and identification of minerals and rocks, including topics related to crystal systems and structures, bonding, mineral chemistry, the nature of magma, solidification of magma, magma genesis and evolution, types of metamorphism, metamorphic mineral reactions, metamorphic zones and facies,
determination of metamorphic grade, and the importance of mineral and rock resources to our society. The laboratory will emphasize methodologies and techniques used to identify and classify common minerals and rocks in hand specimen and thin section. Three class hours and three laboratory hours per week. Prerequisite: GEOS 2400

GEOS-3401 Structural Geology
A study of the mechanics of crustal deformation in the context of plate tectonics. An introduction to the descriptive, kinematic, and dynamic analysis of structures such as folds, faults, joint systems, and foliation. Emphasis on the application of structural cross-sections, stereonet analysis, graphical techniques, and computer applications to problems involving stress and strain of earth materials. Three class hours and three laboratory hours per week. Field trips required; field trip costs must be paid by each student. Prerequisite: GEOS 2401.

GEOS-3402 Paleontology
A study of invertebrate fossils, their classification, morphology, and geologic history. Also included will be an introduction to the principles of paleontologic investigation and their application to the study of geology. Three class hours and three laboratory hours a week. Prerequisite: GEOS 2401, or consent of instructor.

GEOS-3405 Field Methods in Quaternary Geology
A study of the tectonic and climatic controls on long-term landscape evolution. Emphasis will be on field and laboratory techniques for describing Quaternary landforms and deposits. Three class hours per week and an all-day field trip every other Saturday for one semester. Field trips required; field trip costs must be paid by each student. Prerequisite: GEOS 2304.

GEOS-3307 Planetary Geology
An introduction to the geologic processes that operate on the surfaces and within the interiors of rocky ice-rich objects in the Solar System. Earth analogues, remote sensing, and the latest results from the robotic planetary exploration are used to investigate the origin and geology of the solar system. Topics include nebular materials and processes in the early solar system, orbital dynamics, meteorites and impact cratering, formation and evolution of lithospheres and atmospheres, volcanism and tectonics, weathering phenomena, planetary environments, space missions and the data sets they collect. Prerequisite: GEOS 2400

GEOS-3309 Tectonics
Study of the tectonic processes of the Earth with emphasis on the historical development of tectonic theory and current research in tectonics. Topics include: geophysical and geochemical characterization of the Earth's interior, plate kinematics and dynamics, earthquake mechanisms, the nature and origin of continental crusts and margins, and the relationship between tectonics and rock-forming processes. Prerequisite: GEOS 3400

GEOS-3310 Global Climate Change
An intermediate-level study of the fundamental science of global climate change. Topics include an introduction to the global climate system, a review of the fundamentals of energy transfer between earth systems, investigation of the geologic evidence of natural climate change, and evidence for anthropogenic climate change. The course will also delve into the present and future impacts of climate change on natural systems and human activities, and
students will investigate potential viable solutions to global climate change. (Offered every Spring) Prerequisites: One lower division GEOS course.

**GEOS-3411 Hydrology**
A description of the terrestrial hydrologic cycle and its fundamental components including precipitation, evapotranspiration, infiltration, hillslope hydrology, runoff, flood hydrology and groundwater flow. Emphasis will be placed on physical principles governing the movement of water across and through the Earth's surface. Human interaction with all aspects of the hydrologic cycle will be addressed. The laboratory component of the course will focus on data collection, analysis and manipulation, and involve a significant field component. Three class hours and three laboratory hours a week. Field trips are required; field trip expenses must be paid by each student. Prerequisites: GEOS 2304; PHYS 1309/1111 or Phys 1311/1111 or equivalent.

**GEOS-3412 Applied Geophysics**
An introduction to the use of physical principles and measurements in the study of the Earth’s subsurface, with an emphasis on applications in environmental science, engineering, mineral exploration and archaeology. Topics include Fourier analysis, seismic waves in elastic media, refraction tomography, reflection seismology, multichannel analysis of surface waves, gravity, electrical resistivity and groundpenetrating radar. (Same as PHYS 3412) Three class hours and three laboratory hours per week. Field trips are required; field trip expenses must be paid by each student. Prerequisite: PHYS 1310 or 1312 (may be taken concurrently).

**GEOS-3315 Iceland - Its Unique Geological, Economic and Cultural History**
This course will expose students to the unique economic, geologic, and cultural history of Iceland. The economic aspects will focus on the role of financial markets and monetary institutions in economic booms and crashes using Iceland as a case study, possible solutions to public good problems such as the Icelandic fishing quota, business practices which often prioritize protection of the environment and social responsibility, and the role of international trade in development of a small country. The geological history will emphasize Iceland’s plate tectonic setting, volcanism, glacial history and related hazards, geothermal energy, and the effects of climate change. The cultural portion will explore the fundamental role of literature in a country with virtually no illiteracy, and the role of the sagas in the transmission of culture, language, and the law in the country with the oldest parliament in the world. (Offered every other year).

**GEOS-3319 Field Geology in China**
Field study of the evolution of sedimentary basins and mountain belts in China. Emphasis on developing observational and interpretative skills in the field. Additional goals are to gain an appreciation of Chinese culture, language and history by working together with Chinese students and studying a variety of sites of historical and cultural importance. Students interested in geosciences, environmental studies, anthropology, and Chinese languages and cultures are encouraged to apply. Prerequisites: One course in geology, consent of instructor.

**GEOS-3120 Majors' Field Trip**
Field study of selected areas in Texas and surrounding regions: emphasis on developing observational and interpretative skills in the field. May only be taken on a pass-fail basis. Field trip costs must be paid by each student. May be taken twice for credit. Prerequisite: Departmental major or by invitation of the department.
GEOS-3321 Geochemistry
A study of geochemical principles and their application in solving geologic problems. Emphasis is placed on topics in inorganic geochemistry, including phase equilibria, isotopes and trace elements. Prerequisites: GEOS 3400 and MATH 1311 or consent of instructor.

GEOS-3422 Sedimentology and Stratigraphy
The identification, description, and interpretation of sediments, sedimentary rocks, and sedimentary strata; an introduction to the principles of stratigraphy and of sedimentary processes as they relate to modern depositional systems and their ancient analogs. Emphasis will be place on the interpretation of depositional systems and sequence stratigraphy. Three class hours and three laboratory hours a week. Field trips are required; field trip costs must be paid by each student. Prerequisites: GEOS 2401 and 3400.

GEOS-3423 Basin Analysis
Application of stratigraphic concepts to the study of basin evolution and the environmental history and geometry of sedimentary rock successions. Emphasis will be placed on tectonic evolution of basins, principles of stratigraphic correlation, carbonate depositional systems, sequence stratigraphy, event stratigraphy, stratigraphic modeling, and hydrocarbon systems. Laboratory experiments with outcrop sample suites, core and subsurface geophysical data sets. Three class hours and three laboratory hours per a week. Field trips required; field trip costs must be paid by each student. Prerequisites: GEOS 2401 and 3400.

GEOS-3-90 Directed Studies - Junior Level
Individual work under supervision. Credit may vary. Prerequisites: Major or minor standing and consent of project supervisor.

GEOS-3-91 Special Topics
An in-depth study of a topic in geosciences that is otherwise not covered in existing courses. May be repeated for credit on different topics. Prerequisite: Consent of instructor.

GEOS-3-92 Internship
An off-campus internship in professional geoscientific practice. Internships may be arranged with businesses, nonprofit institutions and government agencies and must be supervised by a faculty member. Geoscientific field work, laboratory work or analysis must be conducted during the course of the internship. May be repeated for a maximum of 3 credit hours. May only be taken on a Pass/fail basis. Prerequisites: Prior written approval of the supervising faculty member and departmental permission.

GEOS-4001 Senior Comprehensive Examination
Geosciences and Earth Systems majors with senior standing will take a comprehensive exam. Students will be required to attend a one-hour meeting held early in the Spring semester. The exam will be administered on a Saturday in February. May only be taken on a pass/fail basis. Prerequisites: Departmental major and senior standing.
GEOS-4301 Land Use, Geology, and the Environment
The study of local, regional, and worldwide land use issues in the context of geological and environmental processes. In addition to investigating the impacts of natural processes upon land use, students will also study the complex legal, social, economic, and political factors that affect the land use decision-making process in both rural and urban settings. A term project will emphasize the integration of environmental science, environmental policy, and environmental arts and humanities to address specific real-world land use problems. Prerequisite: Junior or Senior standing and at least one course in GEOS.

GEOS-4-90 Directed Studies - Senior Level
Individual work under supervision. Credit may vary Prerequisites: Major or minor standing and consent of project supervisor.

GEOS-4395 Thesis Research
Student research conducted under the supervision of a Trinity University faculty member leading to written communication of the research in thesis format. Course enrollment requires planning with the thesis director during the Junior year. A written thesis proposal must be submitted to the department. Prerequisites: Senior standing and acceptance by a thesis director.

GEOS-4396 Thesis Research and Presentation
A continuation of student project begun in GEOS 4395. Students are required to write and defend their thesis according to University guidelines set forth in this Bulletin. An oral presentation of the thesis will be made to the students and faculty of the department. Prerequisite: GEOS 4395.