

# Earth Science (ERSC)

Jill A. Marshall  
Program Director  
116 Gearhart Hall  
479-575-2420  
Email: jillm@uark.edu

Earth Science Webpage (<https://fulbright.uark.edu/departments/geosciences/undergraduate/erscbs.php>)

Fulbright College offers a major in earth science leading to the Bachelor of Science degree. Prospective secondary teachers may plan a program, in cooperation with the College of Education, which will satisfy the teacher licensure requirements. Students interested in environmental problems, teaching earth science in public schools, or wishing to pursue graduate work in either geography or geology will obtain much of the necessary foundation through this degree. Because the program outlined below lists only minimum science requirements, it is expected that most students will use some of their elective credit hours to strengthen their mathematics and science backgrounds in areas other than geography and geology. These areas of additional study will be determined through consultation between the student and the adviser.

## Requirements for the B.S. Degree with a Major in Earth Science:

In addition to the University Core (<http://catalog.uark.edu/undergraduatecatalog/academicregulations/universitycore/>) requirements and the Fulbright College of Arts and Sciences Graduation Requirements (<http://catalog.uark.edu/undergraduatecatalog/collegesandschools/jwilliamfulbrightcollegeofartsandsciences/>), the following course requirements must be met. Bolded courses from the list below may be applied to portions of the University/state minimum core requirements.

### Basic Courses

<b>Biology</b>		<b>8</b>
<b>Chemistry or Physics</b>		<b>8</b>
GEOS 1113 Physical Geology (ACTS Equivalency = GEOL 1114 Lecture)		4
& GEOS 1111L and Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab)		
GEOS 1133 Earth Science (ACTS Equivalency = GEOL 1124 Lecture)		4
& GEOS 1131L and Earth Science Laboratory (ACTS Equivalency = GEOL 1124 Lab)		
Select one of the following:		3-4
MATH 2043 Survey of Calculus (ACTS Equivalency = MATH 2203)		
MATH 2053 Finite Mathematics		
MATH 2183 Mathematical Reasoning in a Quantitative World		
MATH 2554 Calculus I (ACTS Equivalency = MATH 2405)		
6 hours in a single world language at the 1013 Elementary II level or higher <sup>1</sup>		6
ASTR 2003 Survey of the Universe (ACTS Equivalency = PHSC 1204 Lecture)		4
& ASTR 2001L and Survey of the Universe Laboratory (ACTS Equivalency = PHSC 1204 Lab)		
<b>Advanced Courses</b>		
GEOS 3023 Introduction to Cartography		3
GEOS 3043 Sustaining Earth		3

GEOS 4353 Meteorology		3
or GEOS 4363 Climatology		
GEOS 2313 Mineralogy		3
GEOS 3413 Sedimentary Geology		3
GEOS 4033 Hydrogeology		3
GEOS 4924 Earth System History (ACTS Equivalency = PHSC 1104)		4
At least 6 additional hours, at the 3000 level or above, in GEOS.		6

**Total Hours** **65-66**

<sup>1</sup> World language courses taken are dependent on placement level in sequence.

**Writing Requirement:** The college writing requirement is to be met by completion of a term paper deemed satisfactory by the student's adviser and instructor of an upper-level geoscience course. The college writing requirement may also be met by the completion of an honors thesis.

## Earth Science B.S. Eight-Semester Degree Program

Students wishing to follow the eight-semester degree plan should see the Eight-Semester Degree Policy (<http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/>) for university requirements of the program. Core requirement hours may vary by individual, based on placement and previous credit granted. Once all core requirements are met, students may substitute a three-hour (or more) general elective in place of a core area.

First Year	Units	
	Fall	Spring
ENGL 1013 Composition I (ACTS Equivalency = ENGL 1013)	3	
Select one of the following:	3-4	
MATH 1203 College Algebra (ACTS Equivalency = MATH 1103)		
MATH 2043 Survey of Calculus (ACTS Equivalency = MATH 2203) <sup>1</sup>		
MATH 2053 Finite Mathematics <sup>1</sup>		
MATH 2183 Mathematical Reasoning in a Quantitative World <sup>1</sup>		
MATH 2554 Calculus I (ACTS Equivalency = MATH 2405) <sup>1</sup>		
GEOS 1113 Physical Geology (ACTS Equivalency = GEOL 1114 Lecture)	4	
& GEOS 1111L Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab)		
1013 Elementary II World Language Course (or higher level)	3	
University/State Core US History requirement	3	
ENGL 1023 Composition II (ACTS Equivalency = ENGL 1023)		3
Select one of the following MATH if still needed, else General Elective:		3-4
MATH 2043 Survey of Calculus (ACTS Equivalency = MATH 2203) <sup>1</sup>		
MATH 2053 Finite Mathematics <sup>1</sup>		

MATH 2183 Mathematical Reasoning in a Quantitative World <sup>1</sup>		
MATH 2554 Calculus I (ACTS Equivalency = MATH 2405) <sup>1</sup>		
General Elective		
GEOS 1133 Earth Science (ACTS Equivalency = GEOL 1124 Lecture)	4	
& GEOS 1131L Earth Science Laboratory (ACTS Equivalency = GEOL 1124 Lab)		
2003 Intermediate I World Language Course (or higher level)	3	
University/State Core Fine Arts or Humanities Course requirement	3	
Year Total:	16	16

Second Year	Units	
	Fall	Spring
GEOS 2313 Mineralogy	3	
CHEM or PHYS Course (as needed)	4	
University/State Core Humanities or Fine Arts Course requirement (as needed)	3	
University/State Core Social Science requirement	3	
General Elective	3	
ASTR 2003 Survey of the Universe (ACTS Equivalency = PHSC 1204 Lecture)		4
& ASTR 2001L Survey of the Universe Laboratory (ACTS Equivalency = PHSC 1204 Lab)		
GEOS 3413 Sedimentary Geology		3
CHEM or PHYS Course (as needed)		4
University/State Core Social Science requirement		3
Year Total:	16	14

Third Year	Units	
	Fall	Spring
BIOL Course (as needed)	4	
GEOS 3023 Introduction to Cartography <sup>1,2</sup>	3	
University/State Core Social Science requirement	3	
Advanced Level Elective <sup>1</sup>	3	
Advanced Level Elective <sup>1</sup>	3	
GEOS 3043 Sustaining Earth		3
BIOL Course (as needed)		4
Advanced Level Elective <sup>1</sup>		3
GEOS 4033 Hydrogeology (Sp)		3
General Elective		1
Year Total:	16	14

Fourth Year	Units	
	Fall	Spring
Select one of the following:	3	
GEOS 4353 Meteorology (as needed) <sup>1,2</sup>		
or Advanced Level Elective <sup>1</sup>		
Upper Level GEOS Course <sup>1,2</sup>	3	
3000-plus Level Elective <sup>1</sup>	3	
General Electives	6	

GEOS 4924 Earth System History (ACTS Equivalency = PHSC 1104)		4
Select one of the following		3
GEOS 4363 Climatology		
or Advanced Level Elective <sup>1</sup>		
Upper Level GEOS Course <sup>1,2</sup>		3
3000-plus Level Elective <sup>1</sup>		3
Year Total:	15	13

---

**Total Units in Sequence: 120**

<sup>1</sup> Meets 40-hour advanced credit hour requirement. See College Academic Regulations (<http://catalog.uark.edu/undergraduatecatalog/collegesandschools/jwilliamfulbrightcollegeofartsandsciences/>).

<sup>2</sup> Meets 24-hour rule (24 hours of 3000-4000 level courses in Fulbright College), in addition to meeting the 40-hour rule. See College Academic Regulations (<http://catalog.uark.edu/undergraduatecatalog/collegesandschools/jwilliamfulbrightcollegeofartsandsciences/>).

#### Teacher Licensure Requirements:

Students interested in pursuing a minor in STEM Education or Secondary Teacher Licensure in mathematics, biology, chemistry, physics, or computer science at the undergraduate level should consult with a STEM Education faculty adviser, [teach@uark.edu](mailto:teach@uark.edu). Another option to obtain secondary teacher licensure is to complete the one-year Master of Arts in Teaching (<http://catalog.uark.edu/undergraduatecatalog/collegesandschools/jwilliamfulbrightcollegeofartsandsciences/mathematicalsciencesmasc/graduatecatalog/programsofstudy/teachereducation/>).

## Courses

### GEOS 1111L. Physical Geology Laboratory (ACTS Equivalency = GEOL 1114 Lab). 1 Hour.

Laboratory exercises concerning the identification of rocks and minerals, use of aerial photographs and topographic maps, and several field trips. Pre- or Corequisite: GEOS 1113. (Typically offered: Fall, Spring and Summer)

### GEOS 1111M. Honors Physical Geology Laboratory. 1 Hour.

Survey of geological processes and products and their relationships to landforms, natural resources, living environments, and human beings. Lecture 3 hours, laboratory 2 hours per week. Corequisite: GEOS 1113H. (Typically offered: Fall) This course is equivalent to GEOS 1111L.

### GEOS 1113. Physical Geology (ACTS Equivalency = GEOL 1114 Lecture). 3 Hours.

Survey of geological processes and products, and their relationships to landforms, natural resources, living environments and human beings. Corequisite: GEOS 1111L. (Typically offered: Fall, Spring and Summer)

### GEOS 1113H. Honors Physical Geology. 3 Hours.

Survey of geological processes and products and their relationships to landforms, natural resources, living environments, and human beings. Lecture 3 hours, laboratory 2 hours per week. Corequisite: GEOS 1111M. (Typically offered: Irregular) This course is equivalent to GEOS 1113.

### GEOS 1123. Human Geography (ACTS Equivalency = GEOG 1113). 3 Hours.

Basic course in human geography stressing the interrelationships between the natural factors of the environment and man's activities, especially the role of geography in the understanding of social problems and economic and political activities. (Typically offered: Fall and Spring)

**GEOS 1123H. Honors Human Geography. 3 Hours.**

Basic course in human geography stressing the interrelationships between the natural factors of the environment and man's activities, especially the role of geography in the understanding of social problems and economic and political activities. Prerequisite: Honors candidacy. (Typically offered: Fall and Spring)  
This course is equivalent to GEOS 1123.

**GEOS 1131L. Earth Science Laboratory (ACTS Equivalency = GEOL 1124 Lab). 1 Hour.**

Laboratory exercises concerning human interactions with the physical environment including the study of earthquakes, volcanoes, flooding, erosion, mass wasting, water supply and contamination, and waste disposal. (Typically offered: Fall and Spring)

**GEOS 1133. Earth Science (ACTS Equivalency = GEOL 1124 Lecture). 3 Hours.**

The application of earth science principles and knowledge of problems created by human occupancy and exploitation of the physical environment. (Typically offered: Fall and Spring)

**GEOS 2003. World Regional Geography (ACTS Equivalency = GEOG 2103). 3 Hours.**

Survey of problems, development potential, and physical and human resources of the developing and developed world. (Typically offered: Fall and Spring)

**GEOS 2003H. Honors World Regional Geography. 3 Hours.**

Survey of problems, development potential, and physical and human resources of the developing and developed world. Prerequisite: Honors candidacy. (Typically offered: Fall and Spring)

This course is equivalent to GEOS 2003.

**GEOS 2313. Mineralogy. 3 Hours.**

General principles of mineralogy, study and identification of common minerals, igneous & metamorphic rocks using hand samples. Prerequisite: GEOS 1113 and CHEM 1103. Corequisite: Lab component. (Typically offered: Fall)

**GEOS 2813. Digital Earth. 3 Hours.**

This course introduces the fundamental concepts and practical geospatial techniques of the digital earth initiative. Students will learn how digital geographical information is produced (also referred to as geospatial data) and utilized in a variety of economic, environmental, and scientific applications. The class will concentrate on how digital geospatial data are produced, integrated and applied in daily life and will review a variety of environmental and socioeconomic applications. (Typically offered: Fall)

**GEOS 2813H. Honors Digital Earth. 3 Hours.**

This course introduces the fundamental concepts and practical geospatial techniques of the digital earth initiative. Students will learn how digital geographical information is produced (also referred to as geospatial data) and utilized in a variety of economic, environmental, and scientific applications. The class will concentrate on how digital geospatial data are produced, integrated and applied in daily life and will review a variety of environmental and socioeconomic applications. Prerequisite: Honors standing. (Typically offered: Fall)  
This course is equivalent to GEOS 2813.

**GEOS 3013. Foundations of Geospatial Data Analysis. 3 Hours.**

Basic mathematical tools applied in geospatial technology, including trigonometry in mapping, linear algebra in remote sensing, optimization in spatial decision support, and graph theory in routing. Course develops the framework for spatial data analysis and decision support. Students may receive credit for the course through testing. Prerequisite: GEOS 3543. (Typically offered: Fall and Spring)

**GEOS 3023. Introduction to Cartography. 3 Hours.**

Students learn basic principles of map design, cartographic theory and field surveying to produce a variety of computer-generated maps. An introductory course designed for students in a variety of different disciplines using AutoCad software and various new technologies. Field trips may be required. (Typically offered: Fall)

**GEOS 3043. Sustaining Earth. 3 Hours.**

Theory and growth of conservation and sustainability, the wise use of the major natural resources of the United States. This course meets the requirement in conservation and sustainability for teachers. Prerequisite: Junior standing. (Typically offered: Fall)

**GEOS 3043H. Honors Sustaining Earth. 3 Hours.**

Theory and growth of conservation and the wise use of the major natural resources of the United States. This course meets the requirement in conservation for teachers. Prerequisite: Junior standing. (Typically offered: Fall)  
This course is equivalent to GEOS 3043.

**GEOS 3063. Geology of Arkansas. 3 Hours.**

A survey of the distribution, genesis, and age of the rocks, fossils, structures, landforms and geological processes of Arkansas. Equivalent to two hours of lecture per week. Field trips required. Prerequisite: GEOS 1113 or GEOS 1113H. (Typically offered: Spring)

**GEOS 3103. Geospatial Technologies Computational Toolkit. 3 Hours.**

Basic computational tools and processes applied in geospatial software, related computer hardware components, systems and applications software, and spatial database fundamentals. Python, including SciPy and NumPy, geospatial implementations will be emphasized. No programming experience is required. Students may receive credit for the course through testing. Prerequisite: GEOS 3543. (Typically offered: Fall and Spring)

**GEOS 3213. Principles of Remote Sensing. 3 Hours.**

Fundamental concepts of remote sensing of the environment. Optical, infrared, microwave, LIDAR, and in situ sensor systems are introduced. Remote sensing of vegetation, water, urban landscapes, soils, minerals, and geomorphology is discussed. The course includes laboratory exercises in GIS software and field spectroscopy. (Typically offered: Fall)

**GEOS 3333. Oceanography. 3 Hours.**

The sea, its landforms; its winds and currents as related to the atmosphere, world climates, and world trade; its basin as avenues for continental drift; its waters as habitat for plant and animal life; its marine and submarine resources as presently and potentially useful to man. Offered as physical science. Prerequisite: Junior standing. (Typically offered: Fall)

**GEOS 3413. Sedimentary Geology. 3 Hours.**

An introductory study of sedimentary rocks from the standpoint of classification, field and laboratory description, genesis, and preservation. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: GEOS 2313. (Typically offered: Spring)

**GEOS 3514. Structural Geology. 4 Hours.**

Survey of deformational features and their geological significance in the crust of the earth. Lecture 3 hours per week. Corequisite: Lab component. Prerequisite: GEOS 1113. (Typically offered: Spring)

**GEOS 3543. Geospatial Applications and Information Science. 3 Hours.**

An introduction to the methods and theory underlying the full range of geographic information science and collateral areas - including GNSS, remote sensing, cadastral, spatial demographics and others. (Typically offered: Fall and Spring)  
This course is cross-listed with ANTH 3543.

**GEOS 3553. Spatial Analysis Using ArcGIS. 3 Hours.**

Applications of analysis of spatial data using ArcGIS tools in map design, on-line mapping, creating geodatabases, accessing geospatial data, geo-processing, digitizing, geocoding, spatial analysis including basic spatial statistics, analysis of spatial distributions and patterning and 3D application using ArcGIS 3D Analyst. Prerequisite: GEOS 3543. (Typically offered: Fall and Spring)

**GEOS 3563. Geospatial Data Mining. 3 Hours.**

Basic tools for analyzing, summarizing and visualizing geospatial data. Exploratory data and spatial data analysis, probability distributions and application, single and multivariate analysis and hypothesis testing, and spatial smoothing and interpolation. Emphasis will be on problem solving in geospatial settings using the R statistical language. Prerequisite: GEOS 3543 and (GEOS 3013 or MATH 2554 or MATH 2043 or DASC 2594) and (GEOS 3103 or DASC 1104 or DASC 2113). (Typically offered: Fall and Spring)

**GEOS 3593. Introduction to Geodatabases. 3 Hours.**

Fundamental concepts and applications of geospatial databases. Schema development and spatial data models for geodata. Spatial and attribute query and optimization, properties and structures of relational and object-oriented geodatabases. Spatial extensions of SQL, spatial indexing, measurement, and geometry. Prerequisite: GEOS 3543 and (GEOS 3013 or MATH 2554 or MATH 2043 or DASC 2594) and (GEOS 3103 or DASC 1104 or DASC 2113). (Typically offered: Fall and Spring)

**GEOS 360V. Undergraduate Special Problems. 1-6 Hour.**

Library, laboratory, or field research in different phases of geology. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

**GEOS 3733. Geospatial Data Science in Public Health. 3 Hours.**

Introduction to geospatial data science, including geographic information systems (GIS) and related technologies, with an emphasis on their practical applications in the fields of public health, global health, healthcare analytics, healthcare administration, and other health-related fields. (Typically offered: Fall)

**GEOS 3873. Geological Data Analysis. 3 Hours.**

Quantitative methods and techniques for analysis and interpretation of geological data. Corequisite: Lab component. Pre- or corequisite: MATH 2564. (Typically offered: Spring)

**GEOS 3901. Junior Honors Course. 1 Hour.**

Special honors research in geology. One hour credit each semester. Prerequisite: Junior standing. (Typically offered: Fall, Spring and Summer)

**GEOS 3911. Junior Honors Course. 1 Hour.**

Special honors research in geology. One hour credit each semester. Prerequisite: Junior standing. (Typically offered: Fall, Spring and Summer)

**GEOS 399VH. Honors Course. 1-6 Hour.**

Honors course. Prerequisite: Junior standing. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

**GEOS 4033. Hydrogeology. 3 Hours.**

Occurrence, movement, and interaction of water with geologic and cultural features. Lecture 3 hours per week. Corequisite: Lab component. Prerequisite: MATH 2043 or MATH 2554, and GEOS 3514. (Typically offered: Spring)

**GEOS 4043. Geography of the Middle East. 3 Hours.**

Physical and cultural landscapes, natural and cultural resources, art and architecture, land use, political history, OPEC, and current problems of North Africa and the Middle East region west of Afghanistan are discussed. Class participation, discussions, slides and films, and student presentations will round out the class. Prerequisite: Junior standing. (Typically offered: Fall)

**GEOS 4043H. Honors Geography of the Middle East. 3 Hours.**

Physical and cultural landscapes, natural and cultural resources, art and architecture, land use, political history, OPEC, and current problems of North Africa and the Middle East region west of Afghanistan are discussed. Class participation, discussions, slides and films, and student presentations will round out the class. Prerequisite: Junior standing. (Typically offered: Irregular)

This course is equivalent to GEOS 4043.

**GEOS 4053. Geomorphology. 3 Hours.**

A quantitative, mechanistic overview of surface processes and landscape evolution. Lecture 2 hours, laboratory 3 hours per week. One to two field trips on weekends (2 day total) are required during the semester. Corequisite: Lab component. Prerequisite: GEOS 3873 or instructor consent. (Typically offered: Spring)

**GEOS 4063. Principles of Geochemistry. 3 Hours.**

Introduction to fundamental principles of geochemistry from historic development to modern concepts. Prerequisite: CHEM 1121L, CHEM 1123 and GEOS 2313. (Typically offered: Fall)

**GEOS 4073. Urban Geography. 3 Hours.**

Areal patterns of modern urban regions and the focus shaping these patterns. Emphasis is placed on American urban areas and their evolution and functional areas. Field work. Prerequisite: Junior standing. (Typically offered: Spring)

**GEOS 4083. Economic Geology. 3 Hours.**

Introduction to mineral deposits used as economic resources. Covers basic geology and geochemistry of mineral deposit formations and the formation of major classes of deposits. Examines the relationship between the distribution of ores, oil, gas, coal, and Plate Tectonics. Explores environmental issues associated with the extraction of earth resources. Prerequisite: GEOS 2313. (Typically offered: Irregular)

**GEOS 4093. History and Philosophy of Geography. 3 Hours.**

This course familiarizes students with the history of geography, the contributions of geographers to scientific thought and theory, and research techniques that are used in geography. Emphasis is given to the integration of statistical and spatial analysis, and their applications in field research. The course includes short field-based projects in and around Northwest Arkansas. (Typically offered: Spring Even Years)

**GEOS 410V. Special Problems in Geosciences. 1-6 Hour.**

Designed to meet the needs of students who wish to study one particular geographic topic in some detail. Prerequisite: Junior standing. (Typically offered: Fall) May be repeated for up to 6 hours of degree credit.

**GEOS 410VH. Honors Special Problems in Geosciences. 1-6 Hour.**

Designed to meet the needs of students who wish to study one particular geographic topic in some detail. Prerequisite: Junior standing. (Typically offered: Fall) May be repeated for up to 6 hours of degree credit.

This course is equivalent to GEOS 410V.

**GEOS 4113. Global Change. 3 Hours.**

Examines central issues of global change including natural and human induced climate change, air pollution, deforestation, desertification, wetland loss urbanization, and the biodiversity crisis. The U.S. Global Change Research Program is also examined. (Typically offered: Spring)

**GEOS 4113H. Honors Global Change. 3 Hours.**

Examines central issues of global change including natural and human induced climate change, air pollution, deforestation, desertification, wetland loss urbanization, and the biodiversity crisis. The U.S. Global Change Research Program is also examined. Prerequisite: Honors candidacy. (Typically offered: Spring)

This course is equivalent to GEOS 4113.

**GEOS 4133. Radar Remote Sensing. 3 Hours.**

Introduction to radar remote sensing and its applications in geology, geography, archeology, engineering, and agriculture. Focuses on Synthetic Aperture Radar (SAR) and advanced techniques including radar stereo, polarimetry, and interferometry. Covers Interferometric SAR (InSAR) for mapping topography and modeling Earth's surface motions due to earthquakes, volcanic eruptions, landslides, and subsidence. Prerequisite: GEOS 3023 or equivalent. (Typically offered: Spring)

**GEOS 4153. Karst Hydrogeology. 3 Hours.**

Assessment of ground water resources in carbonate rock terrains; relation of ground water and surface water hydrology to karst; quantification of extreme variability in karst environments; data collection rationale. Field trips required. Prerequisite: GEOS 4033. (Typically offered: Irregular)

**GEOS 4223. Stratigraphy and Sedimentation. 3 Hours.**

Introductory investigation of stratigraphic and sedimentologic factors important to the study of sedimentary rocks. Lecture 2 hours, laboratory 3 hours per week. A required weekend, two-day field trip will be conducted during the semester. Corequisite: Lab component. Prerequisite: GEOS 3413. (Typically offered: Fall)

**GEOS 4233. Geography of Religion & Sacrality. 3 Hours.**

Explores the spatial nature of the World's major faiths and religious institutions, focusing on the distribution and origins of these religions. Examines the religious beliefs, rituals, architecture, demographics, and art in different societies, cultures, and countries. Considers the tenets and practices of what is sacred and/or spiritual, held in common by a group or community. Prerequisite: Junior or senior standing. (Typically offered: Irregular)

**GEOS 4243. Political Geography. 3 Hours.**

Contemporary world political problems in their geographic context. Development of the principles of political geography with emphasis upon the problems of Eastern Europe, Africa, and Southeast Asia. Prerequisite: Junior standing. (Typically offered: Fall Odd Years)

**GEOS 4253. Petroleum Geology. 3 Hours.**

Distribution and origin of petroleum. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: Geology major and senior standing. (Typically offered: Fall)

**GEOS 4263. Geospatial Data Science - Sources and Characteristics. 3 Hours.**

Covers the wide range of geospatial data sources and characteristics with emphasis on data science applications through hands-on experience recognizing the unique requirements of major sources. Techniques for the integration of disparate, heterogeneous data sets will be covered. Corequisite: GEOS 3563. Prerequisite: GEOS 3543. (Typically offered: Fall)

**GEOS 430V. Internship in Physical Geography. 3-6 Hour.**

Supervised experience in municipal, county, state or private natural resource management agency, or any other such organization approved by instructor. (Typically offered: Fall, Spring and Summer)

**GEOS 4333. Igneous and Metamorphic Petrology. 3 Hours.**

Elementary to advanced study of the origin and evolution of igneous and metamorphic rocks in a variety of plate tectonics settings. Lecture 2 hours, Laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: GEOS 2313. (Typically offered: Spring)

**GEOS 4353. Meteorology. 3 Hours.**

Examination of the atmospheric processes that result in multifarious weather systems. Offered as physical science. Prerequisite: Junior standing. (Typically offered: Fall)

**GEOS 4363. Climatology. 3 Hours.**

Fundamentals of topical climatology followed by a study of regional climatology. Offered as physical science. Prerequisite: GEOS 1133 or GEOS 4353. (Typically offered: Spring)

**GEOS 437V. Geology Field Trip. 1-2 Hour.**

Camping field trip to areas of geologic interest, usually conducted during Spring Break. (Typically offered: Spring) May be repeated for up to 4 hours of degree credit.

**GEOS 4383. Hazard & Disaster Assessment, Mitigation, Risk & Policy. 3 Hours.**

Comprehensive introduction to interdisciplinary approaches to natural and environmental hazards and risk. Hazards and disaster assessment, mitigation, and policy are the focus of the class. Prerequisite: Junior or senior standing. (Typically offered: Spring) May be repeated for up to 6 hours of degree credit.

**GEOS 4383H. Honors Hazard & Disaster Assessment, Mitigation, Risk & Policy. 3 Hours.**

Comprehensive introduction to interdisciplinary approaches to natural and environmental hazards and risk. Hazards and disaster assessment, mitigation, and policy are the focus of the class. Prerequisite: Junior or senior standing. (Typically offered: Spring)

This course is equivalent to GEOS 4383.

**GEOS 4393. American Public Lands & Policy. 3 Hours.**

The course examines the role of American federal public lands in 19th-21st century geography, history, policy, and art. It investigates the growth of conservation, preservation, and management movements in the US by looking at America's national parks, forests, dams, wildlife refuges, wilderness areas, managed and agricultural lands. Prerequisite: Junior or senior standing. (Typically offered: Irregular)

**GEOS 4393H. Honors American Public Lands & Policy. 3 Hours.**

The course examines the role of American federal public lands in 19th-21st century geography, history, policy, and art. It investigates the growth of conservation, preservation, and management movements in the US by looking at America's national parks, forests, dams, wildlife refuges, wilderness areas, managed and agricultural lands. Prerequisite: Honors standing and Junior or senior standing. (Typically offered: Irregular)

This course is equivalent to GEOS 4393.

**GEOS 4433. Geophysics. 3 Hours.**

Derivation from physical principles, of the geophysical methods for mapping the Earth. Computational methods of converting gravity, magnetic, radiometric, electrical, and seismic data into geologic information. Lecture 3 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: MATH 2564 and PHYS 2033 and PHYS 2031L and GEOS 3514. (Typically offered: Irregular)

**GEOS 4473. Applied Climatology. 3 Hours.**

Applied climatology involves the use of climatic data to solve a variety of social, economic and environmental problems, such as for clients in agriculture, water and energy management. The basic purpose of applied climatology is to help society, at all scales and levels, to achieve a better adjustment to the climatic environment. (Typically offered: Fall)

**GEOS 4473H. Honors Applied Climatology. 3 Hours.**

Applied climatology involves the use of climatic data to solve a variety of social, economic and environmental problems, such as for clients in agriculture, water and energy management. The basic purpose of applied climatology is to help society, at all scales and levels, to achieve a better adjustment to the climatic environment. (Typically offered: Fall)

This course is equivalent to GEOS 4473.

**GEOS 4483. Severe Weather. 3 Hours.**

Focuses on the formation and impact of weather phenomena such as blizzards, floods, tornadoes, thunderstorms, hurricanes and droughts. Covers the mechanisms and physics that control severe weather, advanced terminology, physical concepts and scientific methods used in meteorology, and the analysis and interpretation of meteorological data. Prerequisite: GEOS 1133 and GEOS 1131L. (Typically offered: Spring)

**GEOS 4493. Geography of Political Violence. 3 Hours.**

This seminar focuses on the rise of civil conflict in the post-World War II world. We are particularly interested in understanding the institutional challenges facing countries that experience such conflict. The class will develop a contextually-informed understanding of the international system and how it is shaped by civil war. Prerequisite: Junior or senior standing. (Typically offered: Fall Even Years) This course is cross-listed with INST 4103.

**GEOS 4493H. Honors Geography of Political Violence. 3 Hours.**

This seminar focuses on the rise of civil conflict in the post-World War II world. We are particularly interested in understanding the institutional challenges facing countries that experience such conflict. The class will develop a contextually-informed understanding of the international system and how it is shaped by civil war. Prerequisite: Junior or senior standing and honors standing. (Typically offered: Fall Even Years)

This course is cross-listed with GEOS 4493, INST 4103.

**GEOS 4503. Advanced Cartographic Techniques & Production. 3 Hours.**

Covers advanced production and techniques in cartography, including animation, geospatial visualization, pochade, and advanced visualization. Emphasizes client relationships in creating and producing cartographic materials. Prerequisite: GEOS 4523. (Typically offered: Irregular)

**GEOS 4523. Cartographic Design and Production. 3 Hours.**

This course addresses advanced cartographic concepts (i.e. visual hierarchy, aesthetics, image cognition) and production techniques as they relate to computer-assisted mapping. Students produce a variety of maps using Adobe Illustrator (CS 4-6) software to build a map portfolio. Field trips may be required. Prerequisite: GEOS 3023. (Typically offered: Spring)

**GEOS 4533. Introduction to Petroleum Geophysics. 3 Hours.**

Introduction to seismic wave propagation and petroleum seismology with particular emphasis on seismic events, elastic waves, and seismic survey design. Prerequisite: MATH 2564, (PHYS 2033 or PHYS 2074), and GEOS 3514 or instructor consent. (Typically offered: Fall)

**GEOS 4533H. Honors Introduction to Petroleum Geophysics. 3 Hours.**

Introduction to seismic wave propagation and petroleum seismology with particular emphasis on seismic events, elastic waves, and seismic survey design. Prerequisite: MATH 2564, (PHYS 2033 or PHYS 2074), and GEOS 3514 or instructor consent. (Typically offered: Fall)

This course is equivalent to GEOS 4533.

**GEOS 4553. Introduction to Raster GIS. 3 Hours.**

Theory, data structure, algorithms, and techniques behind raster-based geographical information systems. Through laboratory exercises and lectures multidisciplinary applications are examined in database creation, remotely sensed data handling, elevation models, and resource models using boolean, map algebra, and other methods. Prerequisite: GEOS 3543 or ANTH 3543. (Typically offered: Fall)

This course is cross-listed with ANTH 4553.

**GEOS 4563. Geology of Our National Parks. 3 Hours.**

This course examines the underlying geology responsible for selected parks, and explores the interplay of geology, biology, climate, topography, and humans to evaluate the value of the parks, and to anticipate the problems they will face in the near and long-term. Prerequisite: GEOS 1113. (Typically offered: Fall)

**GEOS 4583. Enterprise and Multiuser GIS. 3 Hours.**

GIS practice that's typical of collaborative team-based geospatial organizations. Solve real-world problems through end-to-end GIS design and implementation using ArcGIS Enterprise, extensive federal, state, and local repositories, and high quality software documentation. Includes relevant training in geospatial provenance and metadata, and in enterprise and multiuser GIS administration. (Typically offered: Spring)

**GEOS 4593. Introduction to Global Positioning Systems and Global Navigation Satellite Systems. 3 Hours.**

Fundamentals of navigation, mapping, and high-precision positioning using the Navstar Global Positioning System. Topics include datum definition and transformation, map projections, autonomous and differential positioning using both code and carrier processing, and analysis of errors. Prerequisite: GEOS 3543 or GEOS 5543. (Typically offered: Fall)

This course is cross-listed with ANTH 4593.

**GEOS 4653. GIS Analysis and Modeling. 3 Hours.**

Unlike conventional GIS courses that focus on studying "where", this course will teach students to address beyond "where" using various GIS analysis and modeling techniques to explore "why" and "how". The course will provide theoretical and methodological reviews of the principles of cartographic modeling and multi-criteria decision-making. (Typically offered: Spring)

This course is cross-listed with ANTH 4653.

**GEOS 4663. Low-Temperature Geochemistry of Natural Waters. 3 Hours.**

Covers the low-temperature geochemistry of waters and their associated minerals at Earth's surface. Examines the controls on the chemical composition of natural waters and the minerals precipitated from them. Topics covered will include water-rock interactions, pH, redox, the carbonate-water system, clay minerals and exchange, heavy metals, and a brief introduction to stable isotopes and geomicrobiology. Prerequisite: CHEM 1121L, CHEM 1123, GEOS 1113, and GEOS 1111L. (Typically offered: Fall)

**GEOS 4673. Volcanology. 3 Hours.**

A broad introduction to volcanic processes and their associated hazards. Emphasis will be placed on applying basic physical and chemical principles to understanding volcanic systems. Prerequisite: GEOS 2313. (Typically offered: Irregular)

**GEOS 4686. Geology Field Camp. 6 Hours.**

A professional course taught off campus emphasizing occurrence, description, mapping, and interpretation of major rock types. May not be taken for graduate credit. Prerequisite: GEOS 3413 and GEOS 3514. (Typically offered: Summer)

**GEOS 4693. Environmental Justice. 3 Hours.**

This course deals with the ethical, environmental, legal, economic, and social implications of society's treatment of the poor, the disenfranchised, and minorities who live in the less desirable, deteriorating neighborhoods, communities, and niches of our country. The class integrates science with philosophy, politics, economics, policy, and law, drawing on award-winning films, current news, and case studies. (Typically offered: Spring)

**GEOS 4693H. Honors Environmental Justice. 3 Hours.**

This course deals with the ethical, environmental, legal, economic, and social implications of society's treatment of the poor, the disenfranchised, and minorities who live in the less desirable, deteriorating neighborhoods, communities, and niches of our country. The class integrates science with philosophy, politics, economics, policy, and law, drawing on award-winning films, current news, and case studies. (Typically offered: Spring)

This course is equivalent to GEOS 4693.

**GEOS 4783. Geography of Europe. 3 Hours.**

Geographic regions of the area with emphasis on their present development. Prerequisite: Junior standing. (Typically offered: Irregular)

**GEOS 4793. Geospatial Unmanned Aircraft Systems. 3 Hours.**

Geospatial unmanned aircraft systems (UAS) are becoming key technologies in a number of disciplines. This course will introduce safe and legal operation of UAS in aerial photography, multispectral, thermal and LIDAR applications, geodetic control, photogrammetric and computer vision processing, and the creation of accurate 2D and 3D digital information products. Pre- or Corequisite: GEOS 3213 or GEOS 4593 or equivalent. (Typically offered: Fall)

**GEOS 4813. Geography of Eurasia. 3 Hours.**

Introduction to the culture, society, and politics of Eurasia using the organizing concept of empire from the moment of its consolidation in 1945 to its dissolution in 1991. Focuses on places that have emerged from this order and emphasizes experience and memory at each of these different times and places. Prerequisite: Junior standing. (Typically offered: Spring Even Years)

**GEOS 4924. Earth System History (ACTS Equivalency = PHSC 1104). 4 Hours.**

Physical and biological events that form the history of the earth from its formation to the beginning of the historical era. Corequisite: Lab component. Prerequisite: GEOS 3413 and (GEOS 4223 or GEOS 4333) and GEOS 3514. (Typically offered: Spring)

**GEOS 4933. Ancient Forest Science and Sustainability. 3 Hours.**

Ancient forests preserve beautiful habitat with high ecological integrity. This course will examine the development, spatial distribution, and ongoing destruction of ancient forests worldwide, and how science can contribute to the understanding and sustainable management of these valuable resources. (Typically offered: Spring)

**GEOS 4972H. Senior Honors Course I. 2 Hours.**

Special honors research in geology. Two hours of credit each semester. Prerequisite: Junior honors. (Typically offered: Fall, Spring and Summer)

**GEOS 4982H. Senior Honors Course II. 2 Hours.**

Special honors research in geology. Two hours of credit each semester. Prerequisite: Junior honors. (Typically offered: Fall, Spring and Summer)

**GEOS 4993. Dynamics of Sediment Transport. 3 Hours.**

This is a course focused on how fluids transport sediment and construct stratigraphy. Lectures will develop environmental fluid mechanics and sediment transport from first principles so they can be used to evaluate sedimentological and stratigraphic problems. This framework will be applied to a sedimentological problem using original data and analysis. Pre- or Corequisite: GEOS 4223. Prerequisite: GEOS 3413. (Typically offered: Fall Odd Years)