Geosciences (GEOS)

Courses

GEOS 1111L. General 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.

GEOS 1111M. Honors General 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.
This course is equivalent to GEOS 1111L.

GEOS 1113. General 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. Lecture 3 hours per week. GEOS 1111L is recommended as a corequisite.

GEOS 1113H. Honors General 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.
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.

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.

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.

Survey of problems, development potential, and physical and human resources of the developing and developed world.

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.
This course is equivalent to GEOS 2003.

GEOS 2313. Mineralogy and Petrology. 3 Hours.
General principles of mineralogy and petrology, study and identification of common minerals, igneous & metamorphic rocks using hand samples. Corequisite: Lab component. Prerequisite: GEOS 1113 and CHEM 1103.

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.

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.
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.

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.

GEOS 3033. Building Materials Field Studies. 3 Hours.
Study of durable building materials, their availability, strength, deterioration, limitation and utility. Historic construction techniques, identification of architectural materials, architectural elements assessment, causes and mechanisms of deterioration, conservation and treatment of architectural materials, preservation philosophies and standards and creation of a practical field identification kit will also be covered. Corequisite: Lab component.

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.

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.
This course is equivalent to GEOS 3043.

GEOS 3052. Geology for Engineers. 2 Hours.
Geologic principles involved in construction, reservoir location, etc. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component.

GEOS 3062. Geology of Arkansas. 2 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.

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.

GEOS 3114. Invertebrate Paleontology. 4 Hours.
Survey of the invertebrate phyla commonly preserved as fossils emphasizing their physical and biological characteristics. Lecture 3 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: GEOS 1133 or (BIOL 1543 and BIOL 1541L) or equivalent.
GEOS 3313. Igneous and Metamorphic Rocks. 3 Hours.
Megascopic study and classification of igneous and metamorphic rocks. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: GEOS 2313.

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.

GEOS 3383. Principles of Landscape Evolution. 3 Hours.
Examines the role of waves, rivers, wind, and tectonics in shaping and modifying the surface of the earth. Considers the way in which an understanding of landscape processes is essential to the effective solution of environmental problems. Lecture 3 hours. May be repeated for up to 3 hours of degree credit.

GEOS 3413. Sedimentary Rocks & Fossils. 3 Hours.
An introductory study of sedimentary rocks and fossils 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.

GEOS 3514. Structural Geology. 4 Hours.
Survey of deformatonal features and their geological significance in the crust of the earth. Lecture 3 hours per week. Corequisite: Lab component. Prerequisite: GEOS 1113 or GEOS 3052.

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. 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.

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. Prerequisite: GEOS 3013 and GEOS 3103 or equivalent.

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, GEOS 3013 and GEOS 3103.

GEOS 360V. Undergraduate Special Problems. 1-6 Hour.
Library, laboratory, or field research in different phases of geology. May be repeated for up to 6 hours of degree credit.

GEOS 3901. Junior Honors Course. 1 Hour.
Special honors research in geology. One hour credit each semester. Prerequisite: Junior standing.

GEOS 3911. Junior Honors Course. 1 Hour.
Special honors research in geology. One hour credit each semester. Prerequisite: Junior standing.

GEOS 3923H. Honors Colloquium. 3 Hours.
Covers a special topic or issue, offered as part of the honors program. Prerequisite: Honors candidacy (not restricted to candidacy in geology or geography). May be repeated for degree credit.

GEOS 399VH. Honors Course. 1-6 Hour.
Honors course. Prerequisite: Junior standing. 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.

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.

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. This course is equivalent to GEOS 4043.

GEOS 4053. Geomorphology. 3 Hours.
Mechanics of landform development. Lecture 2 hours, laboratory 3 hours per week. Several local field trips are required during the semester. Corequisite: Lab component. Prerequisite: GEOS 1113 or GEOS 3052.

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.

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.

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.

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.

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. 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. 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.

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.

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, archaeology, 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.

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.

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 4314.

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.

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.

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.

GEOS 430V. Internship in Physical Geography. 3-6 Hour.
Supervised experience in physical geography. Prerequisite: CHEM 1123, GEOS 3313, MATH 2564, PHYS 2074 or instructor consent.

GEOS 4353. Climate Change. 3 Hours.
Fundamentals of topical climatology followed by a study of regional climatology. Offered as physical science. Prerequisite: GEOS 1133 or GEOS 4353.

GEOS 437V. Geology Field Trip. 1-2 Hour.
Camping field trip to areas of geologic interest, usually conducted during Spring Break. Prerequisite: GEOS 3313. 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. 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.

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, wildlife refuges, wilderness areas, managed and agricultural lands. Prerequisite: Junior or senior standing.

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, wildlife refuges, wilderness areas, managed and agricultural lands. Prerequisite: Honors standing and Junior or senior standing.

This course is equivalent to GEOS 4393.

GEOS 440V. Internship in GIS & Cartography. 3-6 Hour.
Supervised experience in GIS and/or cartographic applications with municipal, county, state, or private enterprises. May be repeated for up to 6 hours of degree credit.

GEOS 4413. 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. Prerequisite: GEOS 3023 or GEOS 3543.

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.

GEOS 4443. The Solid Earth: Structure, Composition and Evolution. 3 Hours.
Modern views for the origin of the solid Earth and its structure, composition, and evolution through geologic time. Topics will include examination of relevant geophysical and geochemical constraints used to develop global models for the Earth. Prerequisite: CHEM 1123, GEOS 3313, MATH 2564, PHYS 2074 or instructor consent.

GEOS 4463. 3D Seismic Exploration. 3 Hours.
Interpretation of the spatial component of three-dimensional seismic data in geologic structure and stratigraphy with emphasis on hydrocarbon exploration. Prerequisite: GEOS 3514 or instructor consent.

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.
GEOS 4473H. Honors Applied Climatology. 3 Hours.
Applies climatology to 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. 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.

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. 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. 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.

GEOS 4513. Introduction to GIS Programming. 3 Hours.
This course introduces fundamentals of GIS software engineering and offers hands-on tutorials in customized applications using ArcGIS through programming ArcObjects in VBA / VA.net environment. Topics covered include ArcObjects, different programming syntax and styles, and fundamental routines and functions in ArcGIS. After completing the course, students will have the capability to develop customized ArcGIS applications.

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.

GEOS 4533. Introduction to Petroleum Geophysics. 3 Hours.
Introduction to seismic wave propagation and petroleum geophysics 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.

GEOS 4533H. Honors Introduction to Petroleum Geophysics. 3 Hours.
Introduction to seismic wave propagation and petroleum geophysics 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. 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. 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 each park, 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.

GEOS 4563H. Honors Geology of Our National Parks. 3 Hours.
This course examines the underlying geology responsible for each park, 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. This course is equivalent to GEOS 4563.

GEOS 4583. Vector GIS. 3 Hours.
Introduction to geographic information systems (GIS) applications in marketing, transportation, real estate, demographics, urban and regional planning, and related areas. Lectures focus on development of principles, paralleled by workstation-based laboratory exercises using mainstream GIS software and relational databases. Prerequisite: GEOS 3023 or GEOS 3543. This course is cross-listed with ANTH 4583.

GEOS 4593. Introduction to Global Positioning Systems and Global Navigation Satellite Systems. 3 Hours.
Basics 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. This course is cross-listed with ANTH 4593.

GEOS 4643. Introduction to Internet GIS. 3 Hours.
This course introduces Internet computing and Web GIS and offers hands-on tutorials in customized applications using ArcGIS Server JavaScript API. Topics covered include Internet protocols and Web standards, Web services, and fundamental routines and functions in ArcGIS server development. Students will have the capability to develop customized ArcGIS server applications. Prerequisite: GEOS 4513 or equivalent.

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. This course is cross-listed with ANTH 4653.

GEOS 4653H. Honors 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. This course is cross-listed with GEOS 4653, ANTH 4653.
GEOS 463. 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.

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.

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.

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. This course is cross-listed with SUST 4693.

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. This course is cross-listed with GEOS 4693, SUST 4693.

GEOS 4783. Geography of Europe. 3 Hours.
Geographic regions of the area with emphasis on their present development. Prerequisite: Junior standing.

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 4413 and GEOS 4593 or equivalent.

GEOS 4793H. Honors 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: Honors standing, GEOS 4413 and GEOS 4593 or equivalent. This course is equivalent to GEOS 4793.

GEOS 481V. Cooperative Education Program. 1-6 Hour.
Credit for off-campus, compensated work experience related to geology arranged through the Cooperative Education Office and Department of Geology. May be repeated for degree credit.

GEOS 4863. Quantitative Techniques in Geosciences. 3 Hours.
An introduction to the application of standard quantitative and spatial statistical techniques to geoscientific analysis. Students will use both micro and large system computers in the course. This course is cross-listed with ANTH 4863.

GEOS 4873. Geological Data Analysis. 3 Hours.
Quantitative methods and techniques for analysis and interpretation of geological data. Corequisite: Lab component. Prerequisite: MATH 2564 and GEOS 3514.

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. Graduate enrollment only with departmental permission. Corequisite: Lab component. Prerequisite: GEOS 3514.

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.

GEOS 4972H. Senior Honors Course I. 2 Hours.
Special honors research in geology. Two hours of credit each semester. Prerequisite: Junior honors.

GEOS 4982H. Senior Honors Course II. 2 Hours.
Special honors research in geology. Two hours of credit each semester. Prerequisite: Junior honors.

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.

GEOS 5003. Seminar in Geography. 3 Hours.
Selected topics, the nature of which varies with the need. Prerequisite: Graduate standing. May be repeated for up to 3 hours of degree credit.

GEOS 5011. Colloquium. 1 Hour.
Weekly meetings of faculty, graduates, advanced students and guests to discuss research and trends in the field of geography. May be repeated for up to 2 hours of degree credit.

GEOS 5023. Technical and Proposal Writing for the Geosciences. 3 Hours.
Preparation of technical reports, research proposals, and manuscripts for publication in the area of geosciences.

GEOS 5033. Advanced Vector Geographic Information Systems. 3 Hours.
Advanced vector operations and analysis. Topics will include topological analysis, network analysis, geocoding, conflation, implications of source and product map scale, map generation, error mapping, and cartographic production. Prerequisite: (ANTH 4563 or ANTH 5563 (formerly ANTH 4563)) or (GEOS 4583 or GEOS 5583 (formerly GEOS 4583)) or equivalent.

This course is cross-listed with ANTH 5043.

GEOS 5043. 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. Pre- or Corequisite: GEOS 5543.

GEOS 5053. Quaternary Environments. 3 Hours.
An interdisciplinary study of the Quaternary Period, including dating methods, deposits, soils, climates, tectonics, and human adaptation. Lecture 2 hours, laboratory 2 hours per week. Prerequisite: Graduate standing. This course is cross-listed with ANTH 5053, ENDY 5053.
GEOS 5073. 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. Pre- or Corequisite: GEOS 5543.

GEOS 5083. 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 5043 and GEOS 5073 or equivalent.

GEOS 5093. 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.

GEOS 510V. Special Problems in Physical Geosciences. 1-6 Hour. 
Special problems in Geosciences. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.

GEOS 5113. 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. This course is cross-listed with ENDY 5113.

GEOS 5123. Stratigraphic Principles and Practice. 3 Hours. 
Physical and biological characteristics of sedimentary environments and their correlation in time with emphasis on the local geologic section. Corequisite: Lab component. Prerequisite: GEOS 4223 or GEOS 5323 (formerly GEOS 4223).

GEOS 5133. 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.

GEOS 5143. 3D Seismic Exploration. 3 Hours. 
Interpretation of 3D seismic data for geological structure, stratigraphy, and pore fluid variations with emphasis on hydrocarbon exploration. Credit will not be given for both GEOS 4463 and GEOS 5143. Prerequisite: GEOS 4433 or GEOS 5433 (formerly GEOS 4433).

GEOS 5153. Environmental Site Assessment. 3 Hours. 
Principles, problems, and methods related to conducting an environmental site assessment. An applied course covering field site assessment, regulatory documentation, and report preparation. Prerequisite: GEOS 4033 or GEOS 5263 (formerly GEOS 4033). This course is cross-listed with ENDY 5153.

GEOS 5163. Hydrogeologic Modeling. 3 Hours. 
Topics include numerical simulation of ground water flow, solute transport, aqueous geochemistry, theoretical development of equations, hypothesis testing of conceptual models, limitations of specific methods, and error analysis. Emphasis on practical applications and problem solving. Prerequisite: GEOS 4033 or GEOS 5263 (formerly GEOS 4033) and computer literacy.

GEOS 5173. Urban Geography. 3 Hours. 
(Formerly GEOS 4073.) 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. Graduate degree credit will not be given for both GEOS 4073 and GEOS 5173.

GEOS 5183. Geography of the Middle East. 3 Hours. 
(Formerly GEOS 4043.) 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. Graduate degree credit will not be given for both GEOS 4043 and GEOS 5183.

GEOS 5196. Advanced Field Methods of Applied Hydrogeology. 6 Hours. 
Applied field course emphasizing collection and interpretation of ground water data. Three hours may be applied toward an M.S. degree in geology. Prerequisite: GEOS 4033 or GEOS 5263 (formerly GEOS 4033).

GEOS 520V. Special Problems in Human Geography. 1-6 Hour. 
Special problems in human geography. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.

GEOS 5213. 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.

GEOS 5223. Sedimentary Petrology. 3 Hours. 
Sediments and sedimentary rocks. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: GEOS 4223 or GEOS 5323 (formerly GEOS 4223).

GEOS 5233. Geography of Religion & Sacrality. 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. This course is cross-listed with ENDY 5113.

GEOS 5243. Political Geography. 3 Hours. 
(Formerly GEOS 4243.) 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. Graduate degree credit will not be given for both GEOS 4243 and GEOS 5243.

GEOS 5253. Geomorphology. 3 Hours. 
(Formerly GEOS 4053.) Mechanics of landform development. Lecture 2 hours, laboratory 3 hours per week. Several local field trips are required during the semester. Graduate degree credit will not be given for both GEOS 4053 and GEOS 5253.

GEOS 5263. Hydrogeology. 3 Hours. 
(Formerly GEOS 4033.) Occurrence, movement, and interaction of water with geologic and cultural features. Lecture 3 hours per week. Graduate degree credit will not be given for both GEOS 4033 and GEOS 5263. Corequisite: Lab component. Prerequisite: MATH 2043 or MATH 2554, and GEOS 3514.

GEOS 5273. Principles of Geochemistry. 3 Hours. 
(Formerly GEOS 4063.) Introduction to fundamental principles of geochemistry from historic development to modern concepts. Graduate degree credit will not be given for both GEOS 4063 and GEOS 5273. Corequisite: Lab component. Prerequisite: CHEM 1121L, CHEM 1123 and GEOS 2313.
GEOS 5283. Economic Geology. 3 Hours.
(Formerly GEOS 4083.) 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. Graduate degree credit will not be given for both GEOS 4083 and GEOS 5283. Prerequisite: GEOS 2313.

GEOS 5293. Introduction to Global Positioning Systems and Global Navigation Satellite Systems. 3 Hours.
(Formerly GEOS 4593.) 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. Graduate degree credit will not be given for both GEOS 4593 and GEOS 5293.

This course is cross-listed with ANTH 5593.

GEOS 530V. Special Problems in Regional Geography. 1-6 Hour.
Special problems in regional geography. Prerequisite: Graduate standing.

GEOS 5313. Planetary Atmospheres. 3 Hours.
Origins of planetary atmospheres, structures of atmospheres, climate evolution, dynamics of atmospheres, levels in the atmosphere, the upper atmosphere, escape of atmospheres, comparative planetology of atmospheres.

GEOS 5323. Stratigraphy and Sedimentation. 3 Hours.
(Formerly GEOS 4223.) 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. Graduate degree credit will not be given for both GEOS 4223 and GEOS 5323. Corequisite: Lab component. Prerequisite: GEOS 3413.

GEOS 5333. Research Methods and Materials in Geography. 3 Hours.
Geographical research and the preparation of research papers. Prerequisite: Graduate standing.

GEOS 534V. Internship in Physical Geography. 3-6 Hour.
(Formerly GEOS 430V.) Supervised experience in municipal, county, state or private natural resource management agency, or any other such organization approved by instructor. Graduate degree credit will not be given for both GEOS 430V and GEOS 534V.

GEOS 5353. Meteorology. 3 Hours.
(Formerly GEOS 4353.) Examination of the atmospheric processes that result in multifarious weather systems. Offered as physical science. Graduate degree credit will not be given for both GEOS 4353 and GEOS 5353.

GEOS 5363. Climatology. 3 Hours.
(Formerly GEOS 4363.) Fundamentals of topical climatology followed by a study of regional climatology. Offered as physical science. Graduate degree credit will not be given for both GEOS 4363 and GEOS 5363.

GEOS 537V. Geology Field Trip. 1-2 Hour.
(Formerly GEOS 437V.) Camping field trip to areas of geologic interest, usually conducted during Spring Break. Graduate degree credit will not be given for both GEOS 437V and GEOS 537V. Prerequisite: GEOS 3313. May be repeated for up to 4 hours of degree credit.

GEOS 5383. Hazard & Disaster Assessment, Mitigation, Risk & Policy. 3 Hours.
(Formerly GEOS 4383.) 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. Graduate degree credit will not be given for both GEOS 4383 and GEOS 5383. May be repeated for up to 6 hours of degree credit.

GEOS 5393. Mathematical Modeling of Geological Processes. 3 Hours.
This course explores a variety of topics in applied mathematics and computational methods within the context of studying geological processes and from the perspective of a modeling practitioner. Programming is conducted in Python. Knowledge of Calculus II is necessary.

GEOS 5403. American Public Lands and 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: Graduate standing.

GEOS 5413. Planetary Geology. 3 Hours.
Exploration of the solar system, geology and stratigraphy, meteorite impacts, planetary surfaces, planetary crusts, basaltic volcanism, planetary interiors, chemical composition of the planets, origin and evolution of the Moon and planets.

GEOS 5423. Remote Sensing of Natural Resources. 3 Hours.
Introductory digital image processing of remotely sensed data. Topics include data collection, laboratory design, scientific visualization, radiometric and geometric correction, enhancement, pattern recognition, artificial intelligence, and change detection in natural resource remote sensing. GIS-based exercises and a course project are included. Prerequisite: GEOS 4413 or GEOS 5213.

GEOS 5433. Geophysics. 3 Hours.
(Formerly GEOS 4433.) 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. Graduate degree credit will not be given for both GEOS 4433 and GEOS 5433. Corequisite: Lab component. Prerequisite: GEOS 2313 or GEOS 5123.

GEOS 5443. The Solid Earth. 3 Hours.
Modern views for the origin of the solid Earth and its structure, composition, and evolution through geologic time. Topics will include examination of relevant geophysical and geochemical constraints used to develop global models for the Earth. Prerequisite: GEOS 3313, MATH 2564, CHEM 1123, PHYS 2074 or instructor consent.

GEOS 5453. Introduction to Raster GIS. 3 Hours.
(Formerly GEOS 4553.) 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. Graduate degree credit will not be given for both GEOS 4553 and GEOS 5453. This course is cross-listed with ANTH 5553.

GEOS 5463. Microtectonics. 3 Hours.
Focuses on the microstructural evolution of tectonite rocks and the constraints that can be gleaned from optical microscopic evaluation of rocks in petrographic thin-sections and hand samples. Results are evaluated in the context of plate tectonic theory and geodynamics. Knowledge of mineralogy and petrology equivalent to GEOS 2313 is required. Pre- or Corequisite: GEOS 5563. Corequisite: Lab component.

GEOS 5473. 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.
GEOS 5483. Severe Weather. 3 Hours.
(Formerly GEOS 4483.) 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. Graduate degree credit will not be given for both GEOS 4483 and GEOS 5483.

GEOS 550V. Internship in GIS & Cartography. 3-6 Hour.
(Formerly GEOS 440V.) Supervised experience in GIS and/or cartographic applications with municipal, county, state, or private enterprises. Graduate degree credit will not be given for both GEOS 440V and GEOS 550V. May be repeated for up to 6 hours of degree credit.

GEOS 5513. Introduction to GIS Programming. 3 Hours.
This course introduces fundamentals of GIS software engineering and offers hands-on tutorials in customized applications using ArcGIS through programming ArcObjects in VBA/VA.net environment. Topics covered include ArcObjects, different programming syntax and styles, and fundamental routines and functions in ArcGIS.

After completing the course, students will have the capability develop customized ArcGIS applications.

GEOS 5523. Cartographic Design & Production. 3 Hours.
(Formerly GEOS 4523.) 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. Graduate degree credit will not be given for both GEOS 4523 and GEOS 5523.

GEOS 5533. Introduction to Petroleum Geophysics. 3 Hours.
(Formerly GEOS 4533.) Introduction to seismic wave propagation and petroleum geoscientists with particular emphasis on seismic events, elastic waves, and seismic survey design. Credit will not be given for both GEOS 4533 and GEOS 5533.

Prerequisite: MATH 2564, PHYS 2033, and GEOL 3514 or consent of instructor.

GEOS 5543. Geospatial Applications and Information Science. 3 Hours.
An introduction to the methods and theory underlying the full range of geographic information science and cartographic areas - including GNSS, remote sensing, cadastral, spatial demographics and others.

GEOS 5553. Spatial Analysis Using ArcGIS. 3 Hours.
Applications of analysis of spatial data using ArcGIS tools in map design, on-line mapping, creating geodatabases, accessing spatial 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 or GEOS 5543.

GEOS 5563. Tectonics. 3 Hours.
Development of ramifications of the plate tectonics theory. Analysis of the evolution of mountain belts. Lecture 3 hours per week. Prerequisite: GEOS 3514.

GEOS 5573. Advanced Cartographic Techniques & Production. 3 Hours.
Covers advanced production and techniques in cartography, including animation, geospatial visualization, puchader, and advanced visualization. Emphasizes client relationships in creating and producing cartographic materials. Prerequisite: GEOS 4523 or GEOS 5523.

GEOS 5583. Vector GIS. 3 Hours.
(Formerly GEOS 4583.) Introduction to geographic information systems (GIS) applications in marketing, transportation, real estate, demographics, urban and regional planning, and related areas. Lectures focus on development of principles, paralleled by workstation-based laboratory exercises using mainstream GIS software and relational databases. Graduate degree credit will not be given for both GEOS 4583 and GEOS 5583.

This course is cross-listed with ANTH 5563.

GEOS 5593. Introduction to Geodatabases. 3 Hours.
Fundamental concepts and applications of geospatial databases. Schema development and spatial data models for geodatabase. Spatial and attribute query and optimization, properties and structures of relational and object-oriented geodatabases. Spatial extensions of SQL, spatial indexing, measurement, and geometry. Course will use PostGIS, ESRI File Geodatabases, and MS-SQL.

Prerequisite: GEOS 3543 and GEOS 3103 or equivalent.

GEOS 560V. Graduate Special Problems. 2-6 Hour.
Library, laboratory, or field research in different phases of geology. May be repeated for up to 4 hours of degree credit.

GEOS 5612. Research Methods in Geosciences. 2 Hours.
Survey of research methodologies used in both geology and geography, with an emphasis on quantitative analysis. Preparation of research proposals and presentations in the field of geosciences. Prerequisite: Graduate standing.

GEOS 5643. Introduction to Internet GIS. 3 Hours.
This course introduces Internet computing and Web GIS and offers hands-on tutorials in customized applications using ArcGIS Server JavaScript API. Topics covered include Internet protocols and Web standards, Web services, and fundamental routines and functions in ArcGIS Server development. Students will have the capability to develop customized ArcGIS server applications. Prerequisite: GEOS 5513 or equivalent.

GEOS 5653. GIS Analysis and Modeling. 3 Hours.
(Formerly GEOS 4653.) 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. Graduate degree credit will not be given for both GEOS 4653 and GEOS 5653.

This course is cross-listed with ANTH 5653, ENDY 5043.

GEOS 5663. Low-Temperature Geochemistry of Natural Waters. 3 Hours.
(Formerly GEOS 4663.) 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 geochemistry. Credit will not be given for both GEOS 4663 and GEOS 5663. Prerequisite: CHEM 1121L, CHEM 1123, GEOS 1113, and GEOS 1111L.

GEOS 5673. 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.

GEOS 5693. Environmental Justice. 3 Hours.
(Formerly GEOS 4693.) 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. Credit will not be given for both GEOS 4693 and GEOS 5693.

GEOS 5713. Geology of Our National Parks. 3 Hours.
(Formerly GEOS 4563.) 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. Credit will not be given for both GEOS 4563 and GEOS 5713. Prerequisite: GEOS 1113.
GEOS 5743. Petroleum Geology. 3 Hours.  
(Formerly GEOS 4253.) Distribution and origin of petroleum. Lecture 2 hours, laboratory 2 hours per week. Graduate degree credit will not be given for both GEOS 4253 and GEOS 5743. Corequisite: Lab component. Prerequisite: Admission to the Geology graduate program.

GEOS 5753. Karst Hydrogeology. 3 Hours.  
(Formerly GEOS 4153.) 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. Graduate degree credit will not be given for both GEOS 4153 and GEOS 5753. Prerequisite: GEOS 4033 or GEOS 5263 (formerly GEOS 4033).

GEOS 5783. Geography of Europe. 3 Hours.  
(Formerly GEOS 4783.) Geographic regions of the area with emphasis on their present development. Graduate degree credit will not be given for both GEOS 4783 and GEOS 5783.

GEOS 5793. 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 4413 or GEOS 5213 (formerly GEOS 4413)) and (GEOS 4593 or GEOS 5293 (formerly GEOS 4593)) or equivalent.

GEOS 5853. Environmental Isotope Geochemistry. 3 Hours.  
Introduction to principles of isotope fractionation and distribution in geologic environments, isotopic analytical methods, and extraction of isotope samples; application of isotopes in characterization of geologic processes and interaction with hydrologic, surficial, and biologic attenuation, paleothermometry soil, and biogeochemical processes. May be repeated for up to 3 hours of degree credit. This course is cross-listed with ENDY 5853.

GEOS 5863. Quantitative Techniques in Geosciences. 3 Hours.  
(Formerly GEOS 4863.) An introduction to the application of standard quantitative and spatial statistical techniques to geoscientific analysis. Students will use both micro and large system computers in the course. Graduate degree credit will not be given for both GEOS 4863 and GEOS 5863. This course is cross-listed with ANTH 5863.

GEOS 5873. Geological Data Analysis. 3 Hours.  
(Formerly GEOS 4873.) Quantitative methods and techniques for analysis and interpretation of geological data. Credit will not be given for both GEOS 4873 and GEOS 5873. Corequisite: Lab component. Prerequisite: MATH 2564 and GEOS 3514.

GEOS 5924. Earth System History (ACTS Equivalency = PHSC 1104). 4 Hours.  
(Formerly GEOS 4924.) Physical and biological events that form the history of the earth from its formation to the beginning of the historical era. Credit will not be given for both GEOS 4924 and GEOS 5924. Graduate enrollment only with departmental permission. Corequisite: Lab component. Prerequisite: GEOS 3514.

GEOS 5933. 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.

GEOS 5993. Dynamics of Sediment Transport. 3 Hours.  
The course will give aspiring geologists and civil engineers tools for solving sedimentological problems in their fields. Starting from a grounding in fluid mechanics, we will learn how sediment is transported and stratigraphy accumulated. This will be applied to problems in sedimentology at all scales.

GEOS 600V. Master’s Thesis. 1-6 Hour.  
Master’s thesis. Prerequisite: Graduate standing. May be repeated for degree credit.

GEOS 6013. Seminar in Geoinformatics. 3 Hours.  
Geographic information science and technology research topics of particular interest to the graduate student class. May be repeated for up to 9 hours of degree credit.

GEOS 700V. Doctoral Dissertation. 1-9 Hour.  
Dissertation research. Prerequisite: Graduate standing and Ph.D. candidacy. May be repeated for degree credit.