Earth & Environmental Science (EES)

Course information contained within the Bulletin is accurate at the time of publication in June 2025 but is subject to change. For the most up-to-date course information, please refer to the Course Catalog.

EES 0827. Hidden Figures to Gamergate: Race and Gender in Science and Technology. 3 Credit Hours.
Who do you think of when someone asks you to draw a scientist? In this GenEd course we explore the myriad of ways in which racial and gender stereotypes have affected our perception of what it means to be an accomplished scientist. When we think of influential scientists, the names Claudia Alexander and Carolyn Parker should come as easily to the mind as Buzz Aldrin or Thomas Edison. We will discuss how the public perceives science and scientists, and explore the implications of this in terms of how science serves a diverse society. We will also explore the ways in which violence and misogyny have impacted our digital world. Technology and science change our society; who authors this change influences how we participate in the process and the cultural narrative of who innovates and leads our society, which is critical to the current controversy of science in politics.

Course Attributes: GD

Repeatability: This course may not be repeated for additional credits.

EES 0836. Disasters: Geology vs. Hollywood. 3 Credit Hours.
This course is typically offered in Fall, Spring, and Summer.
Clips from Hollywood disaster movies will drive our inquiry into geologic phenomena. Can you really drive over a lava flow in a jeep? (Dante's Peak) Are we foolish not to prepare for a major earthquake in New York City? (Aftershock) Could global warming melt the polar ice caps turning "dry land" into a myth? (Waterworld) Would the impact of an asteroid the "size of Texas" kill half the Earth by heat and freeze the remainder in a nuclear winter? (Armageddon) Learn the fundamentals of plate tectonics, how petrologic properties control volcanic explosivity, how to calculate earthquake locations from seismic data, and prepare a disaster readiness plan for a major U.S. city. NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core.

Course Attributes: GS, SF

Repeatability: This course may not be repeated for additional credits.

EES 0837. Evolution of Earth and Its Life. 3 Credit Hours.
This course is typically offered in Fall and Spring.
The Earth is our home, but few of us stop to consider in detail how it works and changes. Although popularly applied mostly to biological systems, the word evolution simply means "change through time". This course intends to foster understanding of the Earth as an evolving and changing interconnected system across the vast expanse of 4.5 billion years of geologic history. Where did we come from? How did we get where we are now? What can we expect in the future? Through hands-on experience with fossils and rocks, students discover how to decode information about past Earth environments and ecosystems and the implications of this knowledge for understanding current and future global issues. Special focus is given to major interactions between the living and non-living parts of the Earth system, including major mass extinction events, many of which have been linked to climate shifts with disastrous consequences for living organisms. (Prior to Spring 2022, this course was titled "Evolution & Extinctions". Students may not receive credit for both EES 0837: Evolution & Extinctions and EES 0837: Evolution of Earth and Its Life.) NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core.

Course Attributes: GS, SE, SF, SS

Repeatability: This course may not be repeated for additional credits.

EES 0842. Sustainable Environments. 3 Credit Hours.
This course is typically offered in Fall, Spring, and Summer.
Humans are at a critical juncture in their relationship with the environment. Many of the global changes occurring in the atmosphere, climate, and oceans can be attributed to human activity. While the standard of living has increased for many people across the globe, the technological advancements that have made this possible endanger future generations because of their environmental impacts. Environmental toxins and air pollution are increasing, and fossil fuels and forests are being depleted at unsustainable rates. Now more than ever, the viability of human life depends on the scientific understanding of global environmental change, and on developing science-based policies to both protect the environment and promote human well-being in a just and sustainable manner. Course mission: enhance your capability to be environmentally informed consumers and citizens based on a sound understanding of the ecological, technological, economic, political, and ethical dimensions of environmental sustainability. NOTE: This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core. Students cannot receive credit for this course if they have successfully completed GUS 0842/0942 or ENST 0842/0942.

Course Attributes: GS, SE, SF, SP, SS

Repeatability: This course may not be repeated for additional credits.

EES 0854. Geology of the National Parks. 3 Credit Hours.
This course is typically offered in Fall.
The primary purpose of the National Park Service is to preserve areas of natural or cultural interest for current and future generations. Quite commonly these areas of interest, such as the Grand Canyon, or Yellowstone National Park, are the result of extreme geologic forces which have shaped the landscape. The goal of this class is to use geologic principles to understand the "science of the scenery" of individual parks. Students will also address key issues within individual parks, such as the competing interests of visitor access vs. land management, the societal need for natural resources, and the preservation of unique or delicate ecosystems. NOTE: (1) This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core. (2) Students cannot receive credit for this course if they have successfully completed EES 0954.

Course Attributes: GS, SE, SF, SP, SS

Repeatability: This course may not be repeated for additional credits.

EES 0873. Evil Plots. 4 Credit Hours.
Computer technology and the internet have produced a glut of digital information that can't be communicated without using charts and graphs. But like all forms of human communication, graphs can fib a little or lie outright. There are three basic ways data visualizations can go wrong: (1) The plot can be evil, designed to persuade or mislead rather than inform; (2) the data set may be suspect (too small, biased, or full of errors); or (3) even if the plot and data are okay, they may not support the claims being made. In this class, we will explore the representation and misrepresentation of data, learn the questions to ask about data quality, and how to spot falsehoods and fallacies in the digital age. Examples will be drawn from science, politics, marketing, business and more. Protect yourself by learning to spot evil plots! Students cannot receive credit for this course if they have successfully completed EES 0973.

Course Attributes: GQ

Repeatability: This course may not be repeated for additional credits.

EES 0874. Environmental Life Cycle Analysis: Does Buying "Green" Matter?. 4 Credit Hours.
With increasing societal awareness of environmental sustainability, many industry and business sectors have prioritized the development and application of green technology and/or green processes over the course of a product's life span. Life cycle analysis (LCA) is a scientific methodology that systematically examines both cumulative and potential environmental impacts of a product over its entire life cycle, ranging from the extraction of raw Earth materials to its disposal when all the materials ultimately return to the Earth. LCA can also provide comparative impacts among the different products, and both companies and consumers benefit from the environmental rating systems for their marketing and decision making processes. Through this course, we will learn how LCA model works in detail, using real-world examples, such as paper vs plastic bags, cathode ray tube (CRT) vs liquid crystal display (LCD) technology, as well as electronic wastes.

Course Attributes: GQ, SE, SF, SP, SS

Repeatability: This course may not be repeated for additional credits.

EES 0927. Honors Hidden Figures to Gamergate: Race and Gender in Science and Technology. 3 Credit Hours.
Who do you think of when someone asks you to draw a scientist? In this GenEd course we explore the myriad of ways in which racial and gender stereotypes have affected our perception of what it means to be an accomplished scientist. When we think of influential scientists, the names Claudia Alexander and Carolyn Parker should come as easily to the mind as Buzz Aldrin or Thomas Edison. We will discuss how the public perceives science and scientists, and explore the implications of this in terms of how science serves a diverse society. We will also explore the ways in which violence and misogyny have impacted our digital world. Technology and science change our society; who authors this change influences how we participate in the process and the cultural narrative of who innovates and leads our society, which is critical to the current controversy of science in politics.

Course Attributes: GD, HO

Repeatability: This course may not be repeated for additional credits.

EES 0954. Honors Geology of the National Parks. 3 Credit Hours.
This course is typically offered in Fall.
The primary purpose of the National Park Service is to preserve areas of natural or cultural interest for current and future generations. Quite commonly these areas of interest, such as the Grand Canyon, or Yellowstone National Park, are the result of extreme geologic forces which have shaped the landscape. The goal of this class is to use geologic principles to understand the "science of the scenery" of individual parks. Students will also address key issues within individual parks, such as the competing interests of visitor access vs. land management, the societal need for natural resources, and the preservation of unique or delicate ecosystems. NOTE: (1) This course fulfills a Science & Technology (GS) requirement for students under GenEd and Science & Technology Second Level (SB) for students under Core. (2) Students cannot receive credit for this course if they have successfully completed EES 0854. (3) This is an Honors course.

Course Attributes: GS, HO, SE, SF, SP, SS

Repeatability: This course may not be repeated for additional credits.

EES 0973. Honors Evil Plots. 4 Credit Hours.
Computer technology and the internet have produced a glut of digital information that can't be communicated without using charts and graphs. But like all forms of human communication, graphs can fib a little or lie outright. There are three basic ways data visualizations can go wrong: (1) The plot can be evil, designed to persuade or mislead rather than inform; (2) the data set may be suspect (too small, biased, or full of errors); or (3) even if the plot and data are okay, they may not support the claims being made. In this class, we will explore the representation and misrepresentation of data, learn the questions to ask about data quality, and how to spot falsehoods and fallacies in the digital age. Examples will be drawn from science, politics, marketing, business and more. Protect yourself by learning to spot evil plots! Students cannot receive credit for this course if they have successfully completed EES 0873. This is an Honors course.

Course Attributes: GQ, HO

Repeatability: This course may not be repeated for additional credits.

EES 1001. Introductory Geology. 4 Credit Hours.
This course is typically offered in Fall, Summer I and Summer II.
An introduction to the basic principles and processes of geology. Wide range of topics, including rocks and minerals, surface processes, plate tectonics, and the earth's interior. NOTE: This course can be used to satisfy the university Core Science & Technology First Level (SA) requirement. To determine if this course in combination with another course can satisfy the GenEd Science & Technology requirement, see your advisor.

Course Attributes: SA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 4999 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

EES 2001. Physical Geology. 4 Credit Hours.
This course is typically offered in Fall, Spring, and Summer I.
Physical geology provides a working introduction to Earth materials and the major processes that shape our planet. Geology plays an important role in many aspects of our lives from everyday natural resources including soil (food) and water to environmental hazards and natural disasters. This course is intended to prepare geology and environmental science majors for advanced studies, while also providing all students with general knowledge of how our planet operates, allowing them to become better-informed citizens of the world. Upon completion of this course, students will understand the rock cycle, plate tectonics, geohazards, surface processes and environments, natural resources, and the climate system. Laboratory sessions (3 hours per week) provide hands-on experience and focus on the identification of mineral and rock specimens, map skills, and the visualization and interpretation of Earth processes.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 0702, any MATH course numbered 0800 to 4999 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MA01, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

EES 2002. Energy and Environment. 3 Credit Hours.
This course is typically offered in Spring of even-numbered years.
Energy and Environment examines the scientific principles governing energy technologies and use, and the implications of energy development on our natural resources and environmental quality. The first part of the course will provide an introduction to the basic physical principles behind energy production, existing and emerging energy technologies, and energy use. The second part of the course will provide an understanding of the impacts associated with energy development on land, water and the atmosphere, impact assessment techniques, and interactions among energy, food and water resources. This course will provide an opportunity to become familiar with the future grand challenges in energy development in the context of changing climate and policy scenarios.

Course Attributes: SE, SF, SS

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (any MATH course numbered 0701 to 0702 (C or higher), any MATH course numbered 0800 to 4999 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MA01, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in CRMA18, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

EES 2011. Mineralogy I. 4 Credit Hours.
This course is typically offered in Fall.
Fundamentals of hand-specimen analysis including crystallography, bonding, physical properties, chemical composition and growth of common minerals.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001 and (CHEM 1031 (may be taken concurrently), CHEM 1041 (may be taken concurrently), or CHEM 1951 (may be taken concurrently))

EES 2012. Mineralogy II. 4 Credit Hours.
This course is typically offered in Spring.
Microanalysis by polarized light microscopy, powder x-ray diffractometry and microprobe including site occupancy, crystal growth, and microstructural defects with emphasis on silicates.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2011.

EES 2021. Sedimentary Environments. 4 Credit Hours.
This course is typically offered in Fall and Spring.
Analysis of sediments, physical and biogenic structures, and strata to assess the dynamics of modern and ancient depositional environments. Laboratory and field exercises emphasize data collection, interpretation, and graphic presentation as a means of reconstructing sediment transport mechanisms and depositional settings. NOTE: Required day-long field trips. (Prior to fall 2016, this course was titled "Facies Models.")

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001.

EES 2022. Paleontology and Stratigraphy. 4 Credit Hours.
This course is typically offered in Spring of even-numbered years.
This course provides a working introduction to invertebrate paleontology and the principles of bio-, litho-, and allostratigraphy. Emphasis is placed on combining data from the geological and biological records to understand the sedimentary record through time. Students will gain skill in identifying major invertebrate fossil groups and describing their anatomy, paleoecology, and temporal significance; explore how sedimentological factors influence our understanding of evolution as recorded by the fossil record, and vice versa; and construct measured sections and stratigraphic columns and correlate using multiple stratigraphic techniques. Through two multi-day field trips, students will develop and employ field and map skills while investigating elements of earth history and changes in the tectonic setting of eastern North America through geologic time. NOTE: Two multi-day (including weekends) field trips are required.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2021.

EES 2031. Introduction to Field Methods in the Earth and Environmental Sciences. 1 Credit Hour.
This course is typically offered in Fall.
This course offers a half semester (7-week), intensive introduction to various field methods. Techniques covered will provide a background and foundation to prepare students for both future field courses as well as employment in the environmental industry. Students will learn mapping techniques (geologic and topographic), geologic/soil/water sampling techniques, analysis and understanding of well-log/geophysical data, note taking skills, and the use of a compass to determine location as well as use to determine geologic structures. This course will include multiple field trips. This is a required course for the Certificate in Environmental Professional Training.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001 and EES 2021.

EES 2032. Environmental Sensors. 1 Credit Hour.
This course is typically offered in Summer of odd-numbered years.
This two-week intensive course will provide hands-on experience with implementing field-sensor systems to monitor the environment for research and citizen science projects. The students will familiarize with the fundamental operation principles of a variety of passive and active sensors used widely for long-term field measurements of meteorological and hydrological variables, field installation and maintenance, automation of data collection with data loggers, telemetry, and best practices for acquiring and securing data.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001.

EES 2051. Introduction to Data Visualization and Analysis for Earth and Environmental Science. 3 Credit Hours.
This course is typically offered in the Fall.
This course provides an introduction to the management, visualization, and analysis of data sets common to Earth and Environmental Science. Microsoft Excel and Matlab will be introduced and then used to analyze example data sets which introduce and reinforce key algebraic, calculus and physics concepts. Student understanding and skill is developed through projects analyzing stream flow, earthquake populations, plate tectonics and hot spot motion, atmospheric CO2 concentration, and topography.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001 and (MATH 1022 (may be taken concurrently), MATH 1031 (may be taken concurrently), MATH 1038 (may be taken concurrently), MATH 1041 (may be taken concurrently), MATH 1042 (may be taken concurrently), MATH 1044 (may be taken concurrently), MATH 1941 (may be taken concurrently), MATH 1942 (may be taken concurrently), MATH 1951 (may be taken concurrently), 'Y' in MC6, 'Y' in MATW, 'Y' in MC6A, or 'Y' in MC6T)

EES 2061. Introduction to Geochemistry. 4 Credit Hours.
This course is typically offered in Fall of odd-numbered years.
Application of chemical principles and quantitative methods to understand and solve various geological problems. Field trips and laboratory exercises will emphasize techniques of obtaining and measuring geological samples. Students will analyze, summarize, and present data in oral and written reports.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001 and (CHEM 1031 or CHEM 1951)

EES 2065. Nanogeoscience and Technology. 4 Credit Hours.
This course is typically offered in Fall.
Today, everyone is talking about nanomaterials, even advertisements for consumer products use the prefix "nano" as a keyword for special features. Nanotechnology is one of the most important new technologies of the 21st century. Through this course, history, principles, mechanisms, many exciting phenomena and the processes of nano-scale materials, as well as their applications and environmental impact, will be covered in great detail. The lab component of this course will consist of analyzing nanoparticles in water samples, extracting nanomaterials from consumer products, and monitoring plant growth from soils amended with nanomaterials. Through the course of the lab exercises, students will have hands-on experience on various instruments, including inductively-coupled plasma spectrometry, x-ray diffraction, scanning electron microscopy, and transmission electron microscopy.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1032 (may be taken concurrently), CHEM 1952 (may be taken concurrently), or CHEM 1035) and (CHEM 1033 or CHEM 1953)

EES 2067. Introduction to Environmental Toxicology. 3 Credit Hours.
This course is typically offered in Spring of even-numbered years.
This course covers fundamental concepts of environmental toxicology, including dose-response, exposure routes, biological variation and toxicity phases. Topics include fate and effects of hazardous substances in organisms and the environment, air pollutants, pesticides, insecticides, aquatic toxicity, endocrine disruptors, biomarkers and bioassays, as well as risk assessment.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1032 (may be taken concurrently) or CHEM 1952 (may be taken concurrently)) and (CHEM 1034 (may be taken concurrently) or CHEM 1954 (may be taken concurrently))

EES 2096. Climate Change: Oceans To Atmosphere. 4 Credit Hours.
This course is typically offered in Spring.
Earth's climate is an emergent feature of the flow of energy and matter between the land, ocean, atmosphere, ice, and the biosphere. The decisions we make and the experiences we have in our lifetime are all strongly shaped by the climate around us. Earth's climate has evolved naturally into a variety of states throughout geological time from ice ages to periods over 50 million years ago much hotter than today. As humans evolved and began changing the landscape and emitting greenhouse gases through industrial processes, the climate system has been changing and Earth's global temperature has risen at an unprecedented rate with stark consequences for living organisms and society. Throughout the semester we will study the fundamental dynamics that govern climate from the regional to the global scale including how the circulation and properties of the atmosphere and ocean control the flow of energy and matter within the climate system. Additional topics covered include evidence and causes of shifts in Earth's climate through geological history, the role of greenhouse gas emissions in altering our present climate state, evidence of climate change since the industrial era, and climate model projections of future climate throughout the 21st century. Alongside lecture content, students will produce a manuscript reviewing a topic pertaining to climate change, learning critical research and writing skills relevant to the field of climate science.

Course Attributes: SE, SF, WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001.

EES 2097. Process Geomorphology. 4 Credit Hours.
This course is typically offered in Fall.
The course explores key Earth surface processes and landforms by examining the role of tectonic and climatic forces, as well as biota, in landscape evolution. The quantitative approach focuses on modern systems in order to reconstruct their ancient counterparts, including their subsurface expression in paleo-landscapes. Culminates in a term project based on original research of active geomorphic systems.

Course Attributes: SI, WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001.

EES 2234. Dinosaur Paleobiology. 3 Credit Hours.
This course is typically offered in Spring of odd-numbered years.
Examines "non-avian dinosaurs" as objects of valid scientific inquiry and where appropriate, evaluates media hype surrounding them. Among topics examined in detail are: evolutionary relationships (including phylogeny, together with relationships to modern birds), ecology (including survey of other Mesozoic vertebrate groups, important invertebrates, plant life, biogeography), anatomy (hard and soft tissues), physiology (particularly but not limited to understanding dinosaur temperature regulatory physiology, paleoneurology, molecular traces, growth), behavior (locomotion, posture, reproduction, etc.), and how these animals are reconstructed and restored as living animals (including what is actually known from fossil evidence). This course highlights how applying basic biological principles is used to gain significant insights about what can actually be known about long extinct animals.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (BIOL 1111, BIOL 1911, or 'Y' in BIOW)

EES 3001. Igneous and Metamorphic Petrology. 4 Credit Hours.
This course is typically offered in Fall.
A comprehensive study of Igneous and Metamorphic rocks in both hand samples and thin sections. Understanding of the chemistry, physical properties, global distribution, origin and identification of Igneous and Metamorphic rocks. Lab work will emphasize mineral and rock identification of both hand and thin sections. Thin section production will be introduced. A small group paper and presentation are required, as are day field trips. Scientific literature will be analyzed to examine current issues relating to the Igneous and Metamorphic research.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2011.

EES 3011. Remote Sensing and GIS. 4 Credit Hours.
This course is typically offered in Spring.
The focus of this class is on remote sensing technologies and geographic information systems. Remote sensing is a dynamic field; new, high-resolution satellites are coming online almost daily, and there has been an exponential growth in applications of remote sensing data during the past decade, including: mineral exploration, precision agriculture, watershed management, land use classification, military intelligence, and climate monitoring. The demand for college graduates with experience in this field is growing exponentially as well. By the end of this class you won't be a remote sensing expert, but you will have a fundamental understanding of the uses and limitations of remote sensing data for geologic and environmental applications, as well as fundamental geographic information systems skills.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 3015. Drone Short Course. 1 Credit Hour.
This course is typically offered in even-numbered years in the Spring.
Drones are everywhere. This course offers a short introduction to use of drones, otherwise known as unmanned aerial vehicles (UAVs). Students will be taught use of drones in research and other societal applications, basics of flight and operation of drones, and regulations applicable to drone usage. This course does not provide certification to become a drone pilot, but the steps to certification will be reviewed, and the exam for recreational flying can be completed. Flying experience will be provided through indoor labs.

Repeatability: This course may not be repeated for additional credits.

EES 3021. Groundwater Hydrology. 4 Credit Hours.
This course is typically offered in the Spring.
This course provides an introduction to groundwater geology. Topics include how geology influences groundwater flow and geochemistry, how groundwater and surface water interact, and contamination and remediation issues. Student understanding of groundwater and contaminant movement is developed through a series of homework problems and labs that require basic algebra skills.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in EES 2001 and (MATH 1022 (C or higher), any MATH course numbered 1038 to 4999 (may be taken concurrently), 'Y' in MC6, 'Y' in MC6A, 'Y' in MA04, 'Y' in MATW, 'Y' in CRMA05, or 'Y' in MC6T)

EES 3025. Physical Hydrology. 4 Credit Hours.
This course is typically offered in Fall.
This course examines the physical principles governing the flow of water on and beneath the Earth's surface and the relationship of hydrological processes to other disciplines such as geology, ecology, and atmospheric sciences.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in EES 2001, (MATH 1022 (C or higher), any MATH course numbered 1041 to 4999 (may be taken concurrently), 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, or 'Y' in CRMA05), and (PHYS 1061, PHYS 1961, PHYS 2021, or PHYS 2921)

EES 3031. Field Study in Paleontology. 2 Credit Hours.
This course is not offered every year.
This course offers a half semester (7-week) exploration of paleontological and sedimentological resources locally accessible to the Philadelphia area. Classroom lectures and laboratory activities on regional geology, stratigraphy, and paleofaunas will be interspersed with local field modules where students will learn and refine skills in lithologic description and stratigraphic mapping as well as basic paleontological field excavation and data collection techniques.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2022.

EES 3032. Field and Laboratory Methods in Environmental Geochemistry. 2 Credit Hours.
This course is typically offered in Spring of odd-numbered years.
Students will learn fundamental principles of geochemistry as they apply to environmental problems. Students will learn field sampling techniques and become familiar with the use of laboratory techniques for solid and fluid analysis. Students will prepare field reports synthesizing multiple datasets to explain the processes that are occurring at each site. Field-based methods to discuss include the following: extraction from wells, surface water characterization (sampling and water quality loggers), sediment core sampling, and field analysis techniques such as portable XRF and photoionization detectors. Lab-based methods to discuss include the following: spectrophotometric methods, alkalinity by titration, ion chromatograph, ICP-OES, XRD, and rock/mineral digestion techniques.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1031 or CHEM 1951) and (EES 2011 or EES 2061)

EES 3042. Coastal Processes and Geomorphology. 4 Credit Hours.
This course is typically offered in Spring.
The course will apply a process geomorphological approach to understanding coastal behavior. Subjects will include the global distribution of coasts, wave and tidal hydraulics, barrier morphodynamics, nearshore and aeolian sediment transport, and morphological signatures of extreme events.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (EES 2021, EES 2042, or EES 2097)

EES 3051. Natural Hazards. 4 Credit Hours.
This course is typically offered in Spring.
This 4-credit lab course focuses on the physical processes that control natural disasters, why they may pose a risk to people or infrastructure, how to assess risk, and potential mitigation strategies. Labs are used to develop and analyze data characterizing these physical processes and defining risk; this work focuses on defining what can be measured, monitored, and predicted as the basis of the assessment. The first third of the course is devoted to solid earth hazards under the unifying paradigm of plate tectonics including earthquakes and volcanoes. The middle third of the course is devoted to weather hazards including storms/coastal hazards, floods, and landslides. The final third of the course is devoted to climate change, focusing on how hazards may change including extreme weather, heat waves/droughts, wildfire and feedbacks among hazards such as fire, erosion, and landslides. A critical aspect of the course is use of geoscience data tools to identify and analyze risk from topographic, remote sensing, hydrologic, and other data streams combined with hazard products developed by states, NOAA, FEMA, USGS, and other agencies.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001 and (MATH 1022, STAT 1001, STAT 1102, STAT 2103, GUS 3161, any MATH course numbered 1041 to 4999 (may be taken concurrently), 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, or 'Y' in MC6T)

EES 3065. Nanoscience & the Environment. 4 Credit Hours.
This course is typically offered in Spring of odd-numbered years.
Today, everyone is talking about nanomaterials, even advertisements for consumer products use the prefix "nano" as a keyword for special features. Nanotechnology is one of the most important new technologies of the 21st century. Through this course, history, principles, mechanisms, many exciting phenomena and the processes of nano-scale materials, as well as their applications and environmental impact, will be covered in great detail. The lab component of this course will consist of analyzing nanoparticles in water samples, extracting nanomaterials from consumer products, and monitoring plant growth from soils amended with nanomaterials. Through the course of the lab exercises, students will have hands-on experience on various instruments, including inductively-coupled plasma spectrometry, x-ray diffraction, scanning electron microscopy, and transmission electron microscopy.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (CHEM 1032 (may be taken concurrently), CHEM 1952 (may be taken concurrently), or CHEM 1035) and (CHEM 1033 or CHEM 1953)

EES 3082. Individual Study Program I. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, and Summer I.
Individual independent study and research under supervision of a member of the Earth & Environmental Science Faculty. A final written report will be submitted to the faculty member. For further information and details, see the undergraduate advisor. NOTE: Student must have a cumulative GPA of 3.25 and have completed at least 30 credits (sophomore or junior standing).

Repeatability: This course may be repeated for additional credit.

EES 3091. Research Methods. 3 Credit Hours.
This course is typically offered in Spring.
Research Methods is required for all of the TUteach with Teaching majors. It is one of several content courses specially designed to meet the needs of future teachers. Sections meet two hours per week for non-traditional, interactive lectures and two hours per week for lab. The course is cross-listed in Biology, Chemistry, Earth and Environmental Science, and Physics. The goals of the course are (1) to provide students with the tools that scientists use to solve scientific problems; (2) to give students the opportunity to use these tools in a laboratory setting; (3) to make students aware of how scientists communicate with each other through peer-reviewed scientific literature; and (4) to enable students to understand how scientists develop new knowledge and insights, the most important of which are eventually presented in textbooks and taught in conventional science classes. Students design and carry out four independent inquiries, which they write up and present in the manner that is common in the scientific community. The inquiries incorporate mathematics and the various science disciplines, thus the team of instructors teaching this course have expertise in different disciplines and are available to supervise all students as they work on their inquiries in the lab. The combination of Research Methods and the TUteach course "Perspectives on Science and Mathematics" (Philosophy 2196) provides prospective science and mathematics teachers with an in-depth understanding of how the scientific enterprise works. NOTE: EES 3091 is only available for major credit in the Earth and Space Science with Teaching BS program.

Repeatability: This course may be repeated for additional credit.

Pre-requisites: Minimum grade of C- in (SCTC 1289 or SCTC 1389)

EES 3506. Observing and Modeling Climate Change. 3 Credit Hours.
This course is typically offered in Fall of odd-numbered years.
There is no scientific doubt that human activity has been influencing the climate system since the industrial era due to emissions of greenhouse gases and causing a rise in global mean temperature (i.e., global warming). While Earth's climate and temperature has fluctuated naturally in the past, the rate of current warming in response to human activity is unprecedented and is having a large impact on the climate system and living organisms on our planet. We are experiencing the effects of climate change today in the form of melting of sea ice, glaciers, and ice sheets, sea level rise, increases in the intensity of heat waves, change in frequency and intensity of droughts, extreme rainfall events, and wildfires. The results of climate model simulations suggest that the effects of climate change will worsen throughout the 21st century and beyond if we continue to emit greenhouse gases. In this course we will gain a foundational understanding of anthropogenic climate change and explore the evidence directly through hands-on analysis and visualization of real-world observational datasets. After investigating observational evidence, we will build an understanding of climate models, the experiments performed including climate projections, and how to access, analyze, and visualize publicly available model output. Along the way, students will gain experience in the tools that scientists use to analyze and visualize observational datasets and climate model output. While no prior computational knowledge is assumed, students will be introduced to aspects of the Python programming language, the command line interface, and GitHub. Course content and assignments will be centered around the use of Jupyter Notebooks. This course will be hands-on and assignment and project oriented, with in-class periods geared toward learning to analyze and visualize climate datasets.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 1022, STAT 1001, STAT 1102, STAT 2103, GUS 3161, any MATH course numbered 1041 to 4999 (may be taken concurrently), 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, or 'Y' in MC6T)

EES 3725. Soils and the Environment. 4 Credit Hours.
This course is typically offered in Spring of odd-numbered years.
Soils are life, but the ongoing climate crisis is affecting the stability of soils and changing the way we manage them. The objectives of this course are to introduce you to the science of soil morphology and genesis, and their linkage to the biosphere, atmosphere, hydrosphere, and geosphere in order to investigate the response of soils to anthropogenic modification and climate change. We will explore these topics through a combination of field and laboratory exercises complimented by a variety of lecture topics.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001, EES 2011, and (CHEM 1031 (may be taken concurrently) or CHEM 1951 (may be taken concurrently))

EES 4031. Appalachian Tectonics. 2 Credit Hours.
This course is typically offered in Summer of even-numbered years.
This 2-week intensive course (Summer I) applies classroom and laboratory training from other EES courses to solve geological problems in the field. We will synthesize field observations and measurements from several field localities to understand the formation and erosion of the Appalachian mountains along the eastern coast of the United States. Students should expect to spend a minimum of 4 full days in the field, and on the other days, spend 3 hours in the classroom, and the rest of the day on individual and group work.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2011 and EES 2021.

EES 4082. Individual Study Program II. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, and Summer I.
Individual independent study and research under supervision of a member of the Earth & Environmental Science Faculty. A final written report will be submitted to the faculty member. For further information and details, see the undergraduate advisor. NOTE: Student must have a cumulative GPA of 3.25 and have completed at least 60 credits (junior or senior standing).

Course Attributes: SI

Repeatability: This course may be repeated for additional credit.

EES 4101. Structural Geology. 4 Credit Hours.
This course is typically offered in Spring of even-numbered years.
The purpose of this course is to train students in the concepts and techniques of structural geology. Students will learn how to collect, analyze, and interpret geologic data drawn from a variety of disciplines pertinent to structural geology and present a cohesive argument. Results are presented as maps, reports, and computer models. NOTE: Geology B.S. Capstone.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2011, EES 2021, and (PHYS 1061, PHYS 2021, or PHYS 2921)

EES 4200. Topics in Geoscience. 1 to 3 Credit Hour.
This course is not offered every year.
This seminar will allow students to study current problems in geology and environmental science. NOTE: 3 credit courses may count as elective credit for Earth and Environmental Science majors. May be taken multiple times (on different topics) with permission of instructor.

Repeatability: This course may be repeated for additional credit.

EES 4210. Topics in Geoscience with Lab. 4 Credit Hours.
This course is not offered every year.
This seminar will allow students to study current problems in geology and environmental science. NOTE: Elective for Earth and Environmental Science majors (Geology and Environmental Science). May be taken multiple times (on different topics) with permission of instructor.

Repeatability: This course may be repeated for additional credit.

EES 4502. Ice and Global Climate. 3 Credit Hours.
This course is typically offered in Fall of even-numbered years.
We live in a time of rapid global warming and are faced with adverse effects on human society. Ice, in its various forms from snow to ice sheets, plays an important role in the global climate system by, for example, modulating the solar-energy flux and global sea level. Ice also provides a unique archive of past climate history that contributed to our understanding of global warming today. This course will provide an overview of different forms of ice and their role in Earth's climate system, and foundations in physical understanding of how ice behaves at and near Earth's surface. In addition, contemporary techniques in observations of different forms of ice will be explored with examples in processing and interpretation of publicly available datasets.

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (PHYS 1061, PHYS 1961, PHYS 2021, or PHYS 2921) and EES 2001.

EES 4589. Field Geology. 2 to 6 Credit Hours.
This course is typically offered in Summer.
The purpose of this course is to train students in the techniques and methodologies of field geology. Students will learn how to collect, analyze, and interpret field data across a variety of geologic disciplines. Results are presented as maps, reports, measured sections, and computer models. NOTE: Students must seek prior permission to take the course elsewhere through the Petition to Take a Course at Another Institution. Course selection must be approved by an EES faculty advisor.

Repeatability: This course may be repeated for additional credit.

Pre-requisites: Minimum grade of C- in EES 2011 and EES 2021.

EES 4696. Vertebrate Paleontology and Taphonomy. 3 Credit Hours.
This course is typically offered in Fall of odd years.
This course examines vertebrate fossils and their importance for interpreting and reconstructing terrestrial ecosystems. Students will learn the basics of vertebrate skeletal anatomy, interpret transport and depositional histories of skeletal elements and assemblages, and combine this information with geologic data to reconstruct paleoenvironmental settings and paleocommunity associations. Some class sessions will meet off-campus at local museums.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2021 and (EES 2022, BIOL 1111, or BIOL 1911)

EES 4796. Soils and Paleosols. 4 Credit Hours.
This course is typically offered in Spring of even-numbered years.
The course is divided into two parts: modern soils and paleosols. The goals of this course are to teach students the fundamentals of modern soil genesis and classification in order to interpret ancient soils preserved in the rock record (paleosols), and to incorporate models of soil genesis into the traditional geology paradigm. Students will be exposed to a combination of laboratory methods and field work.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2021 and EES 2022 (may be taken concurrently)

EES 4896. Planetary Geology. 4 Credit Hours.
This course is typically offered in Fall of even-numbered years.
This writing-intensive course explores the modern and ancient geologic processes on other planets and discusses how studies of other planets can aid us in a better understanding of our Earth. The course will also cover topics such as planetary exploration and astrobiology and includes a lab.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in EES 2001, (EES 2011, EES 2021, or EES 2097), and (MATH 1022, STAT 1001, STAT 1102, STAT 2103, any MATH course numbered 1041 to 4999 (may be taken concurrently), 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, or 'Y' in MC6T)

EES 5011. Remote Sensing and GIS. 4 Credit Hours.
The focus of this class is on remote sensing technologies and geographic information systems. Remote sensing is a dynamic field; new, high-resolution satellites are coming on line almost daily, and there has been an exponential growth in applications of remote sensing data during the past decade, including: mineral exploration, precision agriculture, watershed management, land use classification, military intelligence, and climate monitoring. By the end of the semester you will have a fundamental understanding of the uses and limitations of remote sensing data for environmental applications, and a thorough familiarity with geographic information systems.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5015. Drone Short Course. 1 Credit Hour.
Drones are everywhere. This course offers a short introduction to use of drones, otherwise known as unmanned aerial vehicles (UAVs). Students will be taught use of drones in research and other societal applications, basics of flight and operation of drones, and regulations applicable to drone usage. This course does not provide certification to become a professional drone pilot, but the steps to certification will be reviewed, and the exam for recreational flying can be completed. Flying experience will be provided through indoor labs. Graduate students will complete a project involving photogrammetry. This course is typically offered in even-numbered years in the Spring.

Repeatability: This course may not be repeated for additional credits.

EES 5042. Coastal Processes. 4 Credit Hours.
The course will apply a process geomorphological approach to understanding coastal behavior, including global distribution of coasts, wave and tidal hydrodynamics, nearshore and aeolian sediment transport, and morphological signatures of extreme events.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

EES 5050. Special Topics in Field Investigations. 1 to 3 Credit Hour.
This is a field seminar designed to help graduate students develop critical field skills needed for a successful career in environmental science, geoscience, or sustainability. Students must submit a final written document at the conclusion of the field study. Must be taken with permission of the program director of graduate program.

Course Attributes: SF

Repeatability: This course may be repeated for additional credit.

EES 5051. Natural Hazards. 4 Credit Hours.
This course is typically offered in Spring.
This 4-credit lab course focuses on the physical processes that control natural disasters, why they may pose a risk to people or infrastructure, how to assess risk, and potential mitigation strategies. Labs are used to develop and analyze data characterizing these physical processes and defining risk; this work focuses on defining what can be measured, monitored, and predicted as the basis of the assessment. The first third of the course is devoted to solid earth hazards under the unifying paradigm of plate tectonics including earthquakes and volcanoes. The middle third of the course is devoted to weather hazards including storms/coastal hazards, floods, and landslides. The final third of the course is devoted to climate change, focusing on how hazards may change including extreme weather, heat waves/droughts, wildfire and feedbacks among hazards such as fire, erosion, and landslides. A critical aspect of the course is use of geoscience data tools to identify and analyze risk from topographic, remote sensing, hydrologic, and other data streams combined with hazard products developed by states, NOAA, FEMA, USGS, and other agencies.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5052. Fundamentals of Sustainability Science and Environmental Justice. 3 Credit Hours.
How can we apply science to promote intergenerational equity in the face of global environmental change? This graduate-level course provides a transdisciplinary introduction to sustainability science, exploring the complex interactions between human and environmental systems. Students will become acquainted with the key concepts, issues, and debates of this integrative field to apply a systems-thinking approach to solve real-world sustainability problems.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5101. Structural Geology (Graduate). 4 Credit Hours.
The purpose of this course is to train students in the concepts and techniques of structural geology. Students will learn how to collect, analyze, and interpret geologic data drawn from a variety of disciplines pertinent to structural geology and present a cohesive analysis and interpretation of these results. Results are presented as maps, reports, and computer models. A hypothesis driven term project will be conducted by the graduate student on a topic in structural geology. NOTE: This course differs from the undergraduate version EES 4101 through graduate specific laboratory and exam questions, readings, and the term project.

Repeatability: This course may not be repeated for additional credits.

EES 5234. Energy and Environment. 3 Credit Hours.
This course examines the scientific principles governing energy technologies and use, and the implications of energy development on our natural resources and environmental quality. The first part of the course will provide an introduction to the basic physical principles behind energy production, existing and emerging energy technologies, and energy use. The second part of the course will provide an understanding of the impacts associated with energy development on land, water and the atmosphere; impact assessment techniques; and interactions among energy, food and water resources. This course will provide an opportunity to familiarize with the future grand challenges in energy development in the context of changing climate and policy scenarios.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5343. Environmental Sensors. 1 Credit Hour.
Environmental monitoring using sensors is critical to improve our understanding of earth processes and climate, assessing the quality of the environment, developing and calibrating models to predict climate variability and hazards, designing and evaluating sustainable or "green" solutions, and guiding evidence-based environmental policy decisions. This course provides hands-on experience with implementing field-sensor systems to monitor the environment for research and citizen science projects. The students will familiarize with the fundamental operation principles of a variety of passive and active sensors used widely for long-term field measurements of meteorological and hydrological variables, field installation and maintenance, automation of data collection with data loggers and IoTs, telemetry, and best practices for acquiring and securing data.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5401. Analytical Methods in Mineralogy. 4 Credit Hours.
An introduction to the theory and application of X-ray diffraction and spectroscopic techniques for analysis of mineralogical samples. Students will learn the theory underpinning these methods, acquire skills in instrument operation, and apply these skills to research-relevant problems such as phase identification, site occupancy, chemical analysis, and planetary surface studies. Techniques discussed include powder X-ray diffraction, visible, Raman, and infrared spectroscopy, and synchrotron-based X-ray spectroscopic and scattering techniques.

Repeatability: This course may not be repeated for additional credits.

EES 5402. X-ray Crystallography. 4 Credit Hours.
Generation and use of x-rays for diffraction analysis; Analysis of clays and related minerals by x-ray diffraction; Crystal structure patterns and biogeofunctional groups.

Repeatability: This course may not be repeated for additional credits.

EES 5406. Nanoscience and the Environment. 4 Credit Hours.
Nanotechnology has developed rapidly in the past decade, yet our knowledge of its environmental impact, particularly regarding the fate and behavior of nanomaterials in the environment, lags far behind. This course will cover a range of topics concerning nanomaterials in the environment, ranging from the unique size-dependent properties of nanomaterials to their applications in environmental remediation. The lab component of this course will include nanomaterial synthesis and characterization; nanomaterial transport, aggregation, deposition, transformation, and persistence in natural settings; environmental applications of nanomaterials; and nanomaterial characterization techniques, particularly electron microscopy.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5434. Ecohydrology. 3 Credit Hours.
Hydrological and ecological processes are tightly interrelated, with vegetation affecting the hydrological cycle, and hydrologic partitioning of the water budget affecting vegetation dynamics. This course builds on perspectives from ecology, hydrology, and soil science to focus on the emerging, interdisciplinary area of ecohydrology - the science that studies mutual interaction between the hydrological cycle and ecosystems. The first part of the course will deal with fundamental processes controlling the flow of water in the biosphere (in land, atmosphere, soil and plants) and the interactions with ecological processes and human dimensions at different scales. The second part will deal with the implications of ecohydrological feedbacks, covering a broad range of issues including global environmental change, land use change, global desertification/land degradation, urbanization, soil erosion, and the food-energy-water nexus. The concepts and principles discussed in the class will have broad applications ranging from finding innovative solutions to ecosystem degradation and food security, and designing global change responses.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5454. Introduction to Geophysics. 4 Credit Hours.
An introduction to gravity, magnetic, electromagnetic, and seismic exploration methods. Applications include environmental characterization, oil and mineral exploration, geotechnical engineering, and archeology.

Repeatability: This course may not be repeated for additional credits.

EES 5461. Low-Temperature Geochemistry. 4 Credit Hours.
Principles of aqueous geochemistry discussed within the framework of geologic processes. One or two field trips.

Repeatability: This course may not be repeated for additional credits.

EES 5462. Advanced Low-Temperature Geochemistry. 3 Credit Hours.
Study and discussion of topics in aqueous and sedimentary geochemistry.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

EES 5502. Ice and Global Climate. 4 Credit Hours.
We live in a time of rapid global warming and are faced with adverse effects on human society. Ice, in its various forms from snow to ice sheets, play an important role in the global climate system by, for example, modulating the solar-energy flux and global sea level. Ice also provides a unique archive of past climate history that contributed to our understanding of global warming today. This course will provide an overview of different forms of ice and their role in Earth's climate system, and foundations in physical understanding of how ice behaves at and near Earth's surface. In addition, contemporary techniques in observations of different forms of ice will be explored with examples in processing and interpretation of publicly available datasets. Prior to Fall 2023, the course title was "Glaciology."

Course Attributes: SE, SF

Repeatability: This course may not be repeated for additional credits.

EES 5506. Observing and Modeling Climate Change. 3 Credit Hours.
There is no scientific doubt that human activity has been influencing the climate system since the industrial era due to emissions of greenhouse gases and causing a rise in global mean temperature (i.e., global warming). While Earth's climate and temperature has fluctuated naturally in the past, the rate of current warming in response to human activity is unprecedented and is having a large impact on the climate system and living organisms on our planet. We are experiencing the effects of climate change today in the form of melting of sea ice, glaciers, and ice sheets, sea level rise, increases in the intensity of heat waves, change in frequency and intensity of droughts, extreme rainfall events, and wildfires. The results of climate model simulations suggest that the effects of climate change will worsen throughout the 21st century and beyond if we continue to emit greenhouse gases. In this course we will gain a foundational understanding of anthropogenic climate change and explore the evidence directly through hands-on analysis and visualization of real-world observational datasets. After investigating observational evidence, we will build an understanding of climate models, the experiments performed including climate projections, and how to access, analyze, and visualize publicly available model output. Along the way, students will gain experience in the tools that scientists use to analyze and visualize observational datasets and climate model output. While no prior computational knowledge is assumed, students will be introduced to aspects of the Python programming language, the command line interface, and GitHub. Course content and assignments will be centered around the use of Jupyter Notebooks. This course will be hands-on and assignment and project oriented, with in-class periods geared toward learning to analyze and visualize climate datasets.

Course Attributes: SF

Repeatability: This course may not be repeated for additional credits.

EES 5601. Vertebrate Paleontology and Taphonomy. 3 Credit Hours.
This course examines vertebrate fossils and their importance for interpreting and reconstructing terrestrial ecosystems. Students will learn the basics of vertebrate skeletal anatomy, interpret transport and depositional histories of skeletal elements and assemblages, and combine this information with geologic data to reconstruct paleoenvironmental settings and paleocommunity associations. Several class sessions will meet off-campus at local museums; one weekend field trip is required.

Repeatability: This course may not be repeated for additional credits.

EES 5625. Electron Optical Techniques. 4 Credit Hours.
This course will introduce the microanalytical and imaging methods of electron optical instruments such as the Electron Probe Microanalyzer (EPMA) and the Scanning Electron Microscope (SEM). The theory and operation of the instruments will be covered as will the interpretation of images and analytical results.

Repeatability: This course may not be repeated for additional credits.

EES 5702. Sedimentary Petrology. 4 Credit Hours.
This course explores the basic composition and texture of sedimentary rocks in order to understand depositional environment and provenance. This course focuses on sedimentation mechanics, petrography, and diagenesis. Includes a lab.

Repeatability: This course may not be repeated for additional credits.

EES 5725. Soils and Paleosols. 4 Credit Hours.
The course is divided into two parts: modern soils and paleosols. The goals of this course are to teach students the fundamentals of modern soil genesis and classification in order to interpret ancient soils preserved in the rock record (paleosols), and to incorporate models of soil genesis into the traditional geology paradigm. Students will be exposed to a combination of laboratory methods and field work.

Repeatability: This course may not be repeated for additional credits.

EES 5801. Quantitative Structural Geo. 4 Credit Hours.
Repeatability: This course may not be repeated for additional credits.

EES 5802. Tectonics. 3 Credit Hours.
Plate tectonic theory. Structure and geometry of lithospheric plates; mechanisms of divergent, transform and convergent boundaries; subduction; obduction; mantle plumes; large igneous provinces; large sedimentary basins and Phanerozoic orogenic belts.

Repeatability: This course may not be repeated for additional credits.

EES 5811. Planetary Geology. 4 Credit Hours.
This course explores the modern and ancient geologic processes on other planets and discusses how studies of other planets can aid us in a better understanding of our Earth. The course will also cover topics such as planetary exploration and astrobiology. Includes a lab.

Repeatability: This course may not be repeated for additional credits.

EES 8000. Geology Seminar. 1 Credit Hour.
Required of M.A. students. Visiting specialists in a wide variety of geologic fields will lecture and discuss their research.

Repeatability: This course may be repeated for additional credit.

EES 8082. Independent Study Program. 1 to 3 Credit Hour.
Limited to Geology graduate students with permission from the department.

Repeatability: This course may be repeated for additional credit.

EES 8200. Graduate Geology Seminar. 3 to 6 Credit Hours.
Advanced seminar course; subject matter varies from semester to semester. The educational objectives of the course are to focus on current issues at the interfaces of geological processes through advanced technological methods of analysis.

Repeatability: This course may be repeated for additional credit.

EES 8411. Advanced Hydrogeology. 3 to 4 Credit Hours.
This course is typically offered in Spring.
This course covers water resources with an emphasis on groundwater. Topics include quantifying groundwater flow, groundwater-surface water interactions, contaminant transport, and a brief introduction to modeling. Problem sets and labs are used to develop specific skills, including field techniques.

Repeatability: This course may not be repeated for additional credits.

EES 8421. Groundwater Modeling. 3 Credit Hours.
This course offers students a chance to construct models using well known codes such as MODFLOW and other practical tools. The goals of this course are: learn tools for groundwater flow modeling, be able to recognize how to judge models and compare them with reality, and gain computer skills that can be used with a wide variety tools.

Course Attributes: SI

Repeatability: This course may not be repeated for additional credits.

EES 8701. High Temperature Reactions. 4 Credit Hours.
Thermodynamic laws and theory are used to discuss igneous and metamorphic processes. Exact field relationships are combined with thermodynamics to solve applied petrologic problems.

Repeatability: This course may not be repeated for additional credits.

EES 8706. Regional Geology. 3 Credit Hours.
Discussion of the geologic history and tectonics of selected regions.

Repeatability: This course may not be repeated for additional credits.

EES 8711. Economics of Geo Ore Deposits. 3 Credit Hours.
Study of the geology, origin, distribution, economics and extraction methods of major classes of ore deposits.

Repeatability: This course may not be repeated for additional credits.

EES 8911. Teaching of Geology. 0 to 1 Credit Hours.
Required of all teaching assistants in their first semester of teaching. Instruction and evaluation of teaching laboratory, or discussion sections.

Repeatability: This course may be repeated for additional credit.

EES 9991. Master's Research Projects. 1 to 6 Credit Hour.
Short-term, limited research project or laboratory project in the field. This course is not the capstone project course, nor can it be used for thesis based research. The course is for master's students only, including PSM, MA or MS. This class will not confer full-time program status unless nine credits are taken.

Repeatability: This course may be repeated for additional credit.

EES 9993. Comprehensive Examination Prep. 1 Credit Hour.
This 1-credit seminar is designed to prepare students for the MS Comprehensive Exam given at the end of this course, ensuring a fundamental grounding in Earth Science. Students will study material covered in the exam including hydrogeology, geophysics, sedimentology/stratigraphy, earth history, geomorphology, structural geology, GIS, geochemistry, mineralogy and petrology. MS students will take this course in the Spring semester of their first year.

Repeatability: This course may not be repeated for additional credits.

EES 9994. Preliminary Examination Preparation. 1 to 6 Credit Hour.
This course is required for students who are preparing for the preliminary or candidacy examination. Students should enroll after coursework is completed or when preparing for the candidacy exam until the time that the preliminary or candidacy examination is completed. This course will confer full-time status at the minimum credit hour registration limit of one credit. All students must complete a minimum of one credit of this course. Students must complete a total of 6 credit hours of 9994, 9998 and 9999.

Repeatability: This course may be repeated for additional credit.

EES 9995. Capstone Project. 1 to 6 Credit Hour.
Capstone project for master's students including students in PSM, MA or MS. This class will provide full-time status. Students in PSM programs need to register for at least one credit of this course to fulfill program requirements. Additional credits may be required for specific programs. This course will confer full-time status at the minimum credit hour registration limit of one credit.

Repeatability: This course may be repeated for additional credit.

EES 9996. Master's Thesis Research. 1 to 6 Credit Hour.
Course for master's thesis research. Only intended for students in thesis bearing master's programs. A minimum of one credit is required. This course will confer full-time status at the minimum credit hour registration limit of one credit.

Repeatability: This course may be repeated for additional credit.

EES 9998. Pre-Dissertation Research / Elevation to Candidacy. 1 to 6 Credit Hour.
This course is intended for students who are performing research prior to candidacy. Students can register for this course after required courses are completed. This course will confer full-time status at the minimum credit hour registration limit of one credit. Students must be registered for this course during the semester that they are to be elevated to candidacy examination. Students must complete a total of 6 credit hours of 9994, 9998 and 9999.

Repeatability: This course may be repeated for additional credit.

EES 9999. Dissertation Research. 1 to 6 Credit Hour.
The course is for Ph.D. students who have been elevated to candidacy. During the course of their candidacy students must complete a minimum of two credits of dissertation research. This course will confer full-time status at the minimum credit hour registration limit of one credit. Students must complete a total of 6 credit hours of 9994, 9998 and 9999.

Repeatability: This course may be repeated for additional credit.