

# MORTON K. BLAUSTEIN DEPARTMENT OF EARTH AND PLANETARY SCIENCES

<http://eps.jhu.edu/>

The Department of Earth and Planetary Sciences offers programs of study and research in a wide range of disciplines including atmospheric science, ecology, environmental science and studies, geology, geochemistry, geophysics, oceanography, and planetary science. The undergraduate major in Earth and Planetary Sciences is flexible and allows the student, in consultation with a faculty advisor, to devise a program of study that is both rigorous and individualized. The department also supports an interdisciplinary undergraduate program in Environmental Science and Studies (ENVS), which involves faculty from a range of departments across the university. The two ENVS majors and minor introduce students to the many ways in which humans interact with and affect the Earth. The Energy minor is a multi-school program jointly administered with the Department of Electrical and Computer Engineering in the Whiting School of Engineering and affiliated with the Ralph O'Connor Sustainable Energy Institute (ROSEI, <https://energyinstitute.jhu.edu/>).

The department's graduate program develops skills in research through independent investigation under the general guidance of one or more members of the faculty, backed up by relevant course work. Faculty expertise provides particular emphasis on the integration of experimental investigation, theoretical calculation, and quantitative field observations.

## Undergraduate Programs

### Earth and Planetary Sciences (EPS)

The Earth and Planetary Sciences major focuses on the study of the physical, chemical, and biological processes that shape the Earth and other planets. It is designed primarily for science students who wish to have a career involving research and study of the Earth and planets, although it is also suitable for students planning careers in the health professions.

### Environmental Science and Studies (ENVS)

Program website: <http://krieger.jhu.edu/envs> (<http://krieger.jhu.edu/envs/>)

Undergraduate degrees are typically specialized within traditional disciplines, but a primary goal of the ENVS program is to develop the ability of students to think outside of those boxes. The program is solution-focused and trains students to help solve the environmental and sustainability problems facing society today using the powerful tools of science and policy. Students learn theory, research, and practical applications of the natural and social sciences in their coursework, while also examining the relationship between humans and the environment through the lens of the humanities.

The interdisciplinary Environmental Science and Environmental Studies majors and Environmental Studies minor introduce students to human-Earth interactions and processes, our complex relationship with the changing environment, and methods for solving environmental and sustainability problems. The Environmental Science major emphasizes the perspective of the natural sciences, while the Environmental Studies major emphasizes the social science perspective, but there is a set

of common core courses shared by both these majors that create a strong interdisciplinary foundation. These majors prepare students for a variety of potential career paths, including both graduate study and entry-level jobs in an environmentally related field.

In addition to major requirements, students are required to complete the university requirements for the bachelor's degree. See Requirements for a Bachelor's Degree (<https://e-catalogue.jhu.edu/ksas-wse/undergraduate-policies/academic-policies/requirements-bachelors-degree/>).

### Energy Minor

The Energy minor is designed to allow students majoring in a diverse set of disciplines to develop additional expertise in energy, with a focus on the development of both technical skills and the science and policy context of modern energy issues. The goal is to position students to become leaders in the energy field, either directly as entering professionals in industry, government laboratories, and other organizations, or as students in the best graduate programs. For more information, see <https://energyinstitute.jhu.edu/energy-minor/> ([https://energyinstitute.jhu.edu/?page\\_id=5385&preview=true](https://energyinstitute.jhu.edu/?page_id=5385&preview=true)).

### Facilities

The Department of Earth and Planetary Sciences is housed in Olin Hall, a modern building dedicated to the Earth sciences, nestled on a wooded knoll on the western edge of campus. Its facilities include state-of-the-art instrumentation, a departmental library, and modern computer equipment. There are laboratories for crystallography, evolutionary biology/ecology, stable isotope geochemistry, materials science, and fluid and solid mechanics. Olin Hall also contains equipment for modern petrographic work (including a computer-controlled image analysis system), darkroom facilities, and a laboratory for sectioning rocks. There is also a substantial collection of rocks, minerals, and fossils.

A JEOL 8600 electron microprobe in Olin Hall is available to all members of the department. Crystallographic facilities include a modern specimen preparation laboratory for transmission electron microscopy and single-crystal X-ray diffraction studies. The transmission electron microscopy laboratory houses state-of-the-art instruments capable of both high-resolution imaging at the atomic scale and microanalysis at the nanometer scale.

The department contains several computer laboratories containing clusters of workstations and personal computers, together with printers and scanners. These computers are used for numerical simulations, graphics applications, data manipulation, and word processing.

Field studies and excursions form an integral part of the program of instruction and research in geology and are closely integrated with the laboratory and course work. Situated at the fall line between the Coastal Plain and the Piedmont and only an hour's ride from the Blue Ridge and Appalachians, Baltimore is an excellent location for a department with a field-oriented program in geology. The department has a permanent field station for geological research, Camp Singewald, in the Bear Pond Mountains of Washington County, Maryland, and a vehicle for field use.

Supporting facilities on campus include the Milton S. Eisenhower Library, the Space Telescope Science Institute, and the Homewood High-Performance Computing Center. In addition, the JHU Applied Physics Laboratory, the facilities of the Smithsonian Institution and the Geophysical Laboratory and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington are available by special arrangement for students qualified to use them. For students whose

research requires substantial computation, special arrangements can be made to use the supercomputers at the NASA Goddard Space Flight Center and the National Center for Atmospheric Research.

## Programs

- Earth and Planetary Sciences, PhD (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/earth-planetary-science-phd/>)
- Earth and Planetary Sciences, Bachelor of Arts (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/earth-planetary-sciences-bachelor-arts/>)
- Earth and Planetary Sciences, Minor (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/earth-planetary-sciences-minor/>)
- Energy, Minor (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/energy-minor/>)
- Environmental Science, Bachelor of Science (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/environmental-science-bachelor-science/>)
- Environmental Studies, Bachelor of Arts (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/environmental-studies-bachelor-arts/>)
- Environmental Studies, Minor (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/earth-planetary-science/environmental-studies-minor/>)

For current course information and registration go to <https://sis.jhu.edu/classes/>

## Courses

### AS.270.103. Introduction to Global Environmental Change. 3 Credits.

A broad survey of the Earth as a planet, with emphasis on the processes that control global changes. Topics include: the structure, formation, and evolution of the Earth, the atmosphere, oceans, continents, and biosphere. Special attention is given to present-day issues, such as global climate change, natural hazards, air pollution, resource depletion, human population growth, habitat destruction, and loss of biodiversity. Open to all undergraduates.

Area: Natural Sciences

### AS.270.111. The Story of Earth. 1 Credit.

The four and a half billion year story of Earth's global changes focusing on the co-evolution of Earth and Life.

Area: Natural Sciences

### AS.270.114. Guided Tour: The Planets. 3 Credits.

An introduction to planetary science and planetary exploration primarily for non-science majors. A survey of concepts from astronomy, chemistry, geology, and physics applied to the study of the solar system.

Area: Natural Sciences

### AS.270.129. The Grandeur of You & The Universe. 3 Credits.

A common question that the scientific community is confronted with is "Why do I care?" or "How does this relate to and affect me?". We will address these questions by inquiring and exploring where each one of us fit in the grand scheme of the cosmos and its exploration, centered around themes and concepts fundamental in Earth, planetary, and space sciences (EPSS). Using various creative mediums, you will learn to understand and narrate how you, all parts of your identity relate to the story of the universe. This class will allow you to master the fundamentals in EPSS, appreciate and relate to scientific discoveries, understand how to be responsible future scientists and citizens cognizant of broad scientific impacts, and develop and enhance various skills to be able to understand and communicate science.

Area: Natural Sciences

Writing Intensive

### AS.270.202. Introduction to Ecology. 3 Credits.

Ecology is the study of organisms and their environment. This course focuses on the patterns of distribution and abundance of organisms. Topics include population dynamics and regulation, competition, predation, host-parasite interactions, patterns of species diversity, community succession, the flow of energy and matter through ecosystems. We will also discuss the role of natural and human disturbances in shaping communities.

Prerequisite(s): AS.270.103 OR AS.020.151

### AS.270.205. Introduction to Geographic Information Systems and Geospatial Analysis. 3 Credits.

The course provides a broad introduction to the principles and practice of Geographic Information Systems (GIS) and related tools of Geospatial Analysis. Topics will include history of GIS, GIS data structures, data acquisition and merging, database management, spatial analysis, and GIS applications. In addition, students will get hands-on experience working with GIS software.

Area: Engineering, Natural Sciences

### AS.270.211. From Hollow Earth to Plate Tectonics. 3 Credits.

How do mountains form? What do fossils record? Today, answers to these questions might talk of plate tectonics or evolutionary history. However, centuries ago they were met with hypotheses of a shriveling, fluid filled grape-like Earth and the loss of species due to overfishing. Although these rejected hypotheses sound bizarre to the modern ear, they form the backbone of our understanding of the Earth and evidence the importance of the scientific method. The aim of this course is to investigate geologic concepts through the lens of their development through history. Subjects to be covered include the advent of modern geology, the evolution of the ways geologists tell time, and the development of theories related to mountain building and plate movement. Students will also explore modern questions in Earth Science and investigate how hypotheses are tested today. In this seminar-style course, classes will revolve around discussions of secondary and primary sources. By exploring the history of geology, students will gain a deeper understanding of Earth system processes and the application of the scientific method.

### AS.270.220. The Dynamic Earth: An Introduction to Geology. 3 Credits.

Basic concepts in geology, including plate tectonics; Earth's internal structure; geologic time; minerals; formation of igneous, sedimentary, and metamorphic rocks; development of faults, folds and earthquakes; geomagnetism. Corequisite (for EPS Majors): AS.270.221; optional for others. The course is introductory and open to undergraduates at all levels; freshmen are encouraged to enroll.

Area: Natural Sciences

**AS.270.221. The Dynamic Earth Laboratory. 2 Credits.**

This course is a hands-on learning experience for introductory geological concepts and techniques using geological tools, such as mineral/rock samples, microscopes, and maps. Field trips are its essential part. The course is open to undergraduates at all levels; freshmen who wish to get their hands (and boots) dirty are encouraged to enroll.

**Prerequisite(s):** AS.270.220, credit earned or concurrent enrollment  
Area: Natural Sciences

**AS.270.222. Mineralogy. 4 Credits.**

Introduction to the classification, crystallography, and physical properties of minerals. Weekly lab topics include field identification, crystal morphology and symmetry, optical microscopy and Raman spectroscopy. One field trip to the Smithsonian National Museum of History and Research Archives is planned.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.  
Area: Natural Sciences

**AS.270.224. Oceans & Atmospheres. 3 Credits.**

A broad survey of the Earth's oceans and atmospheres, and their role in the environment and climate. Topics covered include waves, tides, ocean and atmosphere circulation, weather systems, tornadoes and hurricanes, El Niño, and climate change. For science and engineering majors  
Area: Natural Sciences

**AS.270.302. Aqueous Geochemistry. 3 Credits.**

Modeling the chemistry of water-rock interactions from weathering and riverine development at Earth's surface to hot springs at depth, fluids in subduction zones in Earth's interior, and the ancient fluids preserved in fluid inclusions. Thermodynamic basis for the calculation of equilibria and irreversible chemical mass transfer involving minerals and aqueous species at low and high temperatures and pressures. The course culminates with practical examples of research interest to individual participants.

**Prerequisite(s):** (AS.030.101 AND AS.030.102) AND (AS.270.220 AND AS.270.221) or equivalents.  
Area: Natural Sciences

**AS.270.303. Earth History. 3 Credits.**

This course will explore the evolution of life in the context of environmental, ecological, and geological changes to the Earth surface system. The goal of the class is to provide students with an understanding of how geological and paleontological records provide insight into the origin(s) of life, oxygenation of the atmosphere, the evolution of multicellularity, evolutionary radiations and extinctions, and modern global change.

**Prerequisite(s):** AS.270.103 OR AS.270.220 OR AS.270.224; or permission of the instructor.  
Area: Natural Sciences

**AS.270.305. Energy Resources in the Modern World. 3 Credits.**

This in-depth survey will inform students on the non-renewable and renewable energy resources of the world and the future prospects. Topics include petroleum, natural gas, coal, nuclear, hydroelectric, geothermal, solar, wind, biomass, and ocean energy. Global production, distribution, usage, and impacts of these resources will be discussed.

Area: Natural Sciences

**AS.270.306. Urban Ecology. 3 Credits.**

Urban ecology has been called the ecology in, of, and for cities. In this course, we will explore how ecological concepts are applied to urban ecosystems and the different approaches to urban ecological research. Topics will include: Biodiversity, water dynamics, energy and heat island effects, and nutrient cycling, urban metabolism, design of greenspace, and sustainability of cities. We will use Baltimore as a case study for studying cities.

**Prerequisite(s):** AS.270.308 OR EN.570.205 OR EN.570.403  
Area: Natural Sciences

**AS.270.307. Geoscience Modeling. 4 Credits.**

An introduction to modern ways to interpret observations in the context of a conceptual model. Topics include model building, hypothesis testing, and inverse methods. Practical examples from geophysics, engineering, and medical physics will be featured.

Area: Natural Sciences

**AS.270.310. Evolution and Development of the Vertebrates. 3 Credits.**

Modern vertebrates (animals with backbones) are the products of a more than 500-million-year evolutionary history. This course surveys that history and uses it to explore such core evolutionary concepts as adaptive radiation, convergence, extinction, homology, phylogenetic taxonomy, and tree thinking. Emphasis will be placed on the origins of the modern vertebrate fauna and how fossils are being integrated with developmental biology to better understand major transitions in the vertebrate body plan.

Area: Natural Sciences

**AS.270.312. Mammalian Evolution. 3 Credits.**

An introduction to the evolutionary history and diversity of mammals, with emphasis on the first half of the Cenozoic - the beginning of the Age of Mammals. The course will focus primarily on the adaptive radiation of mammals (including our own order primates) that followed the extinction of the dinosaurs, exploring the origins and relationships of the major groups of mammals as well as the anatomical and ecological reasons for their success. Lectures will be supplemented with relevant fossils and recent specimens.

Area: Natural Sciences

**AS.270.316. Agroecology: A Global Perspective. 3 Credits.**

How can we balance the increasing global food demand with sustainable ecological practices? How are the agricultural, ecological, and socio-economic aspects of food production intertwined? This course addresses these questions and enables students to critically evaluate existing agroecosystems around the world, with special attention paid to the challenges of global environmental change. Students will be introduced to the principles of agroecology, and they will examine interactions between biodiversity, soil, and people through case studies, peer-reviewed scientific papers, and a field trip to a local agroecosystem

Area: Natural Sciences

**AS.270.317. Conservation Biology. 3 Credits.**

In this course, students examine the meaning and implications of biodiversity with a focus on disciplines associated with conservation biology, wildlife conservation and wildlife management, including taxonomy, genetics, small population biology, chemical and restoration ecology, and marine biology. This includes exploring how conservation biology differs from other natural sciences in theory and in application. Students learn the major threats to biodiversity and what natural and social science methods and alternatives are used to mitigate, stop, or reverse these threats. The course also includes the economic and cultural tradeoffs associated with each conservation measure at the global, national, regional, and local levels. One required field trip.

Area: Natural Sciences

**AS.270.318. Remote Sensing of the Environment. 3 Credits.**

This course is an introduction to the use of remote sensing technology to study Earth's physical and biochemical processes. Topics covered include remote sensing of the atmosphere, land and oceans, as well as remote sensing as a tool for policy makers. Also offered as 270.618  
Area: Natural Sciences

**AS.270.319. Rocks as Clocks. 3 Credits.**

Introduction to radioisotope geo/thermochronology and mantle stable and radioisotope geochemistry. Course covers: (1) methods for dating of rocks and geologic processes using long-half-life radioisotope systems, including the various isotope systems available and their applicability; (2) radioisotope techniques for investigation of the geochemical evolution of the crust and mantle; (3) isotope fractionation and utility of traditional and novel stable isotope geochemistry for interrogating high-temperature processes, and (4) thermochronology and methods for interrogating upper-crustal processes. Recommended course background: AS.270.220 and AS.270.221, or instructor permission.

**AS.270.323. Ocean Biogeochemical Cycles. 3 Credits.**

This course will examine the cycling of trace chemicals in the ocean, consider what we can learn from the distributions of these chemicals about the ocean circulation, and ocean ecosystems. Topics covered will include oceanic biological productivity, open water cycling of nutrients and oxygen, ocean acidification and sediment cycling.  
Area: Natural Sciences

**AS.270.325. Introductory Oceanography. 3 Credits.**

This class is an introduction to a wide range of physical, chemical, and biological phenomena in the world's oceans. Underlying basic principles are exposed wherever possible. Topics covered include: seawater, waves, tides, ocean circulation, chemical oceanography, biogeochemical ocean processes, and remote sensing of the oceans. Recommended Course Background: freshman Physics, Chemistry, Calculus through ordinary differential equations.  
Area: Natural Sciences

**AS.270.332. Soil Ecology. 3 Credits.**

The course introduces basic aspects of cycles and flows in the soil ecosystem, and provides students with an overview of the higher groups of soil organisms. Laboratory and field surveying methods are also covered.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.  
Area: Natural Sciences

**AS.270.333. Mineral Physics Recitation. 2 Credits.**

This course is designed for undergraduate students interested in pursuing geophysics research in the topics of solid state physics or inorganic chemistry. It will consist of a weekly seminar paired with a separate paper reading+discussion group, covering a range of topics on the frontiers of mineral physics. Themes rotate each semester, and Fall 2018 will be paired with the Mineralogy Lecture Series on Modeling and Experimental challenges in Cosmochemistry. Recommended Course Background: Relevant coursework such as Mineralogy or equivalent in other department, and instructor permission.

**AS.270.336. Freshwater Systems. 3 Credits.**

A study of streams, lakes, and groundwater with a focus on aspects of water quality, hydrology, geomorphology, and aquatic ecology that are relevant to human impacts on freshwater systems. US environmental policies and water resource management agencies will also be examined in the context of issues such as dams, cattle grazing, climate change, and water allocation.

**Prerequisite(s):** AS.270.103 OR AS.271.107 or permission of the instructor.

Area: Natural Sciences

**AS.270.337. Freshwater Systems Lab. 1 Credit.**

A hands-on investigation of the water quality, hydrology, geomorphology, and aquatic ecology of streams and other freshwater bodies. Includes field trips to water-related facilities such as drinking water and wastewater treatment plants.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

Area: Natural Sciences

**AS.270.338. Field Methods in Ecology. 3 Credits.**

This course will introduce student to methods used in field-based ecological research addressing population, community and ecosystem-level questions. Outdoor fieldwork is an essential part of the course. Field activities will center around the riparian ecosystem adjacent to the Homewood campus and on the urban ecology of the greater Baltimore region. Students will build skills in data collection, analysis, synthesis, and presentation. Basic statistical instruction in R will be taught to aid data analysis.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.270.202

**AS.270.345. Metamorphic Petrology. 3 Credits.**

Introduction to metamorphic geology and the concepts on which it is built. Ideas and techniques that underpin metamorphic petrology are introduced. Focus is on utility of metamorphic geology in understanding petrogenesis crustal processes and plate tectonics. Local field trip(s) to explore the metamorphic geology of the Baltimore region. Recommended course background: AS.270.220 and AS.270.221, or instructor permission

**Prerequisite(s):** AS.270.220 AND AS.270.221

Area: Natural Sciences

**AS.270.346. Structural Geology Seminar. 1 Credit.**

Seminar class on fundamentals of structural geology. Involves weekly readings/practical exercises on: (1) rock mechanics and deformation processes; (2) commonly-encountered deformation products/structures; (3) deformation style and associated fabrics/textures/structure; (4) metamorphism and deformation; (5) techniques for describing and measuring structures; (6) interpretation of structural data on maps and cross-sections; (7) approaches for inferring large-scale structure from limited data, and (8) methods for visualizing and analyzing structure.

Recommended course background: AS.270.220, or instructor permission.

**Prerequisite(s):** AS.270.220

**AS.270.347. Foundations of Ecology. 3 Credits.**

In this seminar students will read seminal pieces in ecology. Assigned readings will span early 1900s to present. Students will pair a foundational paper with a more current paper on a similar topic to explore the evolution of ecological concepts and approaches over time. This course is aimed at upper level undergraduates and graduate students.

**Prerequisite(s):** AS.270.202

**AS.270.349. Botany in Action: An Evolutionary Approach to Plant Science. 3 Credits.**

We all know what a plant is- they're usually green, you can eat some of them, some have pretty flowers, and some of them make good medicine. But where do these properties come from and how did they arise? Why do we find them in such large numbers? This course focuses on various aspects of botany through the lens of plant evolution. Understanding and critically assessing contemporary and traditional botanical applications, from cosmetics to urban development, requires foundations in plant ecology, evolution physiology, and biochemistry. The class will incorporate lectures, discussions, and hands-on laboratory activities, and students should expect to construct phylogenetic trees, dissect flowers, identify the plants in and around JHU Homewood campus, and calculate the plant biodiversity of their kitchen pantries.

**Prerequisite(s):** AS.270.103 OR AS.270.202

Area: Natural Sciences

**AS.270.350. Sedimentary Geology. 4 Credits.**

Sedimentary rocks are the historical records of the Earth, documenting climate change, mass extinctions, and the evolution of life. This course will provide an introduction to sedimentary processes and sedimentary rocks. Focus is placed on linking physical observations to the ancient environments in which sedimentary rocks once formed. Fundamental tools for interpreting the sedimentary rock record, such as depositional models, geochronology, and chemostratigraphy will be reviewed. Two 1-day weekend field trips will occur over the course of the semester. There will also be weekly 1-hour labs. Lab and field trip times will be determined in the first week of class. Graduate and advanced undergraduate level. Recommended Course Background: AS.270.220 or instructor permission. Area: Natural Sciences

**AS.270.353. Forested Landscapes. 3 Credits.**

Forests are critical global ecosystems that provide not only timber and wood products, but an array of services including habitat for wildlife, water filtration, carbon storage, and recreational opportunities. This integrated seminar-based course features an interdisciplinary approach to understanding forested landscapes that stresses not only inventorying the biotic and abiotic components, but examining how these pieces are distributed in the landscape (patterns) and what forces drive these patterns (processes). Topics focus on the biological, geological, climatological, cultural, and historical underpinnings needed to observe, interpret, and analyze forest communities. It will cover aspects of biogeography, climate forcing of vegetation dynamics, effects of invasive species, land use change and creation of urban forests. This course has an associated 1- credit field trip typically during the summer semester. Please email the instructor if you are interested in this course for more details on the field trip. This field trip counts as a lab requirement for ENVS majors.

Area: Natural Sciences

**AS.270.354. Stable Isotope Geochemistry. 3 Credits.**

Stable isotope measurements are used to probe fundamental questions in the Earth and environmental sciences because they can be used to extract information about chemical, physical, and biological processes associated with the formation of geomaterials. Stable isotope patterns have been used for applications ranging from tracking the rise of oxygen on the early Earth to studying human diet. The majority of the course will focus on light isotope systems (O, C, S, etc.) and low-temperature applications, including: (1) tracing sources and sinks of fluids, sediments, biological materials, and contaminants, (2) studying rates and mechanisms of biochemical reactions, and (3) paleoenvironmental reconstructions. We will also review novel stable isotope applications including heavy isotope systems and mass independent fractionations. At the end of the course, students will be able to make interpretations about how stable isotope patterns inform our knowledge of how geomaterials are formed and provide information about the Earth system. **Prerequisite(s):** AS.270.220 OR AS.270.224

**AS.270.356. A Modern History of Climate Science. 3 Credits.**

This course charts the evolution of the field of climate science over the last 250 years. We will explore the history of scientific development that led to advances in climate research in the 19th and 20th century. We will also explore the political and social context in which climate science evolved in the West and the backlash of climate change denial that developed due to the influence of the fossil fuel industry. While this course is focused on history, students will be exposed to introductory scientific and technical concepts needed to understand basic climate science. Our understanding of the earth's climate has come a long way in the last two centuries. We understand the implications of climate change on humanity and have already begun to feel the effects of the changing climate on our society. Yet, it has taken us too long to prioritize climate action and policy. Why does knowledge not always translate into governance and policy? While we understand how the climate impacts our society, do we understand how our society impacts climate research? We will look for answers to these and more questions in this course from a historical framework.

**Prerequisite(s):** AS.270.103 OR AS.271.360 OR AS.140.302 OR AS.140.388

Area: Natural Sciences

**AS.270.362. Lunar Exploration and Analog Geology. 3 Credits.**

This course involves readings, discussion, and lectures about astronaut-enabled geological exploration of the Moon and analogous terrains on Earth. Topics include: volcanism, impact geology (cratering, ejecta, ballistic sedimentation), faulting, field methods (video and voice descriptions, sampling protocol), and field equipment (spacesuits, rovers, landers, cores, etc.), Apollo history and Artemis plans/current events. Assessment will involve participation, ~5 assignments related to the course objectives, and a presentation or short paper (student's discretion) synthesizing a small range of covered topics of interest to the student at the conclusion.

**AS.270.378. Present and Future Climate. 3 Credits.**

Intended for majors who are interested in the science that underlies the current debate on global warming, the focus is on recent observations one can glean from model simulations. Meets with AS.270.641. Recommended Course Background: AS.110.108-AS.110.109 and AS.171.101-AS.171.102

**Prerequisite(s):** Student may not receive credit for both AS.270.378 and AS.270.641.

Area: Natural Sciences

**AS.270.379. Atmospheric Science. 3 Credits.**

A survey of core topics in atmospheric science, including dynamics, thermodynamics, radiative transfer, and chemistry. The course addresses both basic principles and applications to weather and climate. Recommended pre-requisites: General Calculus and Physics I and/or Oceans and Atmospheres.  
Area: Natural Sciences

**AS.270.396. Special Topics in Planetary Exploration. 3 Credits.**

Geology in the Outer Solar System: This course will focus on the solid bodies of the outer solar system, addressing their formation, surfaces, interiors, evolution, and how we study them via remote sensing and spacecraft investigation. We will use data from the various missions that have investigated the outer system and cover aspects of instrumentation and remote sensing of outer system bodies from the Voyager missions, Galileo, Cassini, and New Horizons. The course includes lecture, discussion, and hands-on lab work. Recommended pre-requisites: Dynamic Earth and/or Introductory planetary science and/or remote sensing, or instructor approval.  
Area: Natural Sciences

**AS.270.400. The Carbon Cycle: Past, Present and Future. 3 Credits.**

This course will explore how the carbon cycle shapes environmental conditions and influences other biogeochemical cycles through an investigation of the modern carbon cycle, major carbon cycle perturbations in the geological record, and projections of future global change. The majority of the class will be structured as a reading seminar, but students will also develop an understanding of how to use quantitative models to evaluate patterns of change associated with both modern and ancient carbon cycle perturbations with implications for predicting future environmental changes. Recommended Prerequisites: AS.270.103 or AS.270.220 or AS.270.224  
Area: Natural Sciences, Quantitative and Mathematical Sciences

**AS.270.404. Planetary Interiors. 3 Credits.**

This course investigates the physical processes occurring in planetary interiors. Topics include formation and differentiation of planetary bodies, planetary structure, thermal evolution, convection, and dynamo generation of magnetic fields. Standard remote sensing methods used to investigate planetary interiors and results from recent planetary satellite missions will also be discussed. Recommended: Knowledge of vector calculus, PDEs and introductory physics.  
Area: Natural Sciences

**AS.270.408. Petrology Seminar. 1 Credit.**

Seminar class on recent developments in igneous and metamorphic petrology. Involves weekly readings on modern methods/understanding in petrogenesis and processes leading to mineral (re)crystallization; rock deformation; fluid transport in rocks; pressure and temperature estimates of rock formation, and rates/durations of thermotectonic processes in the lithosphere. Topics covered will cater to interests and learning goals of those who register in the class.  
**Prerequisite(s):** AS.270.220

**AS.270.410. Planetary Surface Processes. 3 Credits.**

This course explores processes that influence the evolution of planetary surfaces, including impact cratering, tectonics, volcanism, weathering, and sediment transport. These processes manifest themselves as structural deformation of planetary crusts due to loading by volcanoes, formation of craters by asteroid impacts, modification of surfaces by flowing landslides, rivers and glaciers, and the accumulation and transport of sand in dune fields on various planets. Emphasis is on the relationship to similar Earth processes, and the integrated geologic histories of the terrestrial planets, satellites, and asteroids. The focus will be on developing a physical understanding of these processes to interpret the surface characteristics and evolution of planets, satellites, asteroids, and comets from both qualitative assessments and quantitative measurements obtained from spacecraft data. A key component of the class will be the interpretation of these observations from recent and current planetary missions to the Moon, Mars, and other terrestrial bodies. Recommended Course Background: A sound knowledge of Calculus and Introductory Physics, and some prior knowledge of Earth and/or Planetary Science.  
Area: Natural Sciences

**AS.270.412. Spring seminar: Geological Field Studies in California. 2 Credits.**

Field experience is an integral part of a geology student's education. During this course, students will learn to digitize, synthesize, and interpret the observations they made during the January field-based class to interpret the geologic history and structure of southern California. Study USA: Geological Field Studies in California is a co-requisite for this course. For Spring 2020, the focus of the field work and course will be on applying concepts and techniques covered in Dynamic Earth (AS.270.220/1), Sedimentary Geology (AS.270.350), Earth History (AS.270.303), Planets, Life and the Universe (AS.020.334), and Isotope Geochemistry (AS.270.331). Sedimentary rocks are spectacularly exposed in this region and record over a billion years of key events in Earth history. Students will learn how these rocks have shaped our understanding of major evolutionary and environmental shifts in Earth's past, while also learning how to map these units' regional geographic distribution. Finally, students will also learn about the different tectonic events that have shaped the landscape that we see today in the western United States. The class is designed for upper level E&PS majors and E&PS graduate students.

**AS.270.423. Planetary Atmospheres. 3 Credits.**

Fundamental concepts and basic principles of chemistry and physics applied to the study of planetary atmospheres. Vertical structure of planetary atmospheres. Atmospheric radiation, thermodynamics, and transport. Principles of photochemistry. Planetary spectroscopy and remote sensing. Upper atmospheres and ionospheres. Evolution and stability of planetary atmospheres. Recommended Course Background: basic physics, chemistry and calculus  
Area: Natural Sciences

**AS.270.425. Earth and Planetary Fluids. 3 Credits.**

An introductory course on the properties, flow, and transport characteristics of fluids throughout the Earth and planets. Topics covered include: constitutive relationships, fluid rheology, hydrostatics, dimensional analysis, low Reynolds number flow, porous media, waves, stratified and rotating fluids, plus heat, mass, and tracer transport. Illustrative examples and problems are drawn from the atmosphere, ocean, crust, mantle, and core of the Earth and other Planets. Open to graduate and advanced undergraduate students. Recommended Course Background: Basic Physics, Calculus, and familiarity with ordinary differential equations.

Area: Natural Sciences

**AS.270.426. Mineral Physics. 3 Credits.**

Mineral Physics is the study of mineralogical problems through the application of condensed matter physics and solid-state chemistry. Investigations of the thermodynamic and transport properties of minerals at the atomic scale are used to interpret observational data from seismology, geodynamics, geochemistry, and planetary science, an important step toward solving many geologic and geophysical problems. Students in this course will also be introduced to the high pressure and high temperature experiments that measure the physical and mechanical properties of minerals, which is crucial to understanding planetary interiors. Recommended prerequisites: introductory chemistry, physics, mineralogy, or structure of materials.

**AS.270.431. Tectonics Seminar. 1 Credit.**

Introduction to plate tectonics and its "framework" role in understanding the Earth. Key papers will be discussed in a weekly seminar class. Focus will be on early works that helped establish the theory, in addition to recent breakthrough contributions that have led to modifications and improvements to the theory of plate tectonics.

**AS.270.501. Independent Study. 1 - 3 Credits.**

Exploration of topic(s) in earth, planetary, and/or environmental science under the direction of an instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.270.504. Independent Research. 1 - 3 Credits.**

Research in earth, planetary, and/or environmental science conducted under the direction of a faculty advisor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.270.510. Senior Honors Thesis. 1 - 3 Credits.**

Senior thesis research in earth sciences conducted under the direction of a faculty advisor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.  
Writing Intensive

**AS.270.603. Geochemistry Seminar. 1 Credit.**

A variety of topics of current interest involving mineral-fluid interactions will be reviewed.

**AS.270.605. EPS Colloquium. 2 Credits.**

A weekly seminar series in which graduate students present their latest research results and attend Departmental seminars. This course is required for all graduate students in the Department of Earth and Planetary Sciences.

**AS.270.606. EPS Colloquium. 2 Credits.**

A weekly seminar series in which graduate students present their latest research results and attend Departmental seminars. This course is required for all graduate students in the Department of Earth and Planetary Sciences.

**AS.270.612. Tropical Meteorology. 2 Credits.**

The tropics are a region where climate variability has large impacts yet many aspects of the structure are poorly understood. This course will cover the dynamics of tropical circulation and variability. Topics covered will include equatorial planetary waves, Matsuno-Gill models of tropical circulation, tropical air-sea interaction, the Madden-Julian Oscillation, tropical cyclones, dynamics of the El Niño-Southern Oscillation and monsoonal circulation and flow.

**AS.270.614. Atmosphere and Oceanic Vortices. 2 Credits.**

Vortices are observed in the Earth's atmosphere and oceans and in the atmospheres of other planets. Examples are polar vortices in Earth, Mars and Titan's atmospheres, Spots on Jupiter, Saturn, and Neptune, Gulf Stream rings, and eddies throughout the oceans. These vortices are often the most dominant feature of the regional circulation, and understanding their structure and evolution dynamics is necessary to understand the dynamics and transport of atmospheres and oceans. In this course we focus on the structure and dynamics of long-lived vortices, i.e., vortices that exist for longer than typical wave periods. The first section of the course will consist of lectures examining the fundamental dynamics of vortices in rapidly rotating, stratified fluids, while the second section will be seminars discussing more detailed aspects of specific vortices occurring in nature. It is suggested that you have taken 270.425 Earth and Planetary Fluids or another similar introductory fluids class.

**AS.270.615. Inversion Modeling & Data Assimilation. 3 Credits.**

This graduate class will introduce modern inverse modeling and data assimilation techniques. These powerful methods are used in atmospheric science, oceanography, and geophysics and are growing more widespread. Topics will include: singular value decomposition, Green's function inversions, Kalman filtering, and variational data assimilation. The class will include lectures on concepts and theory, and practical experience in the computer laboratory. Permission of Instructor Required

**AS.270.618. Remote Sensing of the Environment. 3 Credits.**

Also offered as 270.318  
Area: Natural Sciences

**AS.270.626. Ocean General Circulation. 3 Credits.**

The aim of this course is to achieve conceptual understanding of the large scale low frequency ocean general circulation. The role of the ocean circulation in earth's climate is emphasized throughout.

**AS.270.628. Seminar in regional field geology. 2 Credits.**

Weekend field trip to explore regional geology. Students are required to prepare short presentations on field trip topics in advance of weekend trip. Attendance at two organizational meetings (to be scheduled) is required. Open to E&PS graduate students and upper level E&PS undergraduate majors and minors. Trip date is 11/9/2019. Consult instructors for details.

**AS.270.630. Physics and Chemistry of Aerosols. 3 Credits.**

This course will cover fundamentals of aerosol physics and chemistry. Topics covered will include aerodynamics and diffusion of aerosol particles, condensation and evaporation, particle size distributions, optics of small particles, characterization of particle composition, and the diversity of aerosols found in planetary atmospheres. Recommended Course Background: Basic Physics and Chemistry. Calculus.

**AS.270.633. Seminar on the IPCC Sixth Assessment. 1 Credit.**

This course will discuss the contents of the Working Group I contribution to the sixth assessment report (AR6) of the Intergovernmental Panel on Climate Change (IPCC).

Area: Natural Sciences

**AS.270.641. Present and Future Climate. 3 Credits.**

Meets with AS.270.378.

**Prerequisite(s):** Student may not receive credit for both AS.270.378 and AS.270.641.

Area: Natural Sciences

**AS.270.653. Earth and Planetary Fluids II. 3 Credits.**

A sequel to AS.270.425 concentrating on planetary-scale atmospheric and oceanic circulation. Physical understanding of the underlying fluid dynamics will be emphasized.

**AS.270.656. Geochemical modeling of water-rock interactions in the deep Earth. 3 Credits.**

Thermodynamic basis for the modeling of irreversible chemical mass transfer involving minerals and aqueous species at elevated temperatures and pressures. Reading will start with classic papers by Helgeson and co-workers and proceed to applications in the literature involving hydrothermal ore deposits, subduction zones, and diamond formation in the upper mantle. The course focusses on developing specific projects of research interest to individual participants. Recommended Course Background: AS.030.101 and AS.030.102 or equivalent, AND AS.270.220 AND AS.270.221 or equivalent, AND AS.270.302 or equivalent.

**AS.270.662. Seminar in Planetary Science. 1 Credit.**

This is a discussion-based course in which students take turns leading the discussion of planetary science journal articles and other relevant publications.

**AS.270.667. Seminar in Soil Ecology. 1 Credit.**

This weekly seminar explores current research focusing on soil physical, chemical, and biological properties, soil functions, and the interactions among soils, microbes, plants, and fauna. Emphasis is on human impacted soils, such as urban and agricultural ecosystems.

Area: Natural Sciences

**AS.270.668. Geobiology Seminar. 2 Credits.**

Geobiology is the study of interactions between life and rocks. In this class we will explore how organisms impact sedimentary records both directly, by leaving behind biosignatures, or indirectly, by affecting their surroundings in a way that promotes formation of certain types of minerals. This will serve as a guide for interpreting geological records during the early evolution of life on Earth, the rise of animals, and major mass extinctions.

Area: Natural Sciences

**AS.270.675. Communication for Scientists. 3 Credits.**

Communication for Scientists" and the description is "This course will cover the various ways in which scientists are expected to communicate throughout the life of a project. Topics will include writing proposals, preparing impactful figures, writing press releases, interacting with the press (press conferences, radio/TV, interviews, etc.), writing for and speaking to the public, social media, and interacting with policy makers."

**AS.270.679. Atmospheric Science. 3 Credits.**

A survey of core topics in atmospheric science, including dynamics, thermodynamics, radiative transfer, and chemistry. The course addresses both basic principles and applications to weather and climate. Recommended pre-requisites: General Calculus and Physics I and/or Oceans and Atmospheres.

Area: Natural Sciences

**AS.270.683. Topics in Mineral Physics. 3 Credits.**

Mineral Physics is the study of mineralogical problems through the application of condensed matter physics and solid-state chemistry. In this course, students will learn about the foundational and developing research capabilities in Mineral Physics, with an emphasis this year on shock compression and experiments at High Energy Density. Topics will include experimental investigation of equation of states, phase transitions, changes in optical and transport properties and other strain-rate dependent phenomena. Topics in Mineral Physics is a special topics course that rotates in subject and may be taken multiple times for credit. **Prerequisite(s):** (EN.510.311 OR EN.510.601) OR AS.270.222 or instructor permission.

**AS.270.684. Mathematical Methods in Earth and Planetary Sciences. 3 Credits.**

A range of standard mathematical methods used in earth and planetary science applications will be studied. A core set of topics will include back-of-the-envelope estimates, differential equations, linear algebra, special functions, and transforms. In addition, students will tailor the course to their needs by choosing from a range of extended topics to explore further. Potential topics include perturbation theory, tensors, probability theory and complex analysis. Open to graduate students and senior undergraduate EPS majors with permission of instructor. Recommended preparation includes knowledge of single and multivariable calculus and linear algebra.

**AS.270.685. Seminar in Virtual Field Experiences: Accessibility, Exploration, and Development. 3 Credits.**

The Earth Sciences traditionally rely heavily on outdoor field education – the purposeful use of an outdoor environment to achieve educational objectives – in higher education. Observations made at the surface of the Earth are fundamental to understanding the processes that have shaped it, and outdoor field education is often considered an essential way to connect classroom theory with actual data and observations. However, despite the demonstrated benefits of outdoor field education, there are persistent, deep-rooted problems with it in higher education, two of which include accessibility issues and financial barriers. There is overwhelming and demonstrated need to make outdoor field education and research more accepting of all who want to participate. This course aims to explore some of these accessibility issues by: 1) reading and discussing peer-reviewed literature on this topic, 2) participating in and learning about already established virtual field trips and tools, and 3) developing our own virtual educational tools and experiences.



**AS.270.686. Cordilleran Controversies. 1 Credit.**

The origins of the American Cordillera – the mountain ranges forming the backbone of North America, Central America, and South America – remain contentious. It is one of the few global orogens in which there was an active margin whose formation mechanisms remain unresolved. This seminar class will begin by reading seminal papers on the application of “new global tectonics” to the Cordillera shortly following the plate tectonic revolution in the late 1960s. Progressing forward in time, the class will continue to read and discuss papers that develop the classic, broadly accepted model that western North America was gradually assembled from the late Paleozoic into the Miocene through east-dipping subduction. The class will then turn to a drastically different model that was first published in a divisive paper in 2009 that turned the classic tectonic interpretation of the Cordillera on its head by proposing that much of western North America was a separate ribbon continent. The final part of the course will focus on papers published during the last 10 years that try to reconcile differences between the two models. Throughout the course, we will evaluate the range of observations and datasets – both geological and geophysical – that are used to support aspects of the two competing models.

**AS.270.688. Exoplanets and their Atmospheres. 3 Credits.**

This course covers the basic theory of planetary atmospheres as applied to extrasolar planets. The fundamental physical processes related to the structure, composition, radiative transfer, chemistry and dynamics of planetary atmospheres are covered, with an emphasis on those related to observable exoplanet properties. We also provide an overview of the observational techniques of exoplanetary atmospheres and discuss the habitability of exoplanets.

**AS.270.693. Special Topics in Dynamo Theory. 1 Credit.**

Current research literature in planetary magnetic fields and dynamo theory will be studied. Topics will vary year-to-year. Students will be responsible for leading discussions on relevant papers from the literature. Open to graduate students and senior undergraduate EPS majors with permission of instructor. Recommended preparation includes knowledge of fluid dynamics, electromagnetism and planetary science.

**AS.270.695. Graduate Skills in Earth and Planetary Sciences. 1 Credit.**

This seminar-style course will enable graduate students in Earth and Planetary Sciences to discuss issues and develop skills relevant to working in earth and planetary science fields. Topics will vary each iteration and may include graduate school expectations, research and communication methods, grant and funding procedures, stress management, organization and management methods, critical conversations, work-life balance, career paths, and JEDI issues and resources in the geosciences. Course open to EPS Graduate Students or by Instructor Permission

**AS.270.807. Research. 10 - 20 Credits.****AS.270.808. Research. 10 - 20 Credits.****AS.271.107. Introduction to Sustainability. 3 Credits.**

Humans are having such a massive impact on Earth systems that some call this the Anthropocene epoch. Should we consider this state of affairs progress or catastrophe? How to we find a sustainable path to the future? This course provides an interdisciplinary introduction to the principles and practice of sustainability, exploring such issues as population, pollution, energy and natural resources, biodiversity, food, justice, and climate change through the lens of systems thinking. Course open to freshmen, sophomores, and juniors. Seniors by instructor permission only.

Area: Social and Behavioral Sciences  
Writing Intensive

**AS.271.302. Exploring Nature. 3 Credits.**

This course integrates the analysis and production of environmental media with weekly outdoor excursions. Students will survey a range of authors, adventurers, journalists, scientists, photographers, acoustic ecologists and filmmakers that have explored the natural world and chronicled the history of human-environmental relations and environmental problems. Field trips to regional parks and green spaces will encourage students to discover their own sense of place, foster a deeper level of ecological awareness and construct personal environmental narratives through careful exploration, observation, documentation and reflection.

Area: Humanities, Social and Behavioral Sciences  
Writing Intensive

**AS.271.304. Sustainable Food Systems. 3 Credits.**

Where does your food come from? What impact does food production have on the environment and human societies? How can food systems become more sustainable as the human population increases? This seminar-style course examines the past, present, and future of agriculture, including topics such as the foodways of indigenous people, modern “factory farming” versus organic agriculture, genetically modified foods, and the interplay among science, economics, policy, and agriculture. Involves hands-on experiences.

Area: Social and Behavioral Sciences

**AS.271.306. Food, Energy, Water, and Power in the Global South: An Interdisciplinary Approach. 4 Credits.**

Worldwide, there has been rapidly growing interest in research, education, and discourse around the Food-Energy-Water-Nexus (FEW-Nexus). This course will provide students with a framework to describe, analyze, and assist in addressing these complex interrelationships associated with coupled human-natural systems at local, regional, and global scales. The course integrates physical and biological sciences, social and behavioral sciences, humanities, and engineering while covering broad frameworks such as ecosystem-based approaches, critical historical and ethnographic analysis, decision science, and relevant research methods. The course culminates in a funded field work experience at several sites in Brazil. Admission by permission of instructors.

**AS.271.307. Environmental Anthropology: Ecological Knowledge, Cultural Practices and Cosmological Systems. 3 Credits.**

Ecological and environmental anthropology course focuses on the anthropological assessment of environmental issues, the management of natural resources and the study of biological, cultural, and behavioral factors as they impinge upon our understanding of the environment and our ability to respond to environmentally based opportunities, problems, and crises. Course activities and assignments will investigate how human knowledge is integrated into ecological systems.

Writing Intensive

**AS.271.311. Climate and Health. 3 Credits.**

This course will examine the impact of climate variability and change on human health and disease, including the adverse health effects related to extreme heat, air quality, nutrition, waterborne infections, insect-borne diseases, and exposure to storms and floods. Adaptation and mitigation strategies, including the health “co-benefits”, will also be examined

**Prerequisite(s):** AS.270.103 OR AS.271.107

Area: Natural Sciences

**AS.271.315. Environmental Films and Literature. 1 Credit.**

This “book club” style seminar focuses on the exploration, discussion and critical analysis of a range of contemporary environmental films and literature.

**AS.271.320. Environmental Photojournalism. 3 Credits.**

Environmental cognition, consciousness and communication are produced, reproduced, interpreted and remembered with the support of visual representations and, in particular, photography. Images increasingly structure our experience of nature, environmental problems, human-environmental relations, and ecological awareness. Students will review critical literature focusing on visual representation theory, the relationship between images and social change, the practice of journalism and the history and typology of environmental photography. An understanding of environmental issues is required. Students will engage with the local community, identify and investigate environmental issues facing Baltimore, participate in photographic critiques, and develop a documentary project. This studio/seminar course is designed with an emphasis on independent research and practice.

Area: Humanities, Social and Behavioral Sciences

Writing Intensive

**AS.271.345. Society and Nature Conflicts: Interdisciplinary Approaches to Studying Environmental Problems Over Time. 3 Credits.**

In this seminar students will read seminal pieces in the field of socio-environmental research. Socio-environmental research recognizes that society and nature inherently interact in such a way that they affect and change one-another - it is not only that society affects the nature or that nature only affects society. Solving environmental problems necessitates understanding this duality and thus an interdisciplinary background. Assigned readings will span early from thinkers on environmental problems (Before 1900) to current approaches to studying and solving environmental problems. It is aimed at upper level undergraduates and graduate students.

**AS.271.360. Climate Change: Science & Policy. 3 Credits.**

Prereq: 270.103 or permission of instructor. This course will investigate the policy and scientific debate over global warming. It will review the current state of scientific knowledge about climate change, examine the potential impacts and implications of climate change, explore our options for responding to climate change, and discuss the present political debate over global warming.

Area: Natural Sciences

**AS.271.399. Research Design. 1 Credit.**

This course will provide students with a strong foundation in the conceptualization and operationalization of research, how to design a research project and explore different research methods in the environmental field. Students will learn key principles of research design including crafting a suitable research question, identifying appropriate methodologies, and writing a formal project proposal.

**AS.271.401. Environmental Ethics. 3 Credits.**

Environmental Ethics is a philosophical discipline that examines the moral relationship between humans and the natural environment. For individuals and societies, it can help structure our experience of nature, environmental problems, human-environmental relations, and ecological awareness. Beginning with a comprehensive analysis of their own values, students will explore complex ethical questions, philosophical paradigms and real-life case studies through readings, films and seminar discussions. Traditional ethical theories, including consequentialism, deontology, and virtue ethics will be examined and applied. Environmental moral worldviews, ranging from anthropocentric to ecocentric perspectives, will be critically evaluated. Organized debates will help students strengthen their ability to deconstruct and assess ethical arguments and to communicate viewpoints rooted in ethical principles. Students will apply ethical reasoning skills to an examination of contemporary environmental issues including, among others, biodiversity conservation, environmental justice, climate change, and overpopulation. Students will also develop, defend and apply their own personal environmental ethical framework. A basic understanding of modern environmental history and contemporary environmental issues is required. Prior experience with philosophy and ethics is not required.

Area: Humanities, Social and Behavioral Sciences

Writing Intensive

**AS.271.402. Water, Energy, and Food Nexus. 3 Credits.**

The water, energy and food (WEF) nexus is a topic of growing interest in the research and policy communities. This course will survey WEF concepts and principles, introduce tools of analysis, and engage students in case studies of critical WEF issues in the United States and internationally.

**AS.271.403. Environmental Policymaking and Policy Analysis. 3 Credits.**

This course provides students with a broad introduction to US environmental policymaking and policy analysis. Included are a historical perspective as well as an analysis of future policymaking strategies. Students examine the political and legal framework, become familiar with precedent-setting statutes such as NEPA, RCRA, and the Clean Air and Clean Water Acts, and study models for environmental policy analysis. Cost benefit studies, the limits of science in policymaking, and the impact of environmental policies on society are important aspects of this course. A comparison of national and international policymaking is designed to provide students with the proper perspective. This course is taught in conjunction with an identical graduate course. All students will be expected to perform at a graduate level.

Area: Social and Behavioral Sciences

**AS.271.496. Senior Capstone. 3 Credits.**

This seminar will provide the academic space, time, and mentoring for students to integrate, synthesize and apply the knowledge and skills obtained through the ENVS curriculum. The course focuses on the development of critical thinking and oral communication skills through intellectual engagement with complex and challenging environmental problems.

**AS.271.499. Senior Seminar. 1 Credit.**

This seminar explores topics related to career development and current events to support senior environmental majors as they transition to post-graduate life and work.

**AS.271.502. Independent Study. 1 - 3 Credits.**

Exploration of topic(s) in environmental studies under the direction of an instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.271.506. Independent Research. 1 - 3 Credits.**

Research in environmental studies conducted under the direction of a faculty advisor.

**AS.271.507. Internship. 1 Credit.**

This course requires students to synthesize, integrate, and apply environmental skills and theory in a practical setting.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.271.509. Applied Experience. 1 Credit.**

This course is designed to accompany a supervised, hands-on experience working on an environmental or sustainability-related internship. In addition to completing 80 hours of applied work, students will prepare a reflective journal, paper, and poster presentation about their experience.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.271.511. Senior Honors Thesis. 1 - 3 Credits.**

Senior thesis research project in environmental science or environmental studies conducted under the direction of a faculty advisor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.  
Writing Intensive

**Cross Listed Courses****Anthropology****AS.070.379. Social Ecology Studio. 3 Credits.**

This course will grapple with the social and cultural dimensions of contemporary ecological problems through a local, project-based approach. Coursework will be organized on a studio basis in partnership with a local environmental organization, Friends of Stony Run. Continuing a collaborative project initiated in the fall of 2019, we will work together to develop interpretive materials for the Stony Run stream and urban watershed adjoining our campus.

Area: Humanities, Social and Behavioral Sciences

**Environmental Health and Engineering****EN.570.367. Sustainability Science and Policy: The Threat of Climate Change. 3 Credits.**

The challenge of sustainability is simultaneously promoting human well-being while protecting the environment. Advancing a transition toward sustainability hinges on applying what we know to what we should do, including undergirding public policies with knowledge—especially knowledge gleaned from science, technology, and engineering. This course examines sustainability science, communications, and public policy through the lens of climate—what is known about climate change and impacts, what motivates public understanding, and what actions through mitigation and adaptation make progress toward sustainability.

**First Year Seminars****AS.001.129. FYS: Environmental Poisons. 3 Credits.**

An exploration of the occurrence and potential effects of poisons in the environment, from naturally occurring ones such as arsenic to those that may be introduced by mankind such as nuclear waste.

Area: Natural Sciences

**AS.001.167. FYS: The Natural History of the Homewood Campus. 3 Credits.**

Johns Hopkins University Homewood campus and its surroundings is a wonderful green space in the middle of Baltimore City. This First-Year Seminar will introduce students to both the visible and cryptic organisms living above- and belowground. A combination of observational and sampling techniques will be used to demonstrate how ecologists collect data about plants, insects, and other organisms. In the classroom, these field observations, combined with reading material will be used to discuss global environmental issues including climate change on biodiversity, invasive species, and human impacts on the landscape. By the end of the course students will be able to generate research questions based upon field observations and appreciate the diverse life forms both in Earth and in our backyard. Students should be prepared to spend many hours outside.

Area: Natural Sciences

**AS.001.217. FYS: From Cell Phones to Hydrogen Cars: Are the Needed Metals Sustainable?. 3 Credits.**

From cellphones to electric cars, hydrogen cars, and windmills critical metals are needed. Will there be enough and where will they come from? We will discuss questions surrounding the exploration and ownership of metallic resources and their exploitation. Who benefits? Who is adversely affected? To address these questions, we look at individual critical metals and their exploitation in a variety of countries. Experiential investigations of critical metals will take place each Monday to provide material for weekly discussion each Wednesday. Some materials include Background knowledge: Craig, J. R., Vaughan, D. J. and Skinner, B. J. (2011) "Earth Resources and the Environment". Prentice Hall, 4th Edn., 508 pp. For investigations: Numerous papers in the literature such as Skinner, B. J. (1976). "Second iron age ahead." *Amer. Sci.* 64(3): 258-269. Gordon, R. B. et al. (2006). "Metal stocks and sustainability." *Proc. Nat. Acad. Sciences* 103(5): 1209-1214. Sullivan, D. E. (2006). Recycled cell phones—a treasure trove of valuable metals, Geological Survey (US) fact sheet <https://doi.org/10.3133/fs20063097>. Sverdrup, H. U. et al. (2019). "On the long-term sustainability of copper, zinc and lead supply, using a system dynamics model." *Resources, Conservation & Recycling: X* 4: 100007. Plötz, P. (2022). "Hydrogen technology is unlikely to play a major role in sustainable road transport." *Nature Electronics* 5(1): 8-10.

Area: Natural Sciences

**Interdepartmental****AS.360.339. Planets, Life and the Universe. 3 Credits.**

This multidisciplinary course explores the origins of life, planet formation, Earth's evolution, extrasolar planets, habitable zones, life in extreme environments, the search for life in the Universe, space missions, and planetary protection. Recommended Course Background: Three upper level (300+) courses in sciences (Biophysics, Biology, Chemistry, Physics, Astronomy, Math, or Computer Science).

**Prerequisite(s):** Students may not register for this class if they have already received credit for AS.020.334 OR AS.020.616 OR AS.171.333 OR AS.171.699 OR AS.270.335 OR AS.360.671

Area: Natural Sciences

**AS.360.671. Planets, Life and the Universe. 3 Credits.**

This multidisciplinary course explores the origins of life, planet formation, Earth's evolution, extrasolar planets, habitable zones, life in extreme environments, the search for life in the Universe, space missions, and planetary protection. Recommended Course Background: Three upper level (300+) courses in sciences (Biophysics, Biology, Chemistry, Physics, Astronomy, Math, or Computer Science).

**Prerequisite(s):** Students may not register for this class if they have already received credit for AS.020.616 OR AS.020.334 OR AS.171.333 OR AS.171.699 OR AS.270.335 OR AS.360.339.

Area: Natural Sciences

**Modern Languages and Literatures****AS.211.231. Planet Amazonia: Culture, History, and the Environment. 3 Credits.**

Without Amazonia, global warming could reach levels that threaten life on the planet. Yet, in an era of deforestation and climate change, Amazonia itself might be on the verge of disappearance, with disastrous consequences for the world. This course proposes interdisciplinary perspectives on Amazonia through a range of works drawn from history, anthropology, archeology, environmental studies, literature, and the arts. We'll look at texts by European travelers and missionaries who contributed to the paradoxical image of Amazonia as a "virgin paradise" or a "green hell"; scientific studies and artists' depictions of the region's flora and fauna; the often-overlooked history of human occupation of the region; and projects to colonize, develop, or conserve the world's largest tropical forest. What importance does Amazonia hold for Latin American and global geopolitics? How do art and literature, including indigenous writings, create, reinforce, or deconstruct clichés about the region? What alternative futures for our planet can Amazonia help us to imagine?

Area: Humanities

**AS.211.327. Ecocinema: Framing Italy's Environmental Crises. 3 Credits.**

Over the past decade, growing numbers of filmmakers in Italy have addressed ecological crises in their work. This class takes an eco-critical approach to contemporary Italian cinema, examining a body of compelling place-centered stories that deal with local and global issues. Defining the scope of eco-cinema and the ways we can interrogate films as ecological texts, we shall screen earth-centered films that raise consciousness about the consequences of human manipulation of the natural world; the complicity of industry, government, and organized crime in creating environmental crises; and the effects of economic and social malaise. Screenings include iconic films such as Michelangelo Antonioni's *Red Desert* (1963), more recent, critically acclaimed films such as Matteo Garrone's *Gomorra* (2008), Alice Rohrwacher's *Happy as Lazzaro* (2018), and many others.

Area: Humanities

**AS.211.424. Climate Change Narratives: Human and Non-Human Transformative Storytelling. 3 Credits.**

In *The Great Derangement* Indian novelist Amitav Ghosh writes that "the climate crisis is also a crisis of culture, and thus of imagination." Worldwide, climate and environmental change is stirring the imaginary of novelists, filmmakers, and artists who are finding ways to frame, emplot, or even perform, an unmanageable phenomenon like climate change. How is climate change shaping new modes of storytelling and aesthetics? How do film, literature, and environmentally conscious art transform our perception of the world we inhabit and its unpredictable changes? Can climate change narratives help us to imagine futures of possibilities, maybe dystopian, uncertain, or even happy, but futures nonetheless? This multimedia course explores, through a transnational perspective, a variety of contemporary novels, films, and other media that attempt answer these questions.

Area: Humanities

**AS.217.425. Latin American Ecocriticism. 3 Credits.**

Increased awareness of climate change has led to a shift in the way we address and intervene in environmental issues in the new millennium. Yet the interest in making sense of the environment has a long history in literature and the arts. How have Latin American writers and artists understood and depicted their environments and environmental questions? How do the form and content of texts and cultural artifacts influence our understanding of the non-human world? Can works of fiction shape ecological transformations? In this course we will discuss texts from the early colonial period to the present, including the literary works of Graciliano Ramos, Horacio Quiroga, and Clarice Lispector; political ecology; film; Ana Mendieta's earth-body art; contemporary experiments in bio-art; postcolonial theory; and the intersection of environmental justice with such topics as nationalism and human rights. Going beyond ecocriticism's original focus on the Anglo-American world, we will engage recent scholarship on Latin America that sheds light on the region's cultural and geopolitical importance to the global climate, with particular attention to Brazil. This course aims to introduce students to current debates in Latin American Ecocriticism and the Anthropocene and thus contribute to an incipient but expanding field.

Area: Humanities

**Near Eastern Studies****AS.130.250. Clapping Rivers, Talking Snakes: Nature in the Hebrew Bible and Ancient Middle East. 3 Credits.**

How did ancient people relate to their environment—the animals, plants, landscapes, and weather with which they interacted? How have modern binary conceptions of 'nature' and 'culture' or 'human' and 'animal' influenced our interpretation of ancient texts (along with ancient societies)? What is "the zoological gaze?" This course will focus on these questions and more as it investigates conceptions of nature in the texts of the Hebrew Bible, as well as texts and material culture from ancient Egypt, Mesopotamia (modern-day Iraq), and the Levant (modern-day Syria, Lebanon, Palestine, Israel, and Jordan). We will interrogate various interpretive lenses, including Posthumanism, Animal Studies, and Metaphor Theory, as we explore themes such as creation, nature and divinity, and animals in rituals, legal texts, and prophecies, among others. No previous familiarity with Hebrew language or the Hebrew Bible is needed.

Area: Humanities

Writing Intensive

**AS.130.378. Geoarchaeology: Applications of Earth Science to Archaeology. 3 Credits.**

Geoarchaeology is a multidisciplinary subfield that applies the tools and techniques of earth science to understand ancient humans and their interactions with environments. This course examines basic topics and concepts, including archaeological site formation, paleo-environmental reconstruction, raw materials and resources, soil science, deposition and erosion of wind and water-borne sediments in different environments such as along rivers, lakes and coastlines, radiocarbon and other chronometric dating methods, and ground-based remote sensing, including ground penetrating radar.

Area: Natural Sciences, Social and Behavioral Sciences

**AS.131.678. Geoarchaeology: Applications of Earth Science to Archaeology. 3 Credits.**

Geoarchaeology is a multidisciplinary subfield that applies the tools and techniques of earth science to understand ancient humans and their interactions with environments. This course examines basic topics and concepts, including archaeological site formation, paleo-environmental reconstruction, raw materials and resources, soil science, deposition and erosion of wind and water-borne sediments in different environments such as along rivers, lakes and coastlines, radiocarbon and other chronometric dating methods, and ground-based remote sensing, including ground penetrating radar.

Area: Natural Sciences, Social and Behavioral Sciences

For current faculty and contact information go to <http://eps.jhu.edu/people/>