# Earth, Environmental, and Planetary Sciences

Website: https://eeps.wustl.edu/

## Courses

**EEPS 1000 Environmental Geology**
Examines the interaction between Earth system and processes with human activities and how solutions can be developed to address environmental problems. Broad topics include: Earth materials, resources, pollution, geologic hazards and global climate change. No prerequisite needed for this class, and is suitable for students with little or no background in Earth or environmental science. Homework assignments or case study discussions will help students make vital connections beween class concepts and real-world scenarios. There will also be 1-2 day field trips designed to help students develop field observation and data collection skills.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1010 Seminar in Earth and Planetary Sciences**
Each week a different faculty member presents a lecture or laboratory demonstration relating to recent discoveries in geology and the planetary sciences, or about general topics dealing with volcanism, earthquakes, plate tectonics, geologic hazards, fossil life, and Earth history. Pass/No Pass only.
Credit 1 unit. A&S IQ: NSM Art: NSM

**EEPS 1020 Earth's Atmosphere**
The past, present, and future of the atmosphere. Present composition and structure. Comparison with atmospheres of other planets. History and origin of the present atmosphere, and chemical and other interactions with the solid earth, oceans, and biosphere. Extraterrestrial effects. Effects of human activities.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1030 Oceanography**
Emphasis on geological, chemical, and physical oceanography. Topics: topography and origin of ocean basins; origin and composition of sea water; effect of compositional variations on biological productivity; dynamics of water movements, including coastal processes.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1040 First-Year Seminar: Geology in the Field**
This course is designed to develop foundational skills in field geology and Earth science while promoting leadership and teamwork. There are no prerequisites, and the class is suitable for students with little or no academic background in Earth science. Students are not required to have extensive outdoor experience, but they must demonstrate enthusiasm for work in challenging environments. Students will receive training in a variety of geological field methods, including field mapping, sampling protocols, section measurement, and structural identification and analysis. This course is field-intensive, with multiple field exercises during class periods and two or three weekend field trips that will involve camping, caving, and backcountry hiking. This course is primarily suited for students who enjoy working outdoors and who intend to major in Earth, Environmental, and Planetary Sciences, Biology, Anthropology, or Archaeology. Course enrollment preference is given to first-year students.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 1050 Habitable Planets**
Why does the Earth have water oceans? Where did our atmosphere come from? Is Earth uniquely habitable among solar system bodies? This course is an exploration of the origins of volatiles such as water and carbon on planetary bodies and of the internal features that help to regulate our planet's surface conditions. The importance of magnetic fields, plate tectonics, and climate feedbacks with respect to the origins and sustenance of life on Earth will be discussed.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 1060 First-Year Opportunity: Exploring the Planets**
How do humans explore other worlds? This course will introduce how NASA and other space agencies explore our Solar System and beyond. The first part of the course will describe why we explore planets, and how decisions are made as to what missions to fly; the latter portion of the course then focuses on past, current, and planned missions to major Solar System bodies. Course content will include faculty- and guest lecturer-led presentations on spacecraft mission design and how missions are implemented. Students will give individual presentations on a planetary body of their choice, and will work in groups to study spacecraft missions currently in flight.
Credit 1 unit. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

**EEPS 1070 Environmental Geology and Energy**
Ways to minimize hazards to the environment from the use of different forms of energy. Geologic hazards of human activity. Earthquake and volcanic hazards; global warming due to greenhouse effect. Feasibility of nuclear waste disposal. Geothermal energy. Air and water pollution. Intended for non-science majors.
Credit 3 units. A&S IQ: NSM Art: NSM

**EEPS 1080 Oceans and the Atmosphere**
Basic concepts of the evolution and physical structures of the Earth's oceans and the atmosphere. Dynamic aspects of the oceans (waves, tides, tsunamis) and atmospheric circulation (weather). Role of biological processes (including anthropogenic) in defining the present oceans and atmosphere. Global climate issues discussed in EEPS 1110.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 1090 Quantitative Reasoning in Environmental Science**
Introduction to practical mathematical methods for understanding environmental aspects of our planet, particularly how the environment changes with time through human interactions. Emphasis on intuitive approaches in devising simple relationships for understanding quantitative outcomes of natural processes. Introduction to basic statistical methods, including hypothesis testing, and how statistics can be applied to environmental problems.
Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 1100 Scientific Issues of the Nuclear Age**
Scientific questions related to the nuclear arms race, nuclear proliferation, arms control, testing and verification of test-ban treaties. Informed policies or decisions involving these issues often rely on the answers to scientific questions. This approach isolates particular questions and issues and builds the skills and knowledge to analyze them, from basic scientific principles and in a quantitative fashion. Focus will be on questions involving Earth and Planetary Sciences, including atmospheric science.
Credit 3 units. A&S IQ: NSM
Typical periods offered: Fall

**EEPS 1110 Introduction to Global Climate Change in the 21st Century**
Global climate and global climate change and their impacts on life and civilization. Integrated view of global climate and the diverse forces that can alter global climate. Historical and potential future consequences of global climate change on human life, our industrial civilization, and its sustainability.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring, Summer

**EEPS 1120 First-Year Seminar: Engineering the Climate**
Geoengineering, the deliberate manipulation of the earth's climate, may be part of a solution to the predicted future global warming. Is this advisable, or even possible? Discussions,lectures, and readings used to learn how earth's climate works. Examination of some proposals for altering the climate. Past attempts for deliberate human alteration of natural systems discussed and evaluated. Consideration of geoengineering as an ethical issue. Prerequisite: first-year undergraduate status.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 1140 Life of the Geologic Past**
Examination of the history of life from its earliest fossil record over three billion years ago to the present. Topics: geological time, fossilization, organic evolution, relation between ancient organisms and ancient environments. Sequence of plants and invertebrates through time with emphasis on remains of mammal-like reptiles, dinosaurs, modern reptiles, mammals.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1150 The Future of Energy**
The course will examine the topic of energy from many human-relevant perspectives in a primarily lecture-based format. Humans use an enormous amount of energy, at the staggering rate of 20 terawatts. Where does this energy come from? How long will it last? What are the consequences? This course will examine these questions and look at energy resources and their consumption from scientific, social, economic, ethical and political viewpoints. The course will first examine what energy is, as well its relation to other concepts such as heat, work, and power. We will then look at the way that energy is used by society. We will examine the different sources of energy, their availabilities, the pros and cons of using them, their consequences, and their futures. We will examine the impacts that the use of fossil fuels is having on the environment, primarily through pollution and greenhouse gas-driven climate change. We will examine the significant environmental injustices associated with energy, its production, and availability. Given that Earth receives more energy from the sun in one hour than all humans use in a year, opportunities for solar-based power (photovoltaic, wind, hydro, biomass) are plentiful. However, how we get to there from where we are now is not clear, and many questions remain (the role of nuclear power, the rate of transition, the role of government, the impacts of climate change, energy storage capabilities, battery vs. hydrogen fuel cell cars, etc.). This course will look at all of these topics related to all of the energy sources, including the roles they played in our past and the roles they might play in our future.
Credit 3 units. BU: SCI
Typical periods offered: Fall

**EEPS 1160 Resources of the Earth**
Introduction to major resources of the Earth: rocks, minerals, water, soil, air. Basics of geology presented so that origin, supply, and uses of resources can be better understood. Environmental awareness stressed. Field trip required.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1180 Geology of National Parks**
Survey of geologic processes occurring at the Earth's surface and its interior using national parks and monuments as the prime venue for presentation. Volcanism and mountain-building; the work of streams, glaciers, and wind; lake and coastline development; stratigraphy and sedimentation; and Earth history. Material presented in a geographic context, with emphasis on landforms and landscape evolution, relating geology to the development and settlement of the U.S.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring, Summer

**EEPS 1250 The Dinosaurs**
The public interest in dinosaurs makes them an ideal organism for exploring the nature of science. In this class, we will separate dinosaur fact from fiction with discussions of evolution, ecology, extinction, anatomy, and behavior. We will also examine the roles of dinosaurs in popular media.
Credit 3 units. Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 1300 Ring of Fire: Earthquakes, Volcanoes, & Plate Tectonics**
Presentation of plate tectonics and physical processes shaping the Earth, using the band of recurring earthquakes and volcanoes (Ring of Fire) that borders the Pacific Ocean as a primary example. Use of plate tectonics to explain origins of continents, oceans, mountains, and effects on evolution of life. Impact of earthquakes and volcanoes on human society. Concept of deep time-evolution of Earth from Big Bang origin of the universe to the present.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1310 Natural Disasters**
Examination of the effects of natural hazards on landscapes of the Earth in general, as well as on populated areas specifically, through numerous case studies. Social, economic, and political consequences of natural disasters. Locations, particularly in the U.S.A., where disasters are likely to occur in the future. Nature of the hazards and what preparations are possible to minimize damage and the number of casualties.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 1400 First Year Seminar: Geology and Human Health**
This course explores the connections between human health and geological processes. Key concepts in geology are introduced as well as the pathways through which natural systems affect human health. A series of case studies will be presented, each describing a specific health hazard and its geological origin. The first set of studies will focus on human health effects associated with windborne exposure to harmful materials, including volcanic emissions, asbestos, dust and aerosols, and the products of coal combustion. The course will then use

the topic of mercury, which is emitted into the atmosphere and then accumulates in aquatic systems, to transition to water and soil borne pathways of exposure. This will be followed by case studies exploring water availability and quality, arsenic in groundwater, with a special emphasis on widespread arsenic poisoning in South and Southeast Asia, lead in mining areas and urban soils, and radon and radioactive materials. Students will conduct team risk assessment projects as well as an individual project.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 1410 First-Year Seminar: Unearthing the Science of Climate Change**
How and why does the climate change? How does the climate system interact with human systems? This course investigates the physical principles of Earth's ever-changing climate, with a special focus on the present-day. Topics include Earth's energy balance; the components of the climate system, including the atmosphere; oceans, cryosphere, geosphere, and biosphere; natural and anthropogenic causes of climate change; climate change detection and attribution; weather extremes; and climate adaption/vulnerability in past and present human societies. Students will explore the science behind hot topics in climate change and learn how peer-reviewed science is communicated to popular audiences. The course format will be a mixture of lectures, demos, facilitated discussions, and student presentations. In addition to gaining scientific background on climate change, students will develop skills in scientific writing and communication to a variety of audiences. No prior coursework in earth science is necessary. This course is open to students of any background who wish to gain literacy in the science of climate change.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 1450 Land Dynamics: Case Studies of Environmental Sustainability**
This course is designed for first- and second-year students and will use lectures, discussions, GIS-related and computational exercises, and field trips to introduce students to a systems approach for identifying, characterizing, and solving issues associated with environmental degradation. The course will focus on three case studies. The first will cover rapid lake drawdown of Mono Lake in northern California due to engineered diversions and subsequent court-ordered recovery to an environmentally sustainable lake level. The second will focus on unresolved consequences associated with channelization and levee development on the lower Missouri River, which put federal agencies in conflict with one another on how to manage the river and its floodplains. The third will cover past and present Pb-Cu-Zn sulfide mining practices in Missouri and attempts to balance the need for these nonrenewable resources while minimizing environmental consequences.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 1710 The Solar System**
Survey of the planets and satellites of our solar system. Includes results from Apollo manned missions to the Moon and spacecraft missions to the planets and their major satellites. Present ideas about the age, formation, and early history of the sun, Earth, and meteorites.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 1996 Earth and Planetary Sciences Elective: 1000-Level**
This course is used for transcribing 1000-level EEPS elective units.
Credit 3 units.
Typical periods offered: Fall, Spring, Summer

**EEPS 2010 Earth and the Environment**
Introduction to the study of the Earth as a dynamic, evolving planet. Emphasis on how internal and surface processes combine to shape the environment. Themes: Earth's interior as revealed by seismic waves; Earth history and global tectonics shown by changes to ocean floors, mountain-building, formation of continents, earthquakes, and volcanism; climate history and global biogeochemical cycles, influenced by circulation of atmosphere and oceans, ice ages, and human activity. Composition and structure of rocks and minerals. Part of the introductory sequence of courses for all Earth, Environmental, and Planetary Sciences and Environmental Studies majors. Three class hours and one two-hour lab a week.
Credit 4 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 2020 Introduction to Earth, Environmental, and Planetary Science**
Introduction to the Earth, its environment, and its place in the solar system. This course is intended to be a starting point for majors in the Department of Earth, Environmental, and Planetary Sciences, or as a standalone course for students from all interests and backgrounds. Themes for this course include Earth's history; the structure and composition of Earth and other planets; the evolution of Earth's surface; natural hazards; climate history; global biogeochemical cycles; and the solar system. Students who are interested in gaining more depth in lab or field techniques, or students who are planning to major in EEPS, should consider co-registering in EEPS 2021.
Credit 3 units. A&S IQ: NSM, AN Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 2021 Introduction to Earth, Environmental, and Planetary Science Lab Section**
Students enrolling in EEPS 2020, who are interested in gaining more depth in lab or field techniques, should consider co-registering in EEPS 2021. This optional 1-credit lab session is an opportunity for students who want to go deeper into Earth, Environmental, and Planetary Sciences. A combination of lab activities, discussion, and field trips will provide context and practical experience that will enhance understanding of EEPS 2020 concepts while preparing students for advanced coursework. Sessions include opportunities to study geologic and environmental processes using hands-on approaches, including field and lab work. Seven meetings, (typically every other week), plus one required field trip on a Saturday. (1 credit)
Credit 1 unit.
Typical periods offered: Fall, Spring

**EEPS 2190 Energy and the Environment**
Examination of the topic of energy from many human-relevant perspectives. Humans use an enormous amount of energy, at the rate of 18 terawatts. Where does this energy come from? How long will it last? What are the consequences? Examination of energy resources and consumption from scientific, social, economic, and political viewpoints. Relationship of energy to concepts such as heat, work, and power. Energy use by society. Energy sources, pros and cons of use, availability now and in the future. Types, abundance, advantages, challenges of renewable energy sources.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall, Spring

**EEPS 2200 Environmental Science**
Introduction to Environmental Science as a discipline. Interlinked geological,atmospheric, hydrological, and biological processes that constitute the environment. Emphasis on natural processes that control climate, composition of air and water, support and distribution of ecosystems. Scientific framework for examining the effects of human activities on the environment. Three class hours and one two-hour laboratory period a week.
Credit 4 units. A&S IQ: NSM Art: NSM

**EEPS 2210 Human Use of the Earth**
Examination of the impacts of a growing population on the Earth, including habitat destruction, resource depletion, and air and water pollution. Population growth, landscape change, and the distribution and uses of the water, mineral, and energy-producing resources of the Earth.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

**EEPS 2996 Earth and Planetary Sciences Elective: 2000-Level**
This course is used for transcribing 2000-level EEPS elective units
Credit 3 units.
Typical periods offered: Fall, Spring, Summer

**EEPS 3080 Topics in Environmental Sustainability**
Mathematical sustainability models; ocean, atmospheric, wetland, agricultural, hydrological, and energy sustainability; depletion of non-renewable resources; effects of pollution, human population, urban environment.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 3100 Geological Field Methods**
Methods and principles of geological field work, including map reading, sampling and sample location, air photo interpretation, and geologic map construction. One class hour and one three-hour laboratory a week, and occasional weekend field trips.
Credit 3 units. A&S IQ: NSM Art: NSM

**EEPS 3150 Environmental Impacts of Human Energy Use**
Students will meet in an active-learning classroom (such as January 110 or McDonnell 362) and work in groups of up to six people at a table. Some projects will be short units, started and completed within a single class period. Other projects will be longer, extending over several class periods. The projects will include debates, analyses of recent journal articles and other primary sources, energy literacy assessments, the creation of educational modules, and quantitative problem-based learning. Classes will include some amount of lecturing, in measured doses, particularly from guest lecturers.
Credit 3 units. A&S IQ: NSM

**EEPS 3173 Soil Science**
Physical, chemical, and biological processes that occur within soil systems. Types of soils and their formation. Major components of soil, including soil water, minerals, organic matter, and organisms. Soils in wetlands and arid regions. Mapping of soils and their spatial variability. Cycling of nutrients and contaminants in soils. Sustainable use of soils and their role in climate change.
Credit 3 units. A&S IQ: NSM
Typical periods offered: Spring

**EEPS 3190 Physical Oceanography**
Ocean circulation, El Nino, dynamical tides, tsunami, coastal ocean, enclosed seas, paleo-ocean, sedimentation, ice-atmosphere-ocean interaction, biology-carbon cycle.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 3230 Biogeochemistry**
Basic concepts of how elements cycle among Earth's crust, oceans, and atmosphere, including perturbations due to human activities. Carbon, nitrogen, phosphorus, sulfur, and water cycles. Isotopic tracers. Feedbacks, forcings, and residence times. Redox cycling and thermodynamics. Biogeochemical box models, and changes in biogeochemical cycles over Earth history. Biogeochemistry of greenhouse gases, biogeochemical feedbacks in the climate system. This course is appropriate for EEPS students, engineering students, environmental science majors, and other students with interest in the environmental or geological sciences.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 3350 Introduction to Petrology**
Classification, origin, mineralogy, and geological occurrence of major igneous and metamorphic rocks. Laboratory emphasis on identification of rocks and minerals in hand specimens and in thin sections. Three class hours and one two-hour laboratory a week.
Credit 4 units. A&S IQ: NSM Art: NSM

**EEPS 3360 Minerals and Rocks in the Environment**
Combined rock and mineral course with focus on environmental issues and applications. Introduction to mineralogic and petrologic concepts relevant to environmental geoscience pursuits. Foundations of mineralogy and crystallography, key mineral groups, foundations of igneous, sedimentary, and metamorphic rock systems. Mineralogy of environmental systems such as soils, marine environments, aerosols, mines, and radioactive wastes. Overview of analysis methods used for environmental geoscience applications. One full-day field trip required. Both EEPS 336 and EEPS 352 may be taken for credit, but only one may count towards the EEPS or EES majors and minors.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 3400 Minerals, Rocks, Resources and the Environment**
This course is designed for undergraduate majors and minors in the Department of Earth, Environmental, and Planetary Sciences to master fundamentals of mineralogy and their context within sedimentary, metamorphic, and igneous rocks, including an introduction to mineral resources and the role of minerals and mineral resources in current environmental issues. The course will provide fundamentals of mineralogy and crystallography, important mineral groups, and foundations of sedimentary, metamorphic, and igneous rock systems. It will provide an overview and lab demo of the modern analytical methods used in mineralogy. The course includes lecture (three hours per week) and a lab component (two hours per week). Prerequisites: EEPS 202 and Chem 105.
Credit 4 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 3410 Introduction to Geochemistry**
This is an undergraduate-level introduction to geochemistry intended for EEPS majors and non-majors interested in understanding how the discipline of chemistry is applied in the Earth, environmental, and planetary sciences. The course is structured to emphasize how elements and compounds are sorted and transferred between a

planet's core, mantle, crust and surface reservoirs. A broad range of topics are covered to prepare students for in-depth study in subsequent classes: the origin of the elements, radioactive decay, chemical bonding, an overview of rock-forming minerals, the composition of the solid Earth, mantle melting and trace element partitioning, properties of solutions, reduction-oxidation reactions, water-rock reactions, the composition of river and ocean waters, the composition of the atmosphere, low-temperature geochemical cycles, subduction zone chemical cycling, and basics of stable and radiogenic isotope geochemistry. Prerequisites: EEPS 202 and Chem 105

Credit 3 units. A&S IQ: NSM

Typical periods offered: Fall, Spring

**EEPS 3420 Environmental Systems**

Introduction to the science of environmental systems and processes. Exploration of key functions of major environmental systems on land, in rivers and lakes, in air, at sea, and in diverse transitional settings at the boundaries between these environments. Evaluation of the ways in which humans alter and are affected by environmental systems. Interspersed throughout the semester will be a review of the major U.S. laws governing human management of environmental systems as well as case studies of environmental disparities in the St. Louis region.

Credit 3 units. A&S IQ: NSM, AN

Typical periods offered: Fall

**EEPS 3520 Earth Materials**

Fundamental principles of crystal chemistry, symmetry and structure of crystals (minerals), X-ray analysis of crystalline materials, information on the important mineral groups (definition of the groups; composition, structure, physical properties, occurrence, and usage of major mineral species); optical mineralogy. Geological and environmental aspects of earth materials. Both EEPS 352 and EEPS 336 may be taken for credit, but only one may count towards the EEPS or EES majors or minors. Three class hours, one two-hour laboratory, and one two-hour discussion period a week.

Credit 5 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Fall

**EEPS 3530 Earth Forces**

Basic concepts regarding the forces that act upon the Earth, how geological materials react to these forces, and the time scale over which they respond. Emphasis on physical concepts needed to understand the geodynamical behavior of the Earth over a broad range of length and time scales. Application and interpretation of geophysical methods to probe the interior of the Earth. Prerequisite: EEPS 202 (may be taken concurrently) and Phys 191. Three class hours and one two-hour laboratory a week.

Credit 4 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Spring

**EEPS 3610 Structural Geology**

The landforms that surround us are constantly being modified by tectonic forces. Structural geology provides a framework for investigating, describing, and quantifying these changes. This course will provide an introduction to the structures that form at all scales, from millimeter-sized fractures to rifts in Earth's lithosphere thousands of kilometers long. Through the study of these features and processes that form them, students will gain a fundamental understanding of the physical evolution of our planet. Topics will include descriptive analysis of microscopic and macroscopic structures, field methods, the physical basis for rock deformation, and global tectonics.

Credit 4 units. A&S IQ: NSM BU: SCI

Typical periods offered: Fall

**EEPS 3730 Fundamentals of Planetary Science**

Overview of planetary science and astrobiology as practiced today, focusing on key scientific questions. Course is an entry point to the EEPS Planetary Science major, but also provides for those interested a deeper immersion than possible in EEPS 171A. Introduces major planetary science themes: surfaces, interiors, atmospheres, and magnetospheres, and their application to terrestrial planets, giant planets and their satellites, dwarf planets, and small bodies. Final portion of the course focuses on life, ocean worlds, and planetary habitability. Prerequisite: EEPS 202.

Credit 3 units. A&S IQ: NSM

**EEPS 3853 Earth History**

Introduction to the concept of deep time and the parallel biological evolutionary and environmental changes that have occurred throughout Earth history. Topics include early evolution of life, rise of atmospheric oxygen, global glaciation, mass extinctions.

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Fall, Spring

**EEPS 3863 The Earth's Climate System**

This course introduces an integrative view of the Earth's climate system and its coupled components - the atmosphere, the oceans, the cryosphere, the biosphere, and the geosphere - and how they interact with each other. The goal is to provide the physical scientific background that is needed to understand climate variability and climate change, both natural and anthropogenic. Topics include energy balance; general circulation of the atmosphere and the oceans; the greenhouse effect; modes of variability such as El Nino; geologic-scale climate change in the geologic past; climate models; climate change detection and attribution; projection of future climates; and societal impacts. In addition to lectures, students will gain hands-on experience analyzing and interpreting real datasets through inquiry-based practicum exercises and in-class discussions. Prerequisites: EEPS 202.

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Fall, Spring

**EEPS 3873 Geospatial Science**

This course introduces students to the interdisciplinary field of geospatial science, which bridges the fields of geographic information systems (GIS), remote sensing, data science, and spatiotemporal analysis. This course will provide an overview of the fundamental concepts of geospatial science, including: visualizing and analyzing raster and vector datasets within a GIS database; coordinate systems, reference frames, and projections; the Geoid and geodetic techniques; remote sensing methods; image acquisition and interpretation; spatiotemporal analysis of geospatial data; sampling, interpolation, and time series analysis; uncertainty, error, accuracy, and precision. This course will be available at both the upper-level undergraduate and the graduate levels. Material will be covered through lectures, assignments, and computer exercises that will give students hands-on experience analyzing and interpreting real geospatial datasets. Exercises for students enrolled in the 587 option will be more in-depth and will require some basic programming experience and familiarity with quantitative techniques. These exercises will provide students with a sampling of geospatial science applications, such as environmental studies, cryospheric science, wildlife management, contagious disease monitoring, demography, and human geography. Students will complete a final project of their choosing that synthesizes the concepts and themes learned in this course; students enrolled in the 587 option are encouraged to develop a project proposal that aligns with their own research interests. Students particularly interested in GIS and remote sensing are further encouraged to also consider EnSt 380 and EEPS 407, respectively.

Credit 4 units. A&S IQ: NSM, AN BU: SCI

Typical periods offered: Fall

**EEPS 3883 GIS for the Earth, Environmental, and Planetary Sciences**

This course will introduce fundamental geospaLal concepts, tools, and analyses through hands-on exercises and assignments. The course will focus on common applications of geographic information systems (GIS) in the earth sciences to illustrate core geospaLal concepts, provide exposure to key data types and analysis tools, and to build proficiency with industry standard GIS software. Class meetings will feature lectures, article discussions, and hands-on exercises to demonstrate common workflows for obtaining, creating, or editing geospatial datasets and using them to perform spatial analysis and create effective map products.

Credit 3 units. A&S IQ: NSM

Typical periods offered: Fall, Spring

**EEPS 3900 Independent Study**

Independent study for undergraduates, to be supervised by a faculty member. Credit to be determined.

Credit 3 units. Art: NSM

Typical periods offered: Fall, Spring

**EEPS 4000 Special Topics**

The content of this course varies each time it is offered, as announced by the Department. With permission of the advisor, this course may be repeated for credit. Variable credit.

Credit 3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall, Spring

**EEPS 4001 Special Topics**

The content of this course varies each time it is offered, as announced by the Department. With permission of the advisor, this course may be repeated for credit.

Credit 3 units. A&S IQ: NSM

**EEPS 4014 Earth Systems Science**

This is a quantitative introduction to physical and chemical interactions among the atmosphere, oceans and solid earth. Topics covered include terrestrial atmospheric chemistry, geochemical cycles, inventories, and reservoirs of carbon, nitrogen, & sulfur, and bulk composition of the Earth.

Credit 3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Spring

**EEPS 4074 Remote Sensing**

Use of different parts of the electromagnetic spectrum (visible, ultraviolet, infrared, and radio wavelengths) for interpretation of physical and chemical characteristics of the surfaces of Earth and other planets. Digital image systems and data processing.

Credit 3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall, Spring

**EEPS 4084 Earth's Atmosphere & Global Climate**

Structure and dynamics of Earth's atmosphere. Basic factors controlling global climate of Earth. Quantitative aspects of remote sensing of atmosphere. Remote sensing instrumentation.

Credit 3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall

**EEPS 4094 Surface Processes**

How do landscapes evolve? This course focuses on the physical processes of erosion and deposition that shape Earth and planetary surfaces. Course aims (1) understanding emergent landscape patterns, (2) reconstructing past conditions using the sedimentary record, and (3) predicting landscape change under climate scenarios. Review of relevant climatic and tectonic processes, followed by detailed discussion of rivers and deltas, hillslopes, weathering, glaciers, and coasts.

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Fall

**EEPS 4104 Earth Remote Sensing Methods and Instrumentation**

Detection of electromagnetic radiation reflected,scattered, or emitted by components of the Earth system. Spectroscopy of remote sensing. Interpretation of received radiation via radiative transfer within a context of real measurements. Theory of instruments and detectors. Comparison of realized equipment to theoretical models.

Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI

Typical periods offered: Fall, Spring

**EEPS 4134 Introduction to Soil Science**

Physical, chemical, and biological processes that occur within soil systems. Types of soils and their formation. Major components of soil, including soil water, minerals, organic matter, and organisms. Soils in wetlands and arid regions. Mapping of soils and their spatial variability. Cycling of nutrients and contaminants in soils. Sustainable use of soils and their role in climate change.

Credit 3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall

**EEPS 4224 Sedimentary Geology**

Survey introduction to sedimentary processes and materials, including description, formation, and interpretation. Sedimentary materials account for most of the Earth's crust, and much of our understanding of Earth history comes from their examination. Many of our economic resources, such as coal, oil, and natural gas, and many environmental problems, are related to or derive from sediments. Goals: understanding and identifying sediments and processes and using them to interpret stratigraphic, paleoenvironmental, and tectonic information; obtaining the understanding of sedimentology that is relevant to environmental issues; increasing scientific literacy and critical thinking. Mandatory field trips.

Credit 4 units. A&S IQ: NSM Art: NSM

Typical periods offered: Fall, Spring

**EEPS 4254 Invertebrate Paleontology**

Study of fossil invertebrates with emphasis on morphology of hard parts, geochronological and geographical distribution, and taxonomy. Comparison of fossil taxa with living representatives and interpretation of paleobiological patterns. Two class hours and one two-hour lab a week.

Credit 3 units. A&S IQ: NSM Art: NSM

**EEPS 4284 Hydrology**

Survey of principles that govern the flow of water in river and groundwater systems in deep geologic environments. Basic equations of fluid flow, dynamics, and the characteristics of drainage basins, rivers, floods, and important aquifers. Exploitation of ground water systems.

Credit 3 units. A&S IQ: NSM Art: NSM

Typical periods offered: Spring

**EEPS 4304 Environmental Mineralogy**
Topics connected with environmental mineralogy, some selected by students. Topics may include: mineral dust such as asbestos, containment materials for nuclear waste disposal, environmental ramifications of the processing and use of phosphate fertilizers, lead in the environment, acid mine drainage, microbial mediation of sulfide oxidation, minerals in the human body, weathering of building materials, materials engineering, and engineering of materials for more effective recycling. Three class hours and one two-hour laboratory a week. Participation in discussions, term paper, two field trips required. Most readings from primary sources.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4374 Igneous & Metamorphic Petrology**
Classification, origin, mineralogy, and geological occurrence of major igneous and metamorphic rocks. Laboratory emphasis on identification of rocks and minerals in hand specimens and in thin sections. Three class hours and one two-hour laboratory a week.
Credit 4 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

**EEPS 4414 Introduction to Geochemistry**
Application of the principles of nuclear and physical chemistry to problems of the composition and differentiation of the Earth. Introduction to nucleosynthesis of the elements, stellar evolution, the periodic properties of the elements, chemical bonding and ionic substitution, geochronology and stable isotope geochemistry, and the age and composition of the Earth, Moon and meteorites.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4424 Aqueous Geochemistry**
Introduction to the geochemistry of natural waters and the processes that alter their composition. Key principles of aqueous geochemistry are introduced and then used to describe the main controls of the chemistry of pristine and polluted soil, surface, and ground water environments. Topics covered include mineral solubility, complexation, acids and bases, carbonate chemistry, rock weathering and clay formation, adsorption and ion exchange, redox reactions, microbial energetics and redox zonations, the geochemistry of iron, sulfur, trace elements, and radionuclides, and geochemical kinetics. Geochemical modeling will be introduced.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 4444 Environmental Geochemistry**
Introduction to the geochemistry of natural waters and the processes that alter their composition. Key principles of aqueous geochemistry and their application to describe the main controls on the chemistry of pristine and polluted soil, surface, and ground water environments. Acids and bases, mineral solubility, carbonate chemistry, chemical speciation, redox reactions, adsorption and ion exchange, and the speciation, mobility, and toxicity of metals. Prerequisites: EEPS 202 and Chem 106 or Chem 112.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 4454 Organic Geochemistry**
Introduction to the composition and analysis of organic material in the environment and geological record. Molecular to global-level perspective of organic matter cycling, reactivity, and fluxes; formation and classification of organic matter, its preservation potential, diagenesis, catagenesis, and kerogen formation; coal, petroleum, and gas formation and accumulation; biomarkers in Earth history; genetics and phylogeny of biomarker compounds; overview of analytical techniques including both structural and isotopic aspects; oceanographic and paleoenvironmental applications of organic biomarkers; contaminants and residue analysis. Prerequisites: EEPS 202 and Chem 106 or Chem 112.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4464 Stable Isotope Geochemistry**
Applications of equilibrium and kinetic isotope fractionation and material balance principles to the distribution of oxygen and hydrogen isotopes in natural systems. Geothermometry and paleotemperatures, mass spectrometry, isotope hydrology and ice cores, fluid-rock interaction, igneous rocks and meteorites. Prerequisites: EEPS 441 and MATH 233.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4524 Introduction to Seismology**
Introduction to earthquake and exploration seismology. Seismic wave propagation, data analysis and processing, earthquake mechanisms, seismic constraints on the structure of the Earth, relationship of seismicity to plate tectonics.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

**EEPS 4534 Interior of the Earth**
Composition and temperature of Earth's mantle and core, determined by geophysical methods. Inferences about mantle and core dynamics, especially interactions. Current understanding and history of interior in fields of seismology, geomagnetism, mineral physics, geodynamics.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4544 Exploration and Environmental Geophysics**
Basic geophysical techniques used in exploration and environmental geophysics, emphasizing seismic and electromagnetic methods. Basic theory, field procedures, and interpretation of data. Use of geophysical instruments on field trips, followed by reduction and analysis of acquired data. Two class hours and one two-hour laboratory a week, and approximately four one-day field trips during the semester. Prerequisites: EEPS 353 and Phys 191 and Math 132.
Credit 4 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4594 Geodynamics**
Fundamental physical processes necessary to understand plate tectonics and a variety of geological phenomena. Heat flow, gravity, elasticity and flexure, rheology of Earth materials.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

**EEPS 4604 Introduction to Structural Geology**
The landforms that surround us are being modified constantly by tectonic forces. Structural geology provides a framekwork for investigating, describing, and quantifying these changes. This course provides an introduction to the structures that form at all scales, from millimeter-sized fractures to plate-boundary-scale rifts. Topics include descriptive analysis of microscopic and macroscopic structures, field methods, the physical basis for rock deformation, and global tectonics. Three hours of lecture and one two-hour laboratory a week. Prerequisites: EEPS 340 and EEPS 353.

Credit 4 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall

**EEPS 4674 Planetary Mission Design**
This course will introduce EEPS, physics, and engineering students to the combined scientific and engineering aspects required for the development of a robotic spacecraft exploration mission to a body in the Solar System. Through Instructor delivered lectures, individual presentations, and a group presentation and a report, students will design a robotic spacecraft exploration mission that satisfies specific target, cost and schedule constraints.
Credit 3 units. A&S IQ: NSM

**EEPS 4684 Geospatial Field Methods**
This course is an introduction to field geospatial surveying using high-precision GNSS systems and UVAs (drones) outfitted with a variety of sensors such as cameras, multispectral sensors, and lidar. Coursework will cover basic principles as well as provide hands on experience. Most of the course is project based, and students will complete a series of exercises designed to familiarize them with the effective use of field equipment. Students will design data collection strategies, collect data, and become familiar with data processing pipelines and visualization techniques. After completing the course, students will be prepared to safely and effectively conduct independent GNSS and drone surveys, and use the data for studies in Earth, environmental, and planetary science, archaeology, environmental science, ecology, landscape architecture, urban design, agriculture and a variety of other field-based disciplines.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Fall

**EEPS 4734 Planetary Geology**
Discussion of the evolution of the terrestrial planets and the outer-planet satellites as evidenced by the geologic records left on the surfaces of these bodies. Focus on major processes affecting planetary surfaces:impact cratering, volcanism, tectonism, and erosion and sedimentation by wind and water. Prerequisite: EEPS 353
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Fall, Spring

**EEPS 4744 Planetary Geochemistry**
A survey of the geochemistry of the planets and their satellites using data from Earth-based, Earth-orbital, and spacecraft observations.
Credit 3 units. A&S IQ: NSM Art: NSM
Typical periods offered: Spring

**EEPS 4864 Paleoclimatology**
The history of Earth's changing climates and environments on timescales from decades to millions of years. Key concepts in paleoclimatology include: external factors affecting the climate system (e.g., orbital cycles, volcanic eruptions, greenhouse gases); internal feedbacks, such as with monsoons and the El Nino- Southern Oscillation; abrupt versus gradual change; interactions with the biosphere (including hominins/humans); and comparison to present-day climate change. Current controversies in paleoclimate.
Credit 3 units. A&S IQ: NSM Art: NSM BU: SCI
Typical periods offered: Spring

**EEPS 4900 Independent Study**
Independent study for advanced undergraduates or for graduate students, to be supervised by a faculty member. Prerequisite: permission of instructor. Credit to be arranged. Prerequisite: permission of instructor.
Credit 12 units.
Typical periods offered: Fall, Spring

**EEPS 4960 Field Geology**
Hands-on application of geological field methods, providing an opportunity for students to synthesize classroom knowledge in a field setting. Students will develop the ability to recognize and analyze Earth processes, and deconstruct complex regional geology. Participation in an extended international field trip during spring break is required. Students must be prepared for an intensive, group-oriented experience. Prerequisite: must be an Earth, Environmental, and Planetary Sciences major and have permission of instructors. Enrollment is limited, and students will be selected through a written application. May be repeated for credit, with instructor permission.
Credit 3 units.
Typical periods offered: Spring

**EEPS 4990 Honors Research**
Independent work for undergraduate Honors, to be supervised by a faculty member. Prerequisites: Senior standing, eligibility for Honors, and permission of instructor.
Credit 3 units.
Typical periods offered: Fall, Spring