

# ESS: EARTH AND SPACE SCIENCES

## Courses

### ESS 501. Environmental Geochemistry. 3 Credits.

Migration and distribution of the chemical elements within the earth; chemistry of the lithosphere, hydrosphere, and biosphere; chemical changes throughout earth history; the geochemical cycle.

### ESS 502. Investigating Earth Materials. 3 Credits.

Origins of minerals and rocks. Observation, data collection, and analysis applied to the study of earth materials. Hands-on experience in sample identification and mineral analysis in the laboratory and field. Introduction to software and Internet resources for minerals and rocks. Preparation of teaching modules involving minerals, rocks, and local geology. Required one-day field trip on a weekend. CHE 103 and 104 or equivalent is strongly recommended.

### ESS 505. Petrology. 3 Credits.

Origin, classification, and identification of rocks. Hand specimen examination.  
ESS 505 Prerequisite: Successful completion of ESS 502 with minimum grade of C-. Corequisite: ESS 505L.

### ESS 505L. Petrology Lab. 0 Credits.

Laboratory studies of the origin, classification, and identification of rocks. Hand specimen examination.  
ESS 505L Corequisite: ESS 505.

### ESS 507. Geology of the Solar System. 3 Credits.

The geology, origin, and properties of planets, comets, asteroids, moons, and meteorites; planetary exploration.

### ESS 520. Structural Geology. 3 Credits.

An introduction to structural analysis: a study of the deformational features of the earth's crust and the forces responsible for producing them.  
ESS 520 Prerequisite: Successful completion of ESS 505 with minimum grade of C-. Corequisite: ESS 520L.

### ESS 520L. Structural Geology Lab. 0 Credits.

Laboratory studies of structural analysis: a study of the deformational features of the earth's crust and the forces responsible for producing them.  
ESS 520L Corequisite: ESS 520.

### ESS 521. Geometrics. 3 Credits.

Application of computational and statistical methods to geological problems. Geologic sampling, data comparisons in environmental, petrologic, paleontologic, and geochemical problems.

### ESS 523. Field Geology of Southeastern Pennsylvania. 3 Credits.

Methods of geologic data collection, analysis, and presentation using a variety of geologic sites in SE Pennsylvania; the use and interpretations of geologic maps to understand the geologic events that produced this region.

### ESS 530. Principles of Oceanography. 3 Credits.

Geology of the ocean floor, water movements, chemical characteristics of sea water, and vertical and horizontal distribution of plants and animals. Brief history of oceanography.

### ESS 531. Introduction to Paleontology. 3 Credits.

Identification, paleobiology, and importance of fossils; paleoecology; and evolution.  
ESS 531 Corequisite: ESS 531L.

### ESS 531L. Introduction to Paleontology Lab. 0 Credits.

Laboratory studies on the identification, paleobiology, and importance of fossils; paleoecology; and evolution.  
ESS 531L Corequisite: ESS 531.

### ESS 532. Advanced Oceanography. 3 Credits.

An advanced course in oceanography covering resources, oceanographic literature, animal-sediment relationships, field techniques, estuaries, salt marshes, sea level changes, and pollution.  
ESS 532 Prerequisite: Successful completion of ESS 330 or ESS 530, with a minimum grade of C-.

### ESS 535. Remote Sensing. 3 Credits.

An introduction to the science and technology of remote sensing and the applications of remote sensing data to geology, oceanography, meteorology, and the environment. Includes a discussion of the history and principles of remote sensing; fundamentals of electromagnetic radiation; theory and types of active and passive remote sensing systems; fundamentals of image interpretation; digital analysis of LANDSAT and AVHRR data; operation of environmental satellites; and future imaging systems.

### ESS 536. Environmental Geology. 3 Credits.

Application of geology to problems such as environmental degradation, pollution, and hazards, which arise from human interaction with natural materials and processes.

### ESS 539. Hydrogeology. 3 Credits.

This applied course covers groundwater flow, well hydraulics, water resources, contaminant transport, and groundwater remediation. Familiarity with calculus is recommended.  
ESS 539 Prerequisite: Successful completion of CHE 103 and ESS 101, with minimum grades of C-.

### ESS 542. Geophysics. 3 Credits.

This course investigates the gravitational, magnetic, seismic, thermal and electrical properties of rocks and minerals and the application of these properties to imaging the subsurface of the earth, both the near-surface and deep interior. Topics also include radioactivity and radiometric dating. One semester of calculus and one semester of physics recommended.

### ESS 543. Geomorphology I. 3 Credits.

Lectures will present the constructional and degradational processes that have shaped present landforms and are constantly modifying those landforms. Laboratories will focus on the interpretation of topographic maps and the use of remote sensing materials.

### ESS 544. Geomorphology II. 3 Credits.

A continuation of the study of earth surface processes. Laboratories will focus on the interpretation of topographic maps and the use of remote sensing materials.  
ESS 544 Prerequisite: Successful completion of ESS 543 with a minimum grade of C-.

### ESS 547. Earth and Space Science Seminar. 1 Credit.

Weekly seminar course featuring guest lectures by geoscience professionals, prominent scientists, faculty, and students. Each week students will read professional literature, attend and participate in the lecture, and write a summary and/or analysis of each seminar. Repeatable for credit.

### ESS 548. International Geology Field Studies. 3 Credits.

Field investigations of selected country's physical environments focusing on geology and natural resources in relationship to cultural traditions, lifestyle and sustainability. Case studies of human adaptation to local and global environmental challenges will be considered. Two hours of lecture and two hours of lab.  
ESS 548 Prerequisite: Successful completion of ESS 101 or ESS 102, with a minimum grade of C-.

Repeatable for credit.

### ESS 549. Advanced Hydrogeology. 3 Credits.

An advanced groundwater course covering complex well hydraulics, contaminant fate and transport processes, heat flow, saltwater and NAPL behavior, numerical groundwater and solute modeling, emerging remediation technologies, isotope methods, and other contemporary topics. A previous course in hydrogeology or significant hydrogeology experience recommended.

### ESS 550. Sedimentation & Stratigraphy. 3 Credits.

The nature and origin of stratified deposits; the temporal-spatial relationships among stratified deposits, and other geologic and biologic phenomena; and the reconstruction of paleoenvironments.  
ESS 550 Corequisite: ESS 550L.

### ESS 550L. Sedimentation & Stratigraphy Lab. 0 Credits.

Laboratory studies of the nature and origin of stratified deposits; the temporal-spatial relationships among stratified deposits, and other geologic and biologic phenomena; and the reconstruction of paleoenvironments.  
ESS 550L Corequisite: ESS 550.

### ESS 555. Intermediate Astronomy. 3 Credits.

An analytical and qualitative analysis of selected astronomical topics: orbits, stellar properties, telescopes, photometry, solar surface details, nebulae, galaxies, and stellar evolution. Two-hour lecture and two-hour lab, including independent observatory work.  
ESS 555 Prerequisite: Successful completion of ESS 111, ESS 112, or PHY 105, with minimum grades of C- or approval of instructor.

**ESS 560. Internship. 1-6 Credits.**

This course provides students with an opportunity to gain on-the-job training and to learn how to work as effective geoscience professionals. Specific learning outcomes include demonstrating the ability to apply content knowledge to real-world geological problems, and learning to perform responsibly as an effective member of an organization. These outcomes will be assessed by mentor review, self-reflection, and a final presentation.  
Repeatable for credit.

**ESS 562. History of Astronomy. 3 Credits.**

The development of astronomical theories from Greek times to the 20th century.

**ESS 565. The Science and Media Connection: Producing and Communicating Science. 3 Credits.**

This course is intended to prepare students to make multimedia products about fundamental scientific phenomena which can be used to educate and teach others. Through both theoretical and practical approaches, students learn skills and concepts that will enable them to complete a series of science-based creative projects and apply these skills toward future use.

**ESS 570. Principles of Meteorology. 3 Credits.**

An in-depth study of the dynamic nature of the atmosphere with an emphasis on the role of weather-related phenomena in daily life.

**ESS 571. Advanced Meteorology. 3 Credits.**

A further investigation of atmospheric behavior, including exploring more advanced meteorology topics, such as vorticity, advection, and the ageostrophic wind. Students also participate in a semester-long research project where an online severe weather database is used to identify atmospheric ingredients necessary to produce severe weather in Pennsylvania. A manuscript and presentation are required at the end of the semester. One introductory meteorology course and one course in algebra/trigonometry required.  
ESS 571 Prerequisite: Successful completion of ESS 170, ESS 370, or ESS 570, with a minimum grade of C-.

**ESS 580. Special Problems. 1-6 Credits.**

Study of special topics and current developments in the earth and space sciences.  
Repeatable for credit.  
Equivalent courses: ESS 480

**ESS 590. Fundamentals of Soil. 3 Credits.**

Soil properties, classification, and genesis from geologic, agricultural, and engineering perspectives. Topics include pedology, soil physics, geotechnical engineering, erosion, septic systems, soil contamination, and remediation.  
ESS 590 Prerequisite: Successful completion of ESS 101 with minimum grade of C-. Corequisite: ESS 590L.

**ESS 590L. Fundamentals of Soil Lab. 0 Credits.**

Laboratory studies of soil properties, classification, and genesis from geologic, agricultural, and engineering perspectives. Topics include pedology, soil physics, geotechnical engineering, erosion, septic systems, soil contamination, and remediation.  
ESS 590L Corequisite: ESS 590.

**ESS 591. Independent Study. 1-3 Credits.**

An investigation by the student.  
Repeatable for credit.

**ESS 594. Geology of Northwestern National Parks. 4 Credits.**

This course includes a field trip to the national parks in South Dakota, Wyoming, Montana, Idaho, northern Utah, and Colorado. The purpose of the course is to look at the geologic features of the national parks in these states and to develop an appreciation of the geology and geologic history of the region.

**ESS 596. Earth Systems Science. 3 Credits.**

Energy drives interactions between the lithosphere, hydrosphere, atmosphere, and ecosphere producing an earth system of biogeochemical cycles that may be in homeostasis or change. The geological records of past icehouse and greenhouse climates are examined as potential models for evaluating the consequences of human-induced global environmental change and the choices that face society at local, national, and international scales. Instruction and assessments designed to model innovative strategies and current themes in earth systems science.  
ESS 596 Prerequisite: Successful completion of ESS 523, ESS 530, ESS 536, or ESS 570, with minimum grades of C-.

**ESS 599. Earth & Space Sciences Transfer Credits (Graduate). 3-9 Credits.**

Transfer Credits  
Repeatable for credit.

**ESS 602. Directed Research. 1-3 Credits.**

This course, typically taken the semester before graduation, provides students dedicated time (~5 hours/week) to focus on a research project with an assigned faculty member, who will serve as a research advisor. By the end of the semester, students must construct and submit a ~15-20 page research manuscript and ~15-30 min oral presentation. These products will then be showcased to a 3-person graduate committee as part of the required final project for the M.S. Geoscience degree. Throughout the semester, the student is expected to communicate regularly to his/her research advisor, provide task updates and receive guidance.  
Repeatable for credit.