

# EARTH AND SPACE SCIENCES (ESS)

*College of the Sciences and Mathematics*

## 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.

Typically offered in Fall & Spring.

### **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.

Typically offered in Fall.

### **ESS 505. Petrology. 3 Credits.**

LEC (2), LAB (2)

Origin, classification, and identification of rocks. Hand specimen examination.

Pre / Co requisites: ESS 505 requires prerequisite of ESS 502.

Typically offered in Spring.

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

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

Typically offered in Spring.

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

LEC (2), LAB (2)

An introduction to structural analysis: a study of the deformational features of the earth's crust and the forces responsible for producing them.

Pre / Co requisites: ESS 520 requires prerequisite of ESS 505.

Typically offered in Spring.

### **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.

Typically offered in Fall.

### **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.

Typically offered in Summer.

### **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.

Typically offered in Spring.

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

LEC (2), LAB (2)

Identification, paleobiology, and importance of fossils; paleoecology; and evolution.

Typically offered in Spring.

### **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.

Pre / Co requisites: ESS 532 requires prerequisites of ESS 330 or ESS 530.

Typically offered in Spring.

### **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.

Typically offered in Spring.

### **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.

Pre / Co requisites: ESS 539 requires prerequisites of ESS 101 and CHE 103 or equivalent.

Typically offered in Spring.

### **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.

Typically offered in Spring.

### **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.

Typically offered in Spring.

### **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.

Pre / Co requisites: ESS 544 requires prerequisite of ESS 543.

### **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.

Typically offered in Fall.

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.

Pre / Co requisites: ESS 548 requires prerequisite ESS101 or ESS102.

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.

Typically offered in Fall.

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

LEC (2), LAB (2)

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.

Typically offered in Fall.

**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.

Pre / Co requisites: ESS 555 requires a prerequisite of ESS 111 or ESS 112 or PHY 105 or approval of instructor.

Consent: Permission of the Department required to add.

Typically offered in Fall.

**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.

Consent: Permission of the Department required to add.

Typically offered in Fall, Spring & Summer.

Repeatable for Credit.

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

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

**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.

Typically offered in Fall.

**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.

Pre / Co requisites: ESS 571 requires prerequisite of ESS 170 or ESS 370 or ESS 570.

Typically offered in Spring.

**ESS 580. Special Problems. 1-3 Credits.**

Study of special topics and current developments in the earth and space sciences.

Consent: Permission of the Department required to add.

Repeatable for Credit.

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

LEC (2), LAB (2)

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.

Pre / Co requisites: ESS 590 requires a prerequisite of ESS 101.

Typically offered in Fall.

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

An investigation by the student.

Consent: Permission of the Department required to add.

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.

Consent: Permission of the Department required to add.

**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.

Pre / Co requisites: ESS 596 requires prerequisites of ESS 523 or ESS 530 or ESS 536 or ESS 570.

Typically offered in Summer.

**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.

Consent: Permission of the Department required to add.

Typically offered in Fall, Spring & Summer.

Repeatable for Credit.