

# DEPARTMENT OF EARTH AND SPACE SCIENCES

## Overview

207 Merion Science Center  
610-436-2727

Department of Earth and Space Sciences (<http://www.wcupa.edu/earthSpaceSciences/>)

Howell Bosbyshell ([hbosbyshell@wcupa.edu](mailto:hbosbyshell@wcupa.edu)), *Chairperson*

Christopher Roemmele ([croemmele@wcupa.edu](mailto:croemmele@wcupa.edu)), *Assistant Chairperson*

The Department of Earth and Space Sciences prepares students for careers in geoscience and geoscience education. The U.S. Bureau of Labor Statistics states that employment of geoscientists is projected to grow by 5% from 2010 to 2020, faster than the average for all occupations. The need for energy, environmental protection, and responsible land and resource management is projected to spur demand for geoscientists in the future. This geoscience degree prepares students for entry-level positions in such occupations and is also a strong foundation for people interested in pursuing advanced degrees. Geoscience is an integrated study of Earth, its geologic history, composition and structure, resources, natural hazards, atmosphere and oceans, and its environment in space. Geoscientists study such phenomena as earthquakes, landslides, floods, volcanoes, coastal erosion, and how these natural hazards impact humans. Geoscientists explore for mineral, energy, and water supplies. Geoscientists also attempt to make predictions about Earth's future based on the past. Since most human activities are related to interaction with the physical components of Earth, geoscience plays a unique and essential role in today's rapidly changing world. The Department of Earth and Space Sciences offers a bachelor of science degree program and a certification program in general science. The department also offers minors in astronomy, earth science, and science education. All programs emphasize analytical skills and build on course work in mathematics, chemistry, physics, and statistics. Written and oral communication is emphasized in a majority of the course work.

- The **B.S. in Geoscience** program offers two areas of concentration that share a common core of geology courses. Students completing either concentration are prepared for careers as professional geoscientists and possess the educational requirements to seek licensure as certified professional geologists. The Geology Concentration (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-geology/>) leads to occupations in managing and exploring for water, energy, and mineral resources; environmental protection, remediation, and management; mitigation of natural hazards; design of land development and management plans; geotechnical consulting; and research. Its curriculum emphasizes depth in the traditional disciplines of geology such as mineral and rock formation, paleontology, structural geology, geomorphology, and hydrogeology. The Earth Systems Concentration (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-earth-systems/>) is intended for students who want a broader understanding of geoscience, astronomy, and human interactions with the environment. In addition to the geology core, students in this concentration take required courses in oceanography, meteorology, and astronomy. This concentration is excellent preparation for students pursuing careers in geoscience, the environmental industry, resource management, environmental law, or environmental policy.
- The **certification program in General Science** enables recipients to teach science in grades 6-9. The certification program meets all guidelines established by the National Council for Accreditation of Teacher Education (NCATE) and the Pennsylvania Department of Education (PDE).

All students must consult with their advisor regularly to ensure timely completion of the degree.

## Programs

### Majors

- B.S. in Geoscience - Earth Systems Concentration (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-earth-systems/>)
  - Accelerated B.S. in Geoscience - Earth Systems Concentration to M.S. in Geoscience (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-earth-systems/>)
- B.S. in Geoscience - Geology Concentration (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-geology/>)
  - Accelerated B.S. in Geoscience - Geology Concentration to M.S. in Geoscience (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-geology/>)

### Minors

- Astronomy (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/astronomy-minor/>)
- Earth Science (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/earth-science-minor/>)
- Geology (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geology-minor/>) (**no longer accepting new students**)
- Science Education (<https://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/science-education-minor/>)

### Graduate Opportunities

See the graduate catalog for more information on the Earth and Space Sciences programs. (<https://catalog.wcupa.edu/graduate/sciences-mathematics/earth-space-sciences/>)

### Policies

- See undergraduate admissions information. (<https://catalog.wcupa.edu/general-information/admissions-enrollment/undergraduate-admissions/>)
- See academic policies. (<https://catalog.wcupa.edu/undergraduate/academic-policies-procedures/>)

All undergraduate students are held to the academic policies and procedures outlined in the undergraduate catalog. Students are encouraged to review departmental handbooks for program tips, suggested course sequences, and explanations of procedures. When applicable, additional policies for specific department programs may be listed below.

### Accelerated Program Policy

Refer to the Accelerated Programs page (<https://catalog.wcupa.edu/undergraduate/accelerated-programs/>) for more information.

## Faculty

### Professors

Richard M. Busch ([rbusch@wcupa.edu](mailto:rbusch@wcupa.edu)) (1990)  
A.B., Franklin and Marshall College; M.A., Temple University; Ph.D., University of Pittsburgh

Marc Gagné ([mgagne@wcupa.edu](mailto:mgagne@wcupa.edu)) (1999)  
B.S., University of Montreal; Ph.D., University of Georgia

Martin Helmke ([mhelmke@wcupa.edu](mailto:mhelmke@wcupa.edu)) (2005)  
B.S., Antioch College; Ph.D., Iowa State University

Daria Nikitina (dnikitina@wcupa.edu) (2006)  
Graduate Coordinator, Earth and Space Sciences  
M.S., Moscow State University; Ph.D., University of Delaware

Karen M. Schwarz (kschwarz@wcupa.edu) (2005)  
B.S., New Mexico Institute of Mining and Technology; Ph.D., Arizona State University

Elizabeth Leeann Srogi (lsrogi@wcupa.edu) (1991)  
B.S., Yale University; Ph.D., University of Pennsylvania

## Associate Professors

Howell Bosbyshell (hbosbyshell@wcupa.edu) (2011)  
Chairperson, Earth and Space Sciences  
B.S., West Chester University; Ph.D., Bryn Mawr College

Joby Hilliker (jhilliker@wcupa.edu) (2004)  
B.S., M.S., Ph.D., Pennsylvania State University

Yong Hoon Kim (ykim@wcupa.edu) (2016)  
B.S., M.S., Seoul National University, Korea; Ph.D., University of South Carolina

Christopher Roemmele (croemmele@wcupa.edu) (2017)  
Assistant Chairperson, Earth and Space Sciences  
B.A., Franklin and Marshall; M.A., Kean University; Ph.D., Purdue University

## Instructor

Cynthia Hall (chall@wcupa.edu) (2008)  
B.S., Howard University; Ph.D., Georgia Institute of Technology

## Courses

### ESC

**ESC 199. Geology and Astronomy Transfer Credits (Graduate). 1-10 Credits.**  
Transfer Credits  
Repeatable for credit.

### ESL

**ESL 199. Earth & Space Sciences Lab Transfer Credits. 1 Credit.**  
Transfer Credits  
Repeatable for credit.

### ESS

**ESS 101. Introduction to Geology. 3 Credits.**  
The earth's composition and history; the processes that occur on and within the earth.  
ESS 101 Corequisite: ESS 101L.  
Gen Ed Attribute: Science Distributive  
Distance education offering may be available.

**ESS 101L. Introduction to Geology Lab. 0 Credits.**  
Laboratory studies of the earth's composition and history; the processes that occur on and within the earth.  
ESS 101L Corequisite: ESS 101.  
Distance education offering may be available.

**ESS 102. Humans and the Environment. 3 Credits.**  
A study of the ability of humans to survive and maintain their life quality, considering the limited resources and recycling capacity of planet Earth. Note: Students completing ESS 102 may not take SCB 102 or ENV 102 for credit.  
Gen Ed Attribute: Interdisciplinary Requirement, Sustainability Pathway  
Equivalent courses: ENV 102

**ESS 111. Other Worlds, Other Stars. 3 Credits.**  
An introductory course in astronomy. Topics will focus on the observable changes in the night sky, the properties of light, the laws of motion, the formation and composition of the solar system, extra solar planets, the properties of stars, stellar evolution and stellar death.  
Gen Ed Attribute: Science Distributive

**ESS 112. Galaxies and Cosmology. 3 Credits.**  
An introductory general education course in astronomy. Topics will focus on the properties of light and matter, the evolution of stars and galaxies, and the expansion, structure, history and fate of the universe. Three hours of lecture.  
Gen Ed Attribute: Science Distributive

**ESS 127. Movies, Media, and Entertainment from an Earth and Space Science Perspective. 3 Credits.**  
An exploration of movies, media, and other mass communication media from an earth and space science perspective. Films, digital media (including trending videos or articles in social media news feeds), traditional news media, and other mass communication entertainment media will be viewed and analyzed to identify earth and space science topics and to correct these inaccuracies.  
Gen Ed Attribute: Science Distributive  
Distance education offering may be available.

**ESS 128. The Science of Natural Disasters. 3 Credits.**  
This course explores the science of natural disasters such as volcanoes, earthquakes, tsunamis, hurricanes, tornadoes, climate change, and asteroid impacts. Students will learn to apply the tools of science to understand the processes behind natural hazards, quantify and communicate risk, and develop mitigation strategies to protect societies and the environment.  
Gen Ed Attribute: Science Distributive  
Distance education offering may be available.

**ESS 130. Our Ocean. 3 Credits.**  
This course examines the physical and biological processes in our ocean. The course begins with an overview of earth and ocean, and the history of earth. It will cover four areas of oceanographic research area: physical, chemical, biological, and geological oceanography.  
ESS 130 Corequisite: ESS 130L.  
Gen Ed Attribute: Science Distributive, Sustainability Pathway

**ESS 130L. Our Ocean Lab. 0 Credits.**  
Laboratory studies that examine the physical and biological processes in our ocean. The course begins with an overview of earth and ocean, and the history of earth. It will cover four areas of oceanographic research area: physical, chemical, biological, and geological oceanography.  
ESS 130L Corequisite: ESS 130.

**ESS 170. Introduction to Our Atmosphere. 3 Credits.**  
Why is the sky blue? What will the weather be tomorrow? What makes tornadoes? How did the ozone hole develop? What is the greenhouse effect? This class will use these questions and others to investigate the basic physical processes that determine the weather and climate on earth. A student who has successfully completed ESS 370 may not subsequently receive credit for ESS 170.  
Gen Ed Attribute: Science Distributive  
Distance education offering may be available.

**ESS 199. Earth & Space Sciences Transfer Credits. 1-10 Credits.**  
Transfer Credits  
Repeatable for credit.

**ESS 201. Field Geology. 3 Credits.**  
An introduction to the basic methods of geologic data collection in the field; analysis, and presentation; literature research; and report writing. One weekend field trip is required.  
ESS 201 Prerequisite: Successful completion of ESS 101 with minimum grade of D-.  
Gen Ed Attribute: Writing Emphasis (select both)

**ESS 204. Historical Geology. 3 Credits.**  
An examination of how Earth has evolved over geologic time, from its origin as a tiny lifeless planetesimal to its present state as a dynamic planetary system teaming with life. Rocks, fossils, and other evidence of Earth's past are analyzed and evaluated with knowledge of modern physical and biological processes to infer Earth's history, understand its present state, and predict its future. Laboratory included. Recommended for students who have completed ESS 101 or another introductory (100-level) science course.  
ESS 204 Corequisite: ESS 204L.  
Gen Ed Attribute: Writing Emphasis (select both)

**ESS 204L. Historical Geology Lab. 0 Credits.**

Laboratory studies of how Earth has evolved over geologic time, from its origin as a tiny lifeless planetesimal to its present state as a dynamic planetary system teeming with life. Rocks, fossils, and other evidence of Earth's past are analyzed and evaluated with knowledge of modern physical and biological processes to infer Earth's history, understand its present state, and predict its future. Recommended for students who have completed ESS 101 or another introductory (100-level) science course.

ESS 204L Corequisite: ESS 204.

**ESS 301. Environmental Geochemistry. 3 Credits.**

An introduction to principles and applications of geochemistry to geologic systems, including surface and ground waters, soils, and rocks.

ESS 301 Prerequisite: Successful completion of CHE 103 and ESS 101, with minimum grades of D-.

**ESS 302. Mineralogy. 3 Credits.**

In-depth survey of the formation, identification, classification, and uses of minerals. Principles of symmetry, crystallography, crystal chemistry, and optical mineralogy. Laboratory and field examination and analysis of minerals.

ESS 302 Prerequisite: Successful completion of CHE 103, ESS 101, and ESS 204, with minimum grades of D-. Corequisite: ESS 302L.

**ESS 302L. Mineralogy Lab. 0 Credits.**

Laboratory studies of the formation, identification, classification, and uses of minerals. Principles of symmetry, crystallography, crystal chemistry, and optical mineralogy. Laboratory and field examination and analysis of minerals.

ESS 302L Corequisite: ESS 302.

**ESS 307. Geology of the Solar System. 3 Credits.**

The geology, origin, evolution, and properties of planets, comets, asteroids, moons, and meteorites.

**ESS 311. Introduction to Astronomy. 3 Credits.**

An introduction to astronomy and astrophysics. Topics include celestial mechanics, the properties of light, matter and energy, the formation of stars and planets, stellar evolution, galaxies, and cosmology. Two hours of lecture and two hours of lab.

ESS 311 Prerequisite: Successful completion of MAT 115, MAT 131, MAT 143, or MAT 161, with minimum grades of D-. Corequisite: ESS 311L.

**ESS 311L. Introduction to Astronomy Lab. 0 Credits.**

Laboratory studies of astronomy and astrophysics. Topics include celestial mechanics, the properties of light, matter and energy, the formation of stars and planets, stellar evolution, galaxies, and cosmology.

ESS 311L Corequisite: ESS 311.

**ESS 321. Geometrics. 3 Credits.**

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

**ESS 323. Gen'l Geol Field Studies of SE Pennsylvania. 3 Credits.**

Occurrence, relationships, and geologic history of the rocks, minerals, and soils of this area, studied at representative locations.

ESS 323 Prerequisite: Successful completion of ESS 302 with minimum grade of D-.

**ESS 330. Introduction to Oceanography. 3 Credits.**

A survey of our present knowledge of the waters and floors of the oceans.

ESS 330 Prerequisite: Successful completion of ESS 101 with minimum grade of D-. Corequisite: ESS 330L.

**ESS 330L. Introduction to Oceanography Lab. 0 Credits.**

Laboratory studies of our present knowledge of the waters and floors of the oceans.

ESS 330L Corequisite: ESS 330.

**ESS 331. Introduction to Paleontology. 3 Credits.**

Identification and study of common fossils in order to understand their life processes and geologic significance.

ESS 331 Corequisite: ESS 331L.

Gen Ed Attribute: Writing Emphasis (select both)

**ESS 331L. Introduction to Paleontology Lab. 0 Credits.**

Laboratory studies related to the identification and study of common fossils in order to understand their life processes and geologic significance.

ESS 331L Corequisite: ESS 331.

**ESS 332. Advanced Oceanography. 3 Credits.**

An advanced course in oceanography covering marine resources, oceanographic literature, animal-sediment relationships, field techniques, estuaries, salt marshes, sea level changes, and pollution.

ESS 332 Prerequisite: Successful completion of ESS 330 with minimum grade of D-.

**ESS 336. Environmental Geology. 3 Credits.**

The application of geological information to human problems encountered in natural phenomena, such as flooding, earthquakes, coastal hazards, and man-made concerns, including waste disposal, land use, and global change.

ESS 336 Prerequisite: Successful completion of ESS 101 with minimum grade of D-.

**ESS 343. Geomorphology. 3 Credits.**

Constructive and degradational forces that have shaped present landforms and are constantly reshaping and modifying landforms. Interpretation of geologic and topographic maps; field studies.

ESS 343 Prerequisite: Successful completion of ESS 101 and ESS 204, with minimum grades of D-.

**ESS 344. Geomorphology II. 3 Credits.**

A continuation of the study of earth surface processes. Interpretation of topographic maps and air photos.

ESS 344 Prerequisite: Successful completion of ESS 343 with minimum grade of D-.

**ESS 347. Earth & Space Science Seminar. 1 Credit.**

One credit weekly seminar featuring guest lectures by Geoscience professionals, prominent scientists, faculty and students. 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 348. 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 348 Prerequisite: Successful completion of ESS 101 or ESS 102 or permission of instructor, with minimum grades of D-.

Repeatable for credit.

**ESS 355. Intermediate Astronomy. 3 Credits.**

An analytical and qualitative analysis of selected astronomical phenomena. Topics include telescope optics (including photographic and photoelectric attachments), lunar and planetary orbits, stellar motions and magnitudes, galactic classifications, and distances. Two hours of lecture and two hours of lab.

ESS 355 Prerequisite: Successful completion of ESS 111 with minimum grade of D-. Corequisite: ESS 355L.

**ESS 355L. Intermediate Astronomy Lab. 0 Credits.**

Laboratory studies of selected astronomical phenomena. Topics include telescope optics (including photographic and photoelectric attachments), lunar and planetary orbits, stellar motions and magnitudes, galactic classifications, and distances. Two hours of lecture and two hours of lab.

ESS 355L Corequisite: ESS 355.

**ESS 362. History of Astronomy. 3 Credits.**

Development of astronomical theories from the ancient Greeks until the 20th century.

ESS 362 Prerequisite: Successful completion of ESS 111 with minimum grade of D-.

**ESS 365. 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 365 Prerequisite: Successful completion of 60 credits.

Gen Ed Attribute: Speaking Emphasis

Equivalent courses: COM 565

**ESS 370. Introduction to Meteorology. 3 Credits.**

A study of the principles governing the earth's atmosphere and how these principles determine weather conditions.

ESS 370 Prerequisite: Successful completion of MAT 115, MAT 131, MAT 143, or MAT 161, with minimum grades of D-. Corequisite: ESS 370L.

**ESS 370L. Introduction to Meteorology Lab. 0 Credits.**

Laboratory studies of the principles governing the earth's atmosphere and how these principles determine weather conditions.

ESS 370L Corequisite: ESS 370.

**ESS 371. Advanced Meteorology. 3 Credits.**

A continuation of the study of the principles governing the earth's atmosphere and how these principles determine weather conditions.

ESS 371 Prerequisite: Successful completion of ESS 370 with minimum grade of D-.

**ESS 394. 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 405. Igneous and Metamorphic Petrology. 3 Credits.**

Theories of the formation of igneous and metamorphic rocks based on field occurrence, physical properties, geochemistry, thermodynamics, and petrography. Classification and identification of rocks. Laboratory and field examination of rocks.

ESS 405 Prerequisite: Successful completion of ESS 201 and ESS 302, with minimum grades of D-. Corequisite: ESS 405L.

**ESS 405L. Igneous and Metamorphic Petrology Lab. 0 Credits.**

Laboratory studies of the formation of igneous and metamorphic rocks based on field occurrence, physical properties, geochemistry, thermodynamics, and petrography. Classification and identification of rocks. Laboratory and field examination of rocks.

ESS 405L Corequisite: ESS 405.

**ESS 420. Structural Geology. 3 Credits.**

Determination of the sequential development and the forces involved in the various structural features of the earth.

ESS 420 Prerequisite: Successful completion of ESS 201 and ESS 302, with minimum grades of D-. Corequisite: ESS 420L.

**ESS 420L. Structural Geology Lab. 0 Credits.**

Laboratory studies of the sequential development and the forces involved in the various structural features of the earth.

ESS 420L Corequisite: ESS 420.

**ESS 435. 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 435 Corequisite: ESS 435L.

**ESS 435L. Remote Sensing Lab. 0 Credits.**

Laboratory studies of 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 435L Corequisite: ESS 435.

**ESS 439. Hydrogeology. 3 Credits.**

This applied course covers groundwater flow systems, well hydraulics, advective contaminant transport, groundwater flow modeling, and sustainable management of water resources.

Special emphasis is placed on scientific and professional ethics while applying hydrogeologic concepts to solve real-world environmental problems that affect communities. Students considering employment in the environmental industry as environmental scientists or professional geologists are encouraged to complete this course.

ESS 439 Prerequisite: Successful completion of ESS 101 with minimum grade of D-. Corequisite: ESS 439L.

Gen Ed Attribute: Ethics Requirement

**ESS 439L. Hydrogeology Lab. 0 Credits.**

Laboratory studies of groundwater flow systems, well hydraulics, advective contaminant transport, groundwater flow modeling, and sustainable management of water resources. Special emphasis is placed on scientific and professional ethics while applying hydrogeologic concepts to solve real-world environmental problems that affect communities. Students considering employment in the environmental industry as environmental scientists or professional geologists are encouraged to complete this course.

ESS 439L Corequisite: ESS 439.

**ESS 442. Geophysics. 3 Credits.**

Gravitational, magnetic, seismic (refraction and reflection), and electrical properties of rocks and minerals in the earth. Physical principles of the earth; geophysics in relation to economic deposits.

ESS 442 Prerequisite: Successful completion of MAT 162; and PHY 140 or PHY 180.

**ESS 447. Earth and Space Science Seminar. 1 Credit.**

A one credit weekly seminar 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.

ESS 447 Prerequisite: Successful completion of ESS 347 with minimum grade of D- or department consent.

Repeatable for credit.

**ESS 450. Sedimentation & Stratigraphy. 3 Credits.**

Lecture and field studies of sediments, sedimentary rocks, depositional processes and environments, and diagenesis. Description, mapping, and correlation of strata to infer temporal-spatial relationships, locate resources, and interpret Earth history.

ESS 450 Prerequisite: Successful completion of ESS 301, ESS 302, ESS 331, and ESS 343, with minimum grades of D-. Corequisite: ESS 450L.

**ESS 450L. Sedimentation & Stratigraphy Lab. 0 Credits.**

Laboratory studies of sediments, sedimentary rocks, depositional processes and environments, and diagenesis. Description, mapping, and correlation of strata to infer temporal-spatial relationships, locate resources, and interpret Earth history.

ESS 450L Corequisite: ESS 450.

**ESS 460. Internship. 1-18 Credits.**

Contact department for more information about this course.

Repeatable for credit.

**ESS 480. Special Problems. 1-6 Credits.**

Reports on special topics and current developments in the earth and space sciences.

Repeatable for credit.

Equivalent courses: ESS 580

**ESS 490. Fundamentals of Soils. 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 490 Prerequisite: Successful completion of ESS 101 with minimum grade of D-. Corequisite: ESS 490L.

**ESS 490L. Fundamentals of Soils 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 490L Corequisite: ESS 490.

**ESS 491. Independent Studies. 1-3 Credits.**

Contact department for more information about this course.

Repeatable for credit.

**ESS 499. The Professional Geoscientist. 3 Credits.**

This is the Geoscience Capstone course, which will serve as a culminating experience in which students will synthesize geoscience knowledge and interests that have been acquired, and along with the development of research skills, apply these skills in preparation of a geoscience research prospectus as an artifact for entry into a graduate program or career. Students will orally present and defend a research prospectus as well as related geoscience content and research topics of interest. Students will also develop competency in leading and partaking in whole and small group discussions and performing scenario-based and topic-based activities.

ESS 499 Prerequisite: Successful completion of 90 credits earned overall, of which 18 credits is in ESS, with minimum grade of D-.

Gen Ed Attribute: Speaking Emphasis



## SCE

### **SCE 320. Science Methods for Grades PK-4. 3 Credits.**

A science methods course for PreK-4 teachers to master classroom and materials preparation and the design of developmentally effective instruction and assessment. Teachers learn methods that promote children's ability to do inquiry and master PA academic standards in science and technology and environment and ecology.

SCE 320 Prerequisite: Teacher Candidacy.

### **SCE 330. Science Methods for Middle Level (4-8). 3 Credits.**

A course to prepare the middle level teachers for teaching science with a focus on the developmental and pedagogical needs of middle level students. Teacher candidates will apply science content, develop knowledge how students learn science, explore materials and resources, and learn how to plan and access effective standards based middle level science instruction.

SCE 330 Prerequisite: Teacher Candidacy.