**GEOLOGY**

**Geology Minor**

Geology Minor Course Offerings

Students must select from the following list to satisfy the requirements for the minor in Geology.

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* Required

**GUIDELINES AND STIPULATIONS**

Course offerings are subject to change.

EES-105 can substitute EES-211 as a prerequisite. Special topics geology courses, GEO-289 or GEO-398, may be applied to the minor. Environmental Engineering and Environmental Science majors may use ENV-32 Hydrology toward the geology minor. Environmental Engineering majors may use ENV-315 Soils toward the geology minor.

**GEO. GEOLOGY**

**GEO-206. SOLID EARTH ENERGY AND MINERAL RESOURCES**

Credits: 3

The distribution in both space and time of fossil fuel (crude oil, natural gas and coal), nuclear fuel minerals, and geothermal sources in the earth’s crust; the formation, accumulation and extraction of these energy resources, and historical, current and projected consumption trends. Additionally, the occurrences and formational processes of metal and non-metal deposits are examined in the context of plate tectonics, earth’s geologic history and energy flow. Three hours of lecture per week. Requirements: open to majors and non-majors. GEO-206 qualifies for the Energy Minor and is cross-listed with EGY-206.

**GEO-211. PHYSICAL GEOLOGY**

Credits: 4

Description, analysis, and laboratory studies of earth materials, structure, and processes, including earth’s surface, interior, age, and origin. Three hours of lecture and three hours of lab per week. Requirements: For CS, Engineering, Math, and Science majors only. Cross listed with EES-211. Click here for course fee.

**GEO-212. HISTORICAL GEOLOGY**

Credits: 3

A study of the geologic record of the earth’s formation and evolution, including methods of dating. Two hours of lecture and three hours of lab per week. Cross listed with EES-212. Click here for course fee.

**Pre-Requisites**

[(GEO-211)] or [(EES-211)] or permission of the instructor.

**GEO-281. MINERALOGY**

Credits: 4

The systematic study of the major classes of the mineral kingdom utilizing the department’s collection. Concepts in crystal chemistry, crystal structure, mineral behavior, crystallography and optical mineralogy are studied and advanced techniques in mineral analysis are used. Three hours of lecture and three hours of lab per week. Cross listed with EES-381. Click here for course fee.

**Pre-Requisites**

[(GEO-211)] or [(EES-211)] and [(CHM-115)].

**GEO-282. PETROLOGY**

Credits: 3

A study of the identification, classification, composition, genesis, and alteration of igneous, sedimentary, and metamorphic rocks and their relation to crustal processes and tectonic environments. Two hours of lecture and three hours of lab per week. Cross listed with EES-382. Click here for course fee.

**Pre-Requisites**

[(GEO-211)] or [(EES-211)] and [(CHM-115)].

**GEO-345. STRATIGRAPHY AND SEDIMENTATION**

Credits: 4

The study of the formation and interpretation of sedimentary systems, from sediment grains to depositional basins. The course starts from the grain scale and moves up to basin and global scales. Three hours of lecture and three hours of lab per week. Click here for course fee.

**Pre-Requisites**

[(GEO-211)] or [(EES-211)] and [(CHM-115)].

**GEO-349. STRUCTURE AND TECTONICS**

Credits: 4

The study of rock deformational processes and resulting structures in the Earth’s crust with application to global and regional tectonics. Lab work and field trips emphasize the use of methods to assist in the geometric and kinematic interpretation of rock structures. Three hours of lecture and three hours of lab per week. Click here for course fee.

**Pre-Requisites**

[(GEO-211)] or [(EES-211)] or permission of the instructor.
GEO-351. PALEOCLIMATOLOGY  
Credits: 3  
The goal of this course is to present an overview of the methods used to reconstruct the earth’s climate history and the techniques used to determine the timing of environmental changes. Paleoclimate data from proxy records, such as ice cores or tree rings, provides a longer perspective on climatic variability than is possible from instrumental or historical records. Particular emphasis will be given to the natural controls on Earth’s climate across a variety of timescales, including plate tectonic, orbital, and millennial, to centennial and sub-decadal variations. The course will focus on the climatic changes during the late Cenozoic – the time of the ice ages. Topics to be discussed will include: paleoclimatic reconstruction, climate and climatic variation, dating methods, ice cores, marine and lake sediments, corals, speleothems, soils, pollen, dendrochronology, documentary data, and paleoclimate models. Two hours of lecture and three hours of lab.  

Click here for course fee.  

Pre-Requisites  
[[EES-211]] or [[GEO-211]]  

GEO-352. HYDROGEOLOGY  
Credits: 3  
An introduction to the study of groundwater: groundwater flow, well hydraulics, groundwater quality and pollution, and resource exploration, evaluation, and management. Lab activities use a mix of field, wet lab, computer and mapping skills. Two hours of lecture and three hours of lab per week.  

Click here for course fee.  

Pre-Requisites  
[[GEO-211]] or [[EES-211]]  

GEO-370. GEOMORPHOLOGY  
Credits: 3  
Fees: 
Land forms, their evolution, and the human role in changing the surface of the earth, utilization of geologic and hydrologic information, and field investigations. Two hours of lecture and three hours of lab per week. Cross listed with [[EES-370]].  

Click here for course fee.  

Pre-Requisites  
[[GEO-211]] or [[EES-211]].  

GEO-375. GEOLOGICAL HAZARDS  
Credits: 3  
Fees: 
This course examines geologic processes that are a natural consequence of plate tectonics and hazardous to life and property. After establishing a framework for geologic hazards study, principle geologic hazards will be investigated. Emphasis will be placed on current scientific understanding, event frequency, forecasting and monitoring and mitigation. Several case studies will be included. Three hours of lecture per week.  

Pre-Requisites  
[[GEO-211]] or [[EES-211]], [[GEO-212]] or [[EES-212]]
GEO-390. APPLIED GEOPHYSICS
Credits: 3
Fees:
An introduction to the application of geophysical methods to geological and environmental investigations. Topics include fundamentals of geophysics and hands-on instrument training and measurement. Instruments may include ground penetrating radar, seismic reflection and refraction, electrical resistivity and electromagnetic induction. Two hours of lecture and three hours of lab per week.
Click here for course fee.

Pre-Requisites
[[MTH-112]], [[PHY-174]], [[GEO-211]] or [[EES-211]] or permission of the instructor

GEO-391. SENIOR PROJECTS I
Credits: 1
Fees:
Design and development of selected research projects in geology under the direction of a faculty member. Capstone research deliverables include a proposal, detailed progress reports and a formal mid-year report. Requirements: Senior standing in Geology and department permission. (See the department for more details about the department permission.)
Click here for course fee.

GEO-392. SENIOR PROJECTS II
Credits: 2
Fees:
Second semester continuation of Senior Projects I. Capstone research deliverables include detailed progress reports, a professional-grade poster, a final written report, and a formal oral presentation of research project. Requirements: Senior standing in Geology and department permission. (See the department for more details about the department permission.)
Click here for course fee.

Pre-Requisites
[[GEO-391]]

GEO-399. COOPERATIVE EDUCATION
Credits: 1-6
Professional cooperative education placement in a private or public organization related to the student's academic objectives and career goals. In addition to their work experiences, students are required to submit weekly reaction papers and an academic project to a Faculty Coordinator in the student’s discipline. See the Cooperative Education section of this bulletin for placement procedures.

Pre-Requisites
Sophomore standing; minimum 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson.

EES. EARTH AND ENVIRONMENTAL SCIENCES

EES-395/396. INDEPENDENT RESEARCH
Credits: Varies with topic 1-3 credits.
Independent study or research of specific earth or environmental science topic at an advanced level under the direction of a departmental faculty member.
Click here for course fees.

Pre-Requisites
Upper class standing and approval of academic advisor, research advisor, and department chairperson.

EES-198/298/398. TOPICS IN EES
Credits: Varies with topic
Departmental courses on topics of special interest, not extensively treated in regularly scheduled offerings, will be presented under this course number on an occasional basis. May be repeated for credit.
Click here for fee for courses with a lab.

Pre-Requisites
Varies with topic studied.

EES-105. PLANET EARTH
Credits: 3
The nature of our planet and how it works are examined in the context of Earth as a constantly changing dynamic system. An emphasis on global scale processes and the interaction of humans and their physical environment is coupled with in-depth coverage of how science is done and the scientific principles that influence our planet, its rocks, mountains, rivers, atmosphere, and oceans. Major sub-topical areas in the Planet Earth series may include geology (Forces of Geologic Change), oceanography (The Restless Ocean), astronomy (The Cosmic Perspective), geography (Global Regions and Geography), and the relationship between people and their physical surroundings (The Global Environment). Intended for students who are not majoring in science, engineering, pre-pharmacy, nursing, or B.S. programs in mathematics or computer science. Two hours of lecture and two hours of lab per week.
Click here for course fees.

Pre-Requisites
No previous background in science or college-level mathematics is required.

EES-201. ENVIRONMENTAL ETHICS AND SUSTAINABILITY
Credits: 1
This course entails an examination of the central topics of environmental ethics and sustainability as viewed from the perspectives of science. Ethical and sustainability paradigms that all environmental scientists should be aware of will be studied. Course is delivered online.

Pre-Requisites
[[EES-240]] or permission of the instructor.
Geology Minor

EES-202. BIOGEOCHEMISTRY
Credits: 3
Fundamentals of the circulation of materials through the earth's air, soils, waters, and living organisms are examined from the perspective of introductory chemical principles. Global cycles of water, carbon, nitrogen, phosphorus, and sulfur are investigated with emphasis on the roles of microorganisms, chemical equilibrium, and oxidation-reduction processes in biogeochemical cycling. Laboratory focuses on 1) student designed projects to gather data that illustrate key concepts in chemical weathering processes in aqueous solutions, oxidation-reduction reactions, and microbial mediation of elemental cycling and 2) building problem solving skills. Two hours of lecture and three hours of lab per week.
Click here for course fees.

Pre-Requisites
[CHM-115].

EES-210. GLOBAL CLIMATE CHANGE
Credits: 3
The nature and function of earth’s global climate are examined from a unified system perspective. Major questions focus on scientific versus public understanding of trends in global temperature, precipitation, and sea level. The course emphasizes negative and positive feedback processes that force key changes in the earth’s climate system: past, present, and future. Topics include fundamentals of global and regional heat and water balance, the role of elemental cycles in controlling climate (e.g., the carbon cycle), descriptive climate classification, long-term, short-term, and catastrophic climatic change (e.g., ice ages and bolide impacts), and human effects on climate (e.g., enhanced greenhouse, rising sea level). This course integrates a scientific understanding of climatic change and explores contemporary social and economic policy responses to change scenarios. Three hours of lecture per week.

EES-211. PHYSICAL GEOLOGY
Credits: 4
Description, analysis, and laboratory studies of earth materials, structure, and processes, including earth’s surface, interior, age, and origin. Three hours of lecture and three hours of lab per week. Requirements: For CS, Engineering, Math, and Science majors only. Cross listed with [[GEO-211]].
Click here for course fees.

EES-212. HISTORICAL GEOLOGY
Credits: 3
A study of the geologic record of the earth’s formation and evolution, including methods of dating. Two hours of lecture and three hours of lab per week. Cross listed with [[GEO-212]].
Click here for course fees.

Pre-Requisites
[[EES-211]] or permission of the instructor.

EES-213. CLIMATE MODELING
Credits: 1
Students will utilize software to construct basic models of Earth Systems. No prior knowledge of the software is assumed or required. Weekly assignments will consist of computer-based modeling exercises, each progressively building upon previous assignments. Specifically, students will utilize software to construct relatively simple models of world population growth, fossil fuel consumption, the global carbon cycle, and the Earth’s energy balance. The final modeling exercise couples the population growth, carbon cycle, and Earth energy balance assignments in an effort to explore the effect of future population growth and carbon dioxide emissions on global mean temperature. Two hours of lab per week.

Co-Requisites
[[EES-210]]

EES-218. ENVIRONMENTAL ETHICS
Credits: 3
An examination of the central problems of environmental ethics as viewed from the perspectives of science and of philosophy. The value of nature and ‘natural objects,’ differing attitudes toward wildlife and the land itself, implications of anthropocentrism, individualism, ecocentrism, and ecofeminism, bases for land and water conservation, and other topics will be examined within a framework of moral and scientific argument. Cross-listed with [[PHL-218]].

Pre-Requisites
[[PHL-101]] or [[EES-240]] or permission of the instructor.

EES-230. OCEAN SCIENCE
Credits: 4
An interdisciplinary approach to the study of the fundamentals of oceanography emphasizing physical, chemical, and biological interrelationships. Three hours of lecture and three hours of lab. Requirements: For CS, Engineering, Math, and Science majors only
Click here for course fees.

EES-240. PRINCIPLES OF ENVIRONMENTAL ENGINEERING & SCIENCE
Credits: 4
A study of physical, chemical, and biological components of environmental systems and a discussion of processes involved in water quality management, air quality management, waste management, and sustainability. Three hours of lecture and three hours of lab per week.
Click here for course fees.

Pre-Requisites
[[MTH-111]] or higher. Requirements For CS, Engineering, Math, and Science majors only.

EES-242. ENVIRONMENTAL HEALTH
Credits: 3
To provide students with an understanding of man’s impact on the environment and how those impacts can be controlled or mitigated. Students completing this course should be able to recognize environmental problems and understand control and preventative measures. Three hours of lecture.

Pre-Requisites
Introductory physics and chemistry. Students who have taken [[EES-240]] will be admitted only with the consent of the instructor.
EES-251. SYNOPTIC METEOROLOGY
Credits: 4
Topics include surface and upper air weather systems, weather phenomena, climate, and local weather influences. Synoptic map analysis and interpretation are emphasized. Three hours of lecture and three hours of lab per week. Requirements: For CS, Engineering, Math, and Science majors only
Click here for course fees.

EES-261. REGIONAL GEOGRAPHY
Credits: 3
Topics covered include maps and charts and basic elements of physical, cultural, historical, and economic geography as applied to specific geographic regions. Three hours of lecture per week.

EES-271. ENVIRONMENTAL MAPPING I: INTRODUCTION TO GPS AND GIS
Credits: 3
Information Systems (GIS), and environmental mapping concepts and applications. Topics include coordinate systems, reference ellipsoids, geodetic datums, map projections, history of GIS, relational database management, quality control, GIS as a decision support tool, and data manipulation, processing, and analysis. Practical field use of GPS is emphasized within the context of understanding system components, satellite signal processing, selective availability, base station differential correction, and data export to GIS. Geospatial data science is discussed within the context of real-world locational phenomena. Two hours of lecture and two hours of lab per week.
Click here for course fees.

EES-272. ENVIRONMENTAL MAPPING II: ADVANCED GIS AND REMOTES SENSING
Credits: 3
Terms Offered: Spring
An advanced course on Geographic Information Systems (GIS) and Remote Sensing. GIS topics build upon introductory-level coursework in EES 271, and introduce more advanced applications of GIS software such as density mapping and interpolation of point data (geostatistical methods), surface analysis and 3D modeling of environmental data, open source alternatives to ArcGIS, and web map development and design. Remote sensing topics include aerial and satellite visual imagery, digital image processing, photogrammetry, Light Detection and Ranging (LiDAR), and multispectral remote sensing systems and theory. The course will also include case studies of remote sensing and GIS techniques applied in environmental studies. Field use of GPS is emphasized, in addition to the use of small Unmanned Aerial Systems (sUAS) to capture aerial digital imagery. Laboratory component emphasizes practical skills and tools in achieving desired results in processing geospatial data, particularly raster data types. Two hours of lecture and three hours of lab per week.
Click here for course fees.

EES-280. PRINCIPLES OF ASTRONOMY
Credits: 4
Topics include orbital mechanics, results of planetary probes, spectra and stellar evolution, and cosmology. Three hours of lecture and three hours of lab per week. Requirements: For Science majors only
Click here for course fees.

EES-302. SCIENCE RESEARCH AND COMMUNICATION
Credits: 1
The aim for this course is to provide students with the necessary foundation to think critically about scientific research and communication. The course introduces students to the (1) philosophy of science, (2) design, execution, and evolution of scientific projects, (3) exploration, evaluation, and management of scientific literature, (4) methods and ethics of scientific communication, and (5) proposal design for a project to be continued into Senior Project (EES/GEO 391/392) that includes a literature review, definition of research questions, objectives, or testable hypotheses, and the methods used to carry out the project. The broader social and political context in which scientific research is situated and must respond to and interact with is also explored. More than that, this course explores the important connections between research design and communication by having students focus on the application of learned theory and skills to projects with Senior Project advisor.

Pre-Requisites
Junior standing.

EES-304. ENVIRONMENTAL DATA ANALYSIS
Credits: 2
To acquaint students majoring in earth and environmental sciences with the techniques and methods of data acquisition and analysis, including environmental sampling methodology and data management. Emphasis will be placed on examination of real data sets from various areas of the earth and environmental sciences with particular emphasis placed on using and applying graphical and statistical procedures used in EES-391-392 (Senior Projects). Two hours of lecture per week.

Pre-Requisites
[MTH-150] and Junior standing or permission of the instructor.

EES-340. CONSERVATION BIOLOGY
Credits: 3
This course will cover the major topics of conservation biology including an introduction to biodiversity, threats to biodiversity, and solutions to diminish extinctions and population declines. Lecture: three hours per week. Cross-listed with [BIO-340].

Pre-Requisites
BIO 121-122, BIO 225-226 or permission of the instructor.

EES-341. FRESHWATER ECOSYSTEMS
Credits: 3
A study of the biological and ecological aspects of streams, lakes, and wetlands from a watershed perspective. An initial introduction to physical, chemical, and geological principles of limnology is followed by a focus on freshwater biology. Laboratories include field-based watershed investigations and lake management assessments using geographic information systems techniques. Cross-listed with [BIO-341]. Two hours of lecture and three hours of lab per week. Offered in alternate years.
Click here for course fees.

Pre-Requisites
[EES-211] or 240 or [BIO-121]-122 or permission of the instructor.
EES-343. MARINE ECOLOGY
Credits: 3
An examination of the biology of marine life within the context of modern ecological principles. The structure and physiology of marine organisms will be studied from the perspectives of adaptation to the ocean as habitat, biological productivity, and interspecific relationships. Emphasis will be placed on life in intertidal zones, estuaries, surface waters, and the deep sea. Two hours of lecture and three hours of lab per week. Cross-listed with [BIO-343]]. Offered in alternate years.
Click here for course fees.

Pre-Requisites
[[EES-211]] and [BIO-121]-122, or permission of the instructor.

EES-344. ECOLOGY
Credits: 4
Ecology examines contemporary ecological thinking as it pertains to the interrelationships of organisms and their environments. Interactions at the populations and community level are emphasized. Two hours of lecture and three hours of lab per week. Cross-listed with [BIO-344]]. Offered in alternate years.
Click here for course fees.

Pre-Requisites
[[BIO-121]]-122, or permission of the instructor.

EES-366. FIELD BOTANY
Credits: 3
This is a specialized summertime field course, which emphasizes a taxonomic, phylogenetic, and ecological survey of higher plants indigenous to Northeastern Pennsylvania. Due to the extensive field work, enrollment is somewhat more restricted than in other courses; therefore, written permission from the instructor is the primary prerequisite for those upperclassmen who wish to register for the course. Cross-listed with [BIO-366]]. Offered in alternate years.
Click here for course fees.

Pre-Requisites
[[BIO-121]]-122, or permission of the instructor.

EES-370. GEOMORPHOLOGY
Credits: 3
Land forms, their evolution, and the human role in changing the surface of the earth, utilization of geologic and hydrologic information, and field investigations. Two hours of lecture and three hours of lab per week. Cross listed with [GEO-370].
Click here for course fees.

Pre-Requisites
[[EES-211]].

EES-381. MINERALOGY
Credits: 4
Terms Offered: Not Currently Offered
The systematic study of the major classes of the mineral kingdom utilizing the department's collection. Concepts in crystal chemistry, crystal structure, mineral behavior, crystallography and optical mineralogy are studied and advanced techniques in mineral analysis are used. Three hours of lecture and three hours of lab per week. Cross listed with [GEO-281].
Click here for course fees.

Pre-Requisites
[[EES-211]] and [CHM-115]].

EES-382. PETROLOGY
Credits: 3
A study of the identification, classification, composition, genesis, and alteration of igneous, sedimentary, and metamorphic rocks and their relation to crustal processes and tectonic environments. Two hours of lecture and three hours of lab per week. Cross listed with [GEO-282].
Click here for course fees.

Pre-Requisites
[[EES-381]].

EES-390. SENIOR PROJECTS I
Credits: 3
This course is presented seminar-style, focusing on Environmental Science topics relevant to current problems, trends, and news. The course serves as an open and constructive venue where students will have an opportunity to delve into themed topics and more holistically discuss environmental science issues. The theme of the course will change each term, but will remain within the Environmental Sciences: ecology, environmental chemistry, sustainability, climate change, hazardous waste, etc. Students are required to read and actively discuss scientific literature, assemble and analyze relevant data, formulate and criticize quantitative/qualitative theories, and explore case studies. Three hours of seminar per week. Requirement: students with senior standing only.

Pre-Requisites
Department permission

EES-391. SENIOR PROJECTS I
Credits: 1
Design and development of selected projects in earth and environmental sciences and other related fields under the direction of a staff member. Technical as well as economical factors will be considered in the design. A professional paper and detailed progress report are required. Requirements: Senior standing in Earth and Environmental Sciences and department permission. (See the department for more details about the department permission.)
Click here for course fees.

Pre-Requisites
Department permission

EES-392. SENIOR PROJECTS II
Credits: 2
Design and development of selected projects in earth and environmental sciences and other related fields under the direction of a staff member. Technical as well as economical factors will be considered in the design. A professional paper to be presented and discussed in an open forum is required.
Click here for course fees.

Pre-Requisites
[[EES-391]] or department permission. (See the department for more details about the department permission.)

EES-394. FIELD STUDY
Credits: 1-3
On-site study of an earth or environmental problem or situation incorporating field documentation and investigative techniques. May be repeated for credit when no duplication of experience results. One hour of lecture, plus field trips.
Click here for course fees.

Pre-Requisites
[[EES-211]] and [EES-240]].
EES-399. COOPERATIVE EDUCATION
Credits: 1-6
Professional cooperative education placement in a private or public organization related to the student's academic objectives and career goals. In addition to their work experience, students are required to submit weekly reaction papers and an academic project to a Faculty Coordinator in the student's discipline. See the Cooperative Education section of this bulletin for placement procedures.

Pre-Requisites
Sophomore standing; minimum 2.0 cumulative GPA; consent of the academic advisor; and approval of placement by the department chairperson.

EES-498. TOPICS
Credits: Varies with topic
Departmental courses on advanced topics of special interest, not extensively treated in regularly scheduled offerings, will be presented under this course number on an occasional basis. Available for either undergraduate or graduate credit. May be repeated for credit.
Click here for fee for courses with a lab.

Pre-Requisites
Senior or graduate standing