

ES - EARTH SCIENCE (ES)

*Course Fees are Per Credit Hour

ES 131. Earth Science/Physical Geology. (4 Credits)

Basic principles governing the dynamic Earth including plate tectonics, volcanism, earthquakes, geologic time, rocks, minerals, weathering and erosion. Three class periods; one 2-hour laboratory period per week. Field trips and/or term projects may be required. (Fall, Spring).
Course Fees: \$60

ES 131CH. Earth Science/Physical Geology - China Onsite. (4 Credits)

Basic principles governing the dynamic Earth including plate tectonics, volcanism, earthquakes, geologic time, rocks, minerals, weathering and erosion. Three class periods; one 2-hour laboratory period per week. Field trips and/or term projects may be required.

ES 131H. Honors Earth Science/Physical Geology. (4 Credits)

Basic principles governing the dynamic Earth including plate tectonics, volcanism, earthquakes geologic time rocks, minerals, weathering and erosion. Students will demonstrate understanding through a series of written assignments, presentations, and laboratory exercises designed to promote critical thinking through analysis of assigned readings drawn from scientific journals and textbooks internet reading assignments, construction of animations and other visualizations for presentation interactive software and research reports. Open to students in the Honors College or by permission of the Department of Physics and Earth Science. Three class periods- one two-hour laboratory period per week Field trips and/or term projects may be required. (Fall, Spring)
Course Fees: \$60

ES 132. Historical Geology. (4 Credits)

The development of the earth as deduced from the examination and interpretation of rocks. Special attention given to the identification and significance of fossils. Three class periods; one 2-hour laboratory period per week. Field trips and/or term projects may be required. Prerequisites: ES 131, or departmental approval. (Spring)
Course Fees: \$60

ES 133. Earth Science/Earth Systems. (4 Credits)

Major concepts of meteorology, oceanography, and astronomy with an emphasis on systems or interrelationships with plate tectonics, geology, weather and climate impacts, biology, minerals, space, exploration of space. Three class periods; one 2-hour laboratory period per week. Field trips and/or term projects may be required. (Fall, Spring).
Course Fees: \$60

ES 146. Sustainable Earth. (4 Credits)

This course explores historical and contemporary environmental issues in Earth science with an emphasis on human-environmental relationships and their influences on sustainability. Inquiry into regional and global environmental issues in geoscience allows students to identify causes, effects, and potential solutions to problems. The course supports the development of geoscience literacy, informed by current scientific understanding of Earth, which is critical to the promotion of good stewardship, sound policy development, and the understanding of diverse perspectives, behaviors and outcomes. Three class periods; one 2-hour laboratory period per week. (Fall, Spring)
Course Fees: \$60

ES 146CH. Sustainable Earth - China Onsite. (4 Credits)

This course explores historical and contemporary environmental issues in Earth science with an emphasis on human-environmental relationships and their influences on sustainability. Inquiry into regional and global environmental issues in geoscience allows students to identify causes, effects, and potential solutions to problems. The course supports the development of geoscience literacy, informed by current scientific understanding of Earth, which is critical to the promotion of good stewardship, sound policy development, and the understanding of diverse perspectives, behaviors and outcomes. Three class periods; one 2-hour laboratory period per week.

ES 200. Climate Change. (4 Credits)

This course examines the science of climate change, including how the climate system operates, the factors that cause climate change across different time scales, how those factors interact, how climate has changed in the past, how scientists use models, observations and theory to make predictions about future climate, and the possible consequences of climate change for our planet. The course explores evidence for changes in ocean temperature, sea level and acidity due to global warming and looks at how climate change today is different from past climate cycles. Finally, the course looks at the connection between human activity and the current warming trend and considers some of the potential social, economic and environmental consequences of climate change. Three class periods; one 2-hour laboratory period per week. (Every other semester)
Course Fees: \$60

ES 200CH. Climate Change - China Onsite. (4 Credits)

This course examines the science of climate change, including how the climate system operates, the factors that cause climate change across different time scales, how those factors interact, how climate has changed in the past, how scientists use models, observations and theory to make predictions about future climate, and the possible consequences of climate change for our planet. The course explores evidence for changes in ocean temperature, sea level and acidity due to global warming and looks at how climate change today is different from past climate cycles. Finally, the course looks at the connection between human activity and the current warming trend and considers some of the potential social, economic and environmental consequences of climate change. Three class periods; one 2-hour laboratory period per week. (Every other semester)

ES 220. Sustainable Ecosystems. (3 Credits)

This course explores the basic principles of ecology, with a particular emphasis on biological and environmental relationships and their influences on sustainable ecosystems. Inquiry into regional and global issues allows students to identify causes, effects, and potential solutions to ecological challenges facing us today and in the future. Topics include energy flow, nutrient cycling, population structure and dynamics, species interaction, succession, and applications to current environmental management issues. (Spring on sufficient demand)
Course Fees: \$60

ES 220CH. Sustainable Ecosystems - China Onsite. (3 Credits)

This course explores the basic principles of ecology, with a particular emphasis on biological and environmental relationships and their influences on sustainable ecosystems. Inquiry into regional and global issues allows students to identify causes, effects, and potential solutions to ecological challenges facing us today and in the future. Topics include energy flow, nutrient cycling, population structure and dynamics, species interaction, succession, and applications to current environmental management issues. (Spring on sufficient demand)
Course Fees: \$60

ES 251. Environmental Systems. (4 Credits)

This course introduces methods of modeling dynamic systems, with particular emphasis on environmental systems which are foundational to interdisciplinary perspectives of sustainability. A focus in understanding sustainability is placed on predicting the behavior of systems through time. Three class periods; one 2-hour laboratory period meets each week.

Prerequisites: ES 131 or ES 133. (Fall, Spring)

Course Fees: \$60

ES 251CH. Environmental Systems - China Onsite. (4 Credits)

This course introduces methods of modeling dynamic systems, with particular emphasis on environmental systems which are foundational to interdisciplinary perspectives of sustainability. A focus in understanding sustainability is placed on predicting the behavior of systems through time. Three class periods; one 2-hour laboratory period meets each week.

Prerequisite: ES 131 or ES 133. (Fall, Spring)

ES 301. Water Resources. (3 Credits)

How much water does the world need to support growing human populations? What are the potential effects of climate change on the world's water resources? Water and water resources are critical issues for the sustenance of nearly every society. This course examines the occurrence, use, management, and conservation of water and water resources in the U.S. and around the world. It further discusses the environmental, economic, and social implications of floods, droughts, dams, and water usage as well as current issues in water quality, water pollution, and water resource regulation. Students will gain an understanding of the environmental, societal, and political impacts of water, water resources, and changes in water supply and availability, and they will be introduced to current and emerging trends in water resource issues, development, and technology. (Fall on sufficient demand)

Course Fees: \$60

ES 301CH. Water Resources - China Onsite. (3 Credits)

How much water does the world need to support growing human populations? What are the potential effects of climate change on the world's water resources? Water and water resources are critical issues for the sustenance of nearly every society. This course examines the occurrence, use, management, and conservation of water and water resources in the U.S. and around the world. It further discusses the environmental, economic, and social implications of floods, droughts, dams, and water usage as well as current issues in water quality, water pollution, and water resource regulation. Students will gain an understanding of the environmental, societal, and political impacts of water, water resources, and changes in water supply and availability, and they will be introduced to current and emerging trends in water resource issues, development, and technology. (Fall on sufficient demand)

ES 302. Energy. (3 Credits)

This course provides an introduction to energy systems and energy resources. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized. (Spring on sufficient demand)

Course Fees: \$60

ES 302CH. Energy - China Onsite. (3 Credits)

This course provides an introduction to energy systems and energy resources. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized. (Spring on sufficient demand)

ES 303. Sustainable Food and Agriculture. (3 Credits)

In this course, we will examine the social, economic and environmental dimensions of agriculture, the emerging global challenges revolving climate change, resource depletion, and various movements within agriculture including the Green Revolution, integrated crop management, conservation agriculture, organic, sustainable, regenerative, permaculture, and "climate smart" agriculture. We will explore the concept of food security in all of its dimensions including production, storage, distribution, access and stability. We will place special emphasis on challenges to global food security, constraints on the modern "conventional" farming system, and sustainable strategies to increase global food production. (Even-numbered years, Spring on sufficient demand)

Course Fees: \$60

ES 303CH. Sustainable Food and Agriculture - China Onsite. (3 Credits)

In this course, we will examine the social, economic and environmental dimensions of agriculture, the emerging global challenges revolving climate change, resource depletion, and various movements within agriculture including the Green Revolution, integrated crop management, conservation agriculture, organic, sustainable, regenerative, permaculture, and "climate smart" agriculture. We will explore the concept of food security in all of its dimensions including production, storage, distribution, access and stability. We will place special emphasis on challenges to global food security, constraints on the modern "conventional" farming system, and sustainable strategies to increase global food production. (Even-numbered years, Spring on sufficient demand)

ES 304. Waste. (3 Credits)

Exploration of the relationships among consumption, waste, pollution, and environmental sustainability. Students will examine challenges involving management of various kinds of waste streams (municipal, hazardous, toxic, and wastewater); assess consumption trends past and present; and explore the connection of waste production and disposal. Through activities such as measuring their own waste stream and assessing community-level waste management (landfilling, recycling and composting), students critically evaluate the economic, political, and ecological impacts of linear vs. circular waste stream practices. (Spring on sufficient demand)

Course Fees: \$60

ES 304CH. Waste - China Onsite. (3 Credits)

Exploration of the relationships among consumption, waste, pollution, and environmental sustainability. Students will examine challenges involving management of various kinds of waste streams (municipal, hazardous, toxic, and wastewater); assess consumption trends past and present; and explore the connection of waste production and disposal. Through activities such as measuring their own waste stream and assessing community-level waste management (landfilling, recycling and composting), students critically evaluate the economic, political, and ecological impacts of linear vs. circular waste stream practices. (Spring on sufficient demand)

ES 320CH. Environmental Justice - China Onsite. (3 Credits)

This course examines the fundamentals of environmental justice - the idea that all people and communities have the right to equal environmental protection under the law, and the right to live, work and play in communities that are safe, healthy and free of life-threatening conditions. It explores current and emerging issues, as well as the application of environmental justice to environmental policy and planning. While this course focuses mainly on the United States, international issues and perspectives are also considered. (Spring on sufficient demand)

ES 320W. Environmental Justice. (3 Credits)

This course examines the fundamentals of environmental justice - the idea that all people and communities have the right to equal environmental protection under the law, and the right to live, work and play in communities that are safe, healthy and free of life-threatening conditions. It explores current and emerging issues, as well as the application of environmental justice to environmental policy and planning. While this course focuses mainly on the United States, international issues and perspectives are also considered. (Spring on sufficient demand)

Course Fees: \$60

ES 330. Meteorology. (3 Credits)

Components of weather systems; atmospheric temperature, pressure, and humidity; interpretation of weather maps and elements of forecasting. Also listed as GE 330 but creditable only in field for which registered. Field trips and/or term projects may be required. Prerequisite: ES 131, GE 111 or GE 112 or departmental approval. (Fall).

Course Fees: \$60

ES 348. Earth Resources. (4 Credits)

This course supports understanding of the field of sustainability in the context of the systems of Earth Sciences. Sustainability is commonly defined as meeting the needs of the generation without compromising the ability of future generations to meet their own needs. It is characterized by the overarching concerns: maintaining ecological and environmental health; creating economic welfare; and ensuring social justice. This course explores how the human and natural systems interact in a time of visible climate change, diminishing natural resources, and rising rates of consumption through using real world examples.

Three class periods; one 2-hour laboratory period per week. Prerequisites: ES 131 or ES 133. (Spring)

Course Fees: \$60

ES 350. Introduction to Geophysics. (4 Credits)

A geophysics course in which principles of physics are applied to studies of Earth structure and dynamics from crust to core. The study includes exploring geophysical tools like seismology, gravity, magnetism, heat flow, and geodesy which are used to understand the age, whole-earth and near-surface structure, and to quantify the kinematics and dynamics of plate tectonics. Three class periods; one 2-hour laboratory per week. Prerequisites: PH 251 and MA 125. (Fall)

Course Fees: \$60

Course Fees: \$60

ES 365. Data Analysis in Geophysics. (3 Credits)

Emphasis is placed on manipulation and analysis of geophysical data in a Unix/Linux environment. Topics will include Unix, programming in MATLAB®, scripting (sh and csh), AWK, Seismic Analysis Code (SAC), Generic Mapping Tools (GMT), and Adobe Illustrator, and an overview of Fortran and C. Students will acquire a working knowledge of a wide range of scientific programming and scripting languages implemented by geoscientists. Three class periods per week. Prerequisite: ES 131, ES 350 or departmental approval. (Spring, and upon sufficient demand).

Course Fees: \$60

ES 375. Technology and the Environment. (3 Credits)

A course designed to acquaint the student with the dynamic state of our technological world; interrelationships of pollution, energy, natural resources, food, and populations, with emphasis on human health issues. Field trips and/or term projects may be required. Prerequisite: advanced standing or departmental approval. (Spring, odd-numbered years)

Course Fees: \$60

ES 410. Tectonics. (3 Credits)

Plate tectonics is the fundamental theory in geology that illuminates dynamic Earth processes. The theory explains volcanoes, earthquakes, mountains, and the oceans. Students will investigate topics such as historical continental drift, earthquakes, subduction zones, the creation and destruction of the ocean floor, and mountain building and interpret data related to these. Three class periods; one 2-hour laboratory period per week. Prerequisite: ES 131 or ES 133. (Fall)

Course Fees: \$60

ES 420. Seismology. (4 Credits)

This course provides an introduction to concepts in seismology. Studies include wave propagation in the Earth as well as constraints on Earth structure and earthquake theory, development of the wave equation, source theory, and array seismic tomography. Techniques will be introduced in single wave propagation, array seismology with large data sets, seismic tomography, seismic anisotropy, introduction to inverse theory, signal processing, and reflection seismology. Applications and seismic image analysis relevant to plate tectonics, earthquakes, and the Earth's interior will be discussed. Three class periods; one 2-hour laboratory per week. Prerequisites: ES 131, ES 350 or department approval. (Spring)

Course Fees: \$60

ES 431. Structural Geology. (3 Credits)

The nature, classification, origin, and quantification of geologic structures, with emphasis on sedimentary rocks. Three class periods; one 2-hour laboratory period per week. Field trips and/or term projects may be required. Prerequisite: ES 131. (Fall, odd-numbered years)

Course Fees: \$60

ES 431L. Structural Geology Lab. (1 Credit)

Laboratory analysis, including computer mapping of folds, faults, and other structural features. Laboratory exercises are designed to develop computer skills. Required for geology major. One 2-hour laboratory period per week. Prerequisite: concurrent enrollment in ES 431. (Fall, odd-numbered years)

Course Fees: \$60

ES 445. Mineralogy. (4 Credits)

Crystal chemistry, crystallography; physical properties of minerals; mineral stability, identification, and occurrence. Three class periods; one 2-hour laboratory per week. Field trips and/or term projects may be required. Prerequisite: ES 131. (Spring, Even-numbered years)

Course Fees: \$60

ES 455W. Paleobiology. (4 Credits)

Fundamental biological problems, including speciation, systematics, evolution, extinction, functional morphology, paleoecology, and biogeography will be addressed from the perspective of the fossil record. Three class periods; one 2-hour laboratory per week. Field trips and/or term projects may be required. Also listed as BI 455W, but creditable only in the field for which registered. Prerequisites: ES 132 or departmental approval. (Fall, Even-numbered years)

Course Fees: \$60

ES 470. Internship. (1-3 Credits)

Open to majors or minors in Earth System Sustainability. Provides for special field experience by working in cooperation with a public or private agency for a minimum of four hours per week per credit hour. The student will be required to maintain a daily journal regarding their work assignments, accomplishments and daily experiences. A written report must be provided to the departmental faculty at the end of the semester. Internship may be off campus at a pre-approved site with credit depending on scope of project. May not be repeated. International students must receive approval from the Office of International Affairs prior to course registration. Prerequisite: Departmental approval required. (Fall, Spring, Summer)

Course Fees: \$60

ES 480CH. Topics in Earth Science - China Onsite. (1-4 Credits)

Topics will be selected from astronomy, environmental science, geology, marine geology, meteorology, and oceanography. Departmental approval required. Special fee: \$30.00 (may be required depending on the topic). (Offered upon sufficient demand)

ES 480W. Topics in Earth Science. (1-4 Credits)

Topics will be selected from astronomy, environmental science, geology, marine geology, meteorology, and oceanography. Departmental approval required. (Offered upon sufficient demand)

Course Fees: \$60

ES 481. Topics in Earth Science. (1-4 Credits)

Topics will be selected from astronomy, environmental science, geology, marine geology, meteorology, and oceanography. Departmental approval required. (Offered upon sufficient demand)

Course Fees: \$60

ES 481CH. Topics in Earth Science - China Onsite. (1-4 Credits)

Topics will be selected from astronomy, environmental science, geology, marine geology, meteorology, and oceanography. Departmental approval required. (Offered upon sufficient demand)

ES 482. Topics in Earth Science. (1-4 Credits)

Topics will be selected from astronomy, environmental science, geology, marine geology, meteorology, and oceanography. Departmental approval required. (Offered upon sufficient demand)

Course Fees: \$60

ES 488. Hydrogeology. (3 Credits)

The interrelationships between water and geologic materials and processes, primarily subsurface water. Prerequisite: ES 131. (Spring, even-numbered years)

Course Fees: \$60

ES 489. Senior Capstone Research. (1-3 Credits)

Students will pursue an area of field-based research interest in sustainability related to the Earth Sciences. Projects are subject to faculty approval prior to engagement. Students will meet regularly with the assigned faculty member(s) to develop the project plans, to implement plans, and to prepare a paper reflecting the research. Scheduled work and conferences equal three hours per week per credit hour. Students will present research to at least one professional group. A maximum of 2 credit hours may be offered in the summer. A total of 3 credit hours required. Prerequisite: Departmental approval required. (Fall, Spring, Summer)

Course Fees: \$60

ES 495. Directed Research. (1-3 Credits)

Experimental, theoretical, or computational investigation of problems in sustainability under the direction of departmental faculty, with enrollment and projects subject to prior approval of the department. Formal reports of research progress will be required for credit. Scheduled work and conferences require a minimum average of three hours per week per credit hour. May be repeated up to a maximum of six credit hours. A maximum of 2 credit hours will be offered during the summer term. Also listed as PH 495 but creditable only in field for which registered. Prerequisite: Departmental approval required. (Fall, Spring, Summer).

Course Fees: \$60