EARTH SCIENCES (EARTH)

EARTH 2: The Earth System and Global Change

3 Credits

An interdisciplinary introduction to the processes, interactions and evolution of the earth's biosphere, geosphere and hydrosphere. EARTH 002 Gaia - The Earth System (3) (GN) (BA) This course meets the Bachelor of Arts degree requirements.EARTH 002 is a broad introduction to the Earth and to the forces and processes that shape the present-day global environment. The course focuses on global-scale changes, both natural and human-induced. These include: global climate change, destruction of stratospheric ozone, and tropical deforestation, species extinction, and the loss of biodiversity. The discussion of these modern environmental issues occupies about 40% of the course. Unlike other "environmental" courses, this one sets these issues in the context of the long-term evolution and natural variability of the Earth systems. Thus, the course is structured around three major themes--the issues of global change, time scales of change, and understanding the Earth as a system. By the end of this course, we expect students to: 1) Recognize that: - the Earth operates as a complex system, - there is considerable interaction between the different components of this system (e.g. atmosphere, oceans, solid Earth, and biota), - changes in one part of the system can be expected to impact all others to a greater of lesser degree. 2) Develop an understanding of how the Earth system operates at the global scale, and the consequences this has for regional variability. 3) Understand how this system has evolved through time. 4) Understand how to use systems and graphical analyses to predict system response to perturbations. As a result of this course, we expect students to: 1) Synthesize this information to better appreciate the complexity of modern global change issues. 2) Be in a position to make more informed judgments on the nature and seriousness of these issues.

Bachelor of Arts: Natural Sciences
General Education: Natural Sciences (GN)

EARTH 100: Environment Earth

3 Credits

Natural processes and their relationship to anthropogenic influences. General principles of global cycles and the role they play in natural hazards, global warming, ozone depletion, etc. EARTH 100 Environmental Earth Science (3) (GN)(BA) This course meets the Bachelor of Arts degree requirements. "Environment Earth" is designed to generate a student's interest in natural processes and the effects humans have on these processes. In addition, students are encouraged to think critically about environmental problems and discover the complexity of these issues. An emphasis on the discrepancies between political rhetoric, media reporting and scientific data provides students the opportunity to evaluate conflicting arguments for themselves.The goals of this course are (1) to develop students' understanding about our Earth and human effects on natural resources, (2) to foster the ability to critically evaluate scientific arguments, and (3) to practice expressing reasoned opinions on complex problems. To achieve these goals, grades are based on examinations, homework assignments, written reports and oral presentations. Exams use a traditional multiple choice format and are based on the lecture and readings. However, questions are designed to test a student's knowledge of the principles and interrelationships discussed rather on memorization of facts and terms. Homework assignments are given on approximately a weekly basis. Questions cover the most important concepts of the text and lecture and encourage consistent reading to complement lectures. These exercises have two purposes. First, the short answer nature of questions provides practice in writing logical, concise paragraphs while ensuring the student understands key concepts. Second, assurance that students are reading chapters concurrent with the lecture topics allows the instructor to interact with the class more effectively during class discussions. Two written reports are given to test a student's ability to comprehend scientific articles and explain the science and its implications for environmental policy. A wide variety of topics are suggested based mainly on newspaper and magazine articles on environmental issues, but students can select almost any topic related to the environment with prior instructor approval. Students must then research the science behind the media coverage via library and web-based resources. The class web site (http://www.geosc.psu.edu/People/Faculty/FacultyPages/Kubicki/earlOO.html) is designed to facilitate searches related to course topics. Papers are judged based on the clarity of writing, the quality of scientific data included, and discussion of the implications of the research. Oral presentations debating two sides of environmental issues will be conducted. Small teams (4-5 students) will be assigned one side of an issue and each member will participate in a debate against another team. These debates will develop students' speaking and team-building, skills. Although each student will be responsible for a section of the debate, factual research will be carried out as a group to present the best overall case.

Bachelor of Arts: Natural Sciences
General Education: Natural Sciences (GN)

EARTH 100H: Environment Earth: Environment and Energy

3 Credits

Examination of climate change and energy issues. EARTH 100H Environment Earth: Environment and Energy (3) (GN) In this course, students will be asked to investigate the natural processes that affect the Earth’s climate and their effects on Life on Earth. Once a fundamental understanding of natural processes is developed, then an examination of the anthropogenic atmospheric changes covers the increases in greenhouse gases mainly due to fossil fuel use and agriculture. After discussing the potential environmental and economic impacts of increased greenhouse gases on Man and Nature, the major energy sources will be studied for their potential to meet increasing energy needs and their possible ability to mitigate climate change.

General Education: Natural Sciences (GN)
Honors

EARTH 101: Natural Disasters: Hollywood vs. Reality

3 Credits

Analysis of the causes and consequences of natural disasters; comparison of popular media portrayal of disasters with perspective from scientific research. EARTH 101 Natural Disasters: Hollywood vs. Reality (3) (GN;US) (BA) This course meets the Bachelor of Arts degree requirements.This course investigates a variety of natural hazards and disasters. We will use the popular media as a starting point for discussions and development of tools for analyzing the causes of disasters. Using excerpted segments of "disaster films" in conjunction with scientific treatments, we can identify the causes,

consequences and public perceptions of natural hazards. Small group discussions and cooperative research held "real time" in the classroom will be a major component of this course. The goal is to help students develop both an understanding of natural hazards and disasters, and enhance their understanding of scientific approaches to problem solving. During the course approximately four to five topics selected from the list of volcanoes,, earthquakes, hurricanes, tornadoes, flooding, bolloid (e.g., asteroid) impacts, and tsunami (tidal waves) will be covered. For each topic, we will incorporate the following activities: (a) short edited excepts from disaster movies (or equivalent) of approximately 10 minutes each; (b) discussions by small groups of students (approximately 10 per group) to identify scientific issues to be addressed; (c) development of scientific background and tools via faculty lectures, tutorials, and library or web-based activities; (d) cooperative learning activities by small student groups--each group working together to address one of the identified scientific issues; (e) group presentations of results of the cooperative learning activity; and (f) individual writing activities producing focused reports on specific scientific issues. A typical topic will be covered in three weeks (six class meetings) with approximately 50 percent of the time (in class) allotted to group activities and discussion; lecturing by the faculty will involve approximately 25 percent of the time, with the remaining 25 percent of the time used for video and Wed-based presentations. Grades will be based on participation in "breakout" group discussions and cooperative activities, writing assignments ((two to three pages each) associated with each topic, and an annotated "disaster diary" of natural disasters which have occurred during the course. Each writing assignment will be aimed at a client audience (e.g., municipal government, businesses, or the general public) and written to explain the exposure to natural hazards or potential for disaster faced by the client. This course has no prerequisites and should be accessible to all students. Through cooperative activities students can benefit from the range of expertise brought to the course by their colleagues and thus address scientific issues beyond the reach of any individual.

Bachelor of Arts: Natural Sciences
United States Cultures (US)
General Education: Natural Sciences (GN)

EARTH 103: Earth in the Future: Predicting Climate Change and Its Impacts Over the Next Century

3 Credits

Climate predictions for the coming century are utilized to examine potential impacts on regions, sectors of society, and natural ecosystems. EARTH 103 Earth in the Future: Predicting Climate Change and It's Impacts Over the Next Century (3) (GN) (BA) This course meets the Bachelor of Arts degree requirements.The United States is actively working on national assessment of the impacts of the climate change predicted to occur over the next century. The U.S. National Assessment has developed three major documents, an Overview written for Congress, a Foundation document giving the sources of information and their interpretation, and a series of regional (e.g. Northeast, Midwest, etc) and sector (water, health, agriculture, forests, and coastlines) reports. These reports present an exceptional opportunity to connect advances in the natural sciences to society. The course has four major objectives: (1) to gain an understanding of climate science and of the possible scenarios of how climate may change in the future. [the basis for these scenarios and their limitations will be an important element]; (2) to analyze the linkages between climate and major human and natural systems (e.g. agriculture, human health, water, coastal ecosystems, and forests), necessary to assess the potential impacts of climate change; (3) to demonstrate that the impacts of climate change, and the way in which society responds, is dependent on factors such as age, economic capability, lifestyle (e.g. urban vs. rural), generational differences, and cultural differences; and (4) to understand the different types of responses that humans may have to climate change, including adaptations to change and possible mechanisms to mitigate the factors that are forcing change to occur. The course includes smaller enrollment computer laboratory/discussion sessions designed to (1) provide hands-on data analysis and interpretation and the exploration of climate linkages to natural and human systems; (2) promote discussion and formal debate around key issues; and (3) develop tools to assess class perceptions of vulnerabilities and appropriate responses. Several of these elements will be developed with a team or group approach. Grading will be based primarily on a student record, or portfolio, stemming from a combination of lab exercises, written material, and debate materials. Tests on lecture material will be a secondary evaluation mechanism. This course fulfills a Natural Sciences General Education requirement, as well as course requirements for the Earth major. It provides a natural partner to Earth-as-a-System (Earth 002) that focuses on Earth system concepts and the scientific evidence for a changing planet throughout Earth history and into the future.

Bachelor of Arts: Natural Sciences
General Education: Natural Sciences (GN)

EARTH 104: Climate, Energy and Our Future

3 Credits

This course presents the past, present, and possible future response of Earth's climate to human energy use. EARTH 104 Climate, Energy and Our Future (3) (GN) This class explores how we can shift our society to a sustainable energy system that improves our quality of life, our economy, and our natural environment. Energy provides well-being, jobs and about 10% of our economy, while powering the rest. But, energy is also the least sustainable part of our economy—we rely on fossil fuels that we are burning about a million times faster than nature saved them for us. These fossil fuels, mostly coal, oil and gas, help us grow food and avoid some environmental disasters, but the limited fossil-fuel supplies mean we must move toward a more sustainable system. And, we will be better off by avoiding damaging climate changes from fossil-fuel CO2 if we move before all of the fossil fuels are gone. The warming influence of fossil-fuel CO2 is shown by physics known for more than a century and really refined by the US Air Force after WWII. History, data, and models confirm the physics, giving us high confidence that burning much of the remaining fossil-fuel resource and releasing the CO2 will cause much larger climate changes than we have experienced so far. This class will explore the big issues in energy, including the value of burning oil rather than whales, and other historical insights. Then, after looking at the basic science and engineering of our energy system and how it affects climate, we will examine the multitude of options for the future, including alternative energy sources, conservation, and intentionally manipulating the climate. The economics, policies and ethics of these options will help us consider how to build a sustainable energy system that will encourage economic growth and improved quality of life, while at the same time defending against potentially catastrophic future climate change.

General Education: Natural Sciences (GN)

EARTH 105N: Environments of Africa: Geology and Climate Change

3 Credits

Significant natural features of Africa as related to human endeavor; case studies include the Nile, climate change, and natural resources. EARTH 105N Environments of Africa: Geology and Climate History (3) (GN/GS;IL)(BA) This course meets the Bachelor of Arts degree requirements. Environments of African: Geology and Climate History investigates the interrelationships between geology, hydrology, land use, societies and human development in several areas of Africa. We focus primarily on regions north of the equator, although there is a brief segment on South Africa mining. Specific topics include the Nile River (sources of the Nile, agricultural practices, effects of damming the Nile, hydropolitics), the Sahara and Sahel (salt mines, climate change, drought, water resources), and natural resources and their role in politics (gold, diamonds, oil, and gas). The theme of climate change cuts across the entire semester. The quantitative and analytical components of the course involve working through a combination of map exercises and data manipulations (flood stage, groundwater age, rainfall and temperature records). Writing exercises are conducted both individually (essays, analysis of readings) and in collaborative teams (climate change analysis). Readings for the course come from the popular scientific literature; current refereed research journals, and transcribed oral histories of African people. Faculty lectures will comprise ~30% of the course, and student presentations ~20%, with the remainder of the time devoted to in-class collaborative exercises. There are no pre-requisites for this course. It will be offered annually with a maximum enrollment of 100 students.The goals of the course are to (1) explore the relationship between human society and the natural world; (2) develop quantitative and scientific reasoning skills; (3) introduce the scientific study of Africa. The topics that we explore (e.g., global climate change, allocation of limited water resources) are important political issues that affect people in developed and developing countries throughout the world. It is crucial that the next generation of citizens be informed as to how scientific data is obtained, presented, and interpreted by scientists as well as politicians. Students will work individually and (more commonly) in teams to analyze real data from natural African systems, and will then report their findings to the class both orally and in writing. Examples of the data sets include 100-year records of monthly rainfall and temperature from stations throughout the continent, fossil suites from ancient lake cores in the modern Sahara, and historical writings of Nile flood levels from pre-Biblical times. Through these exercises students will gain an appreciation of the scope of geological time and change, and will be able to incorporate this new long-term perspective into identification and resolution of modern questions.

Bachelor of Arts: Natural Sciences
International Cultures (IL)
General Education: Natural Sciences (GN)
General Education: Social and Behavioral Scien (GS)
General Education - Integrative: Interdomain
GenEd Learning Objective: Crit and Analytical Think
GenEd Learning Objective: Integrative Thinking
GenEd Learning Objective: Key Literacies

EARTH 106: The African Continent: Earthquakes, Tectonics and Geology

3 Credits

Study of earthquakes and seismic waves to learn about the geology and plate tectonics of the African continent. EARTH 106 Shaking Up Africa: The Geology and Tectonics of Africa (3) (GN)(BA) This course meets the Bachelor of Arts degree requirements. Earthquakes are natural phenomena that can cause immense human suffering because of intense ground shaking, and are consequently of great societal importance. Earthquakes are also important because the seismic waves that generate the ground shaking provide scientists with important information about Plate Tectonics and geology, in particular information about the structure and composition of our planet and how the insides of the planet are deforming. In this course, earthquakes in Africa and the seismic waves they generate are used to help students to learn about the geology of Africa and how the earth beneath the African continent is being deformed by Plate Tectonics.EARTH 106 is designed in four modules. Modules, in turn, are divided into weekly lessons. Offered in a "hybrid" format, each weekly lesson includes a single face-to-face class meeting, complemented by online reading assignments, self-check learning activities, and discussions. The online, hands-on learning activities are similar to the labs conducted in similar courses that are offered solely in face-to-face environment, including the manipulation of geographic data, map reading exercises, and rock and mineral identification activities. They are designed to help students learn skills and knowledge that they then apply to a course project. While the weekly lesson activities involve working with seismic data from East Africa, the course project requires students, working in small groups, to apply their skills and knowledge to another geographic area of the African continent. In addition to the weekly lesson activities and the course project, students are required to complete weekly quizzes that assess comprehension of the online reading assignments. Quizzes that come at the end of a module also assess the skills and knowledge addressed in the lesson learning activities for that module.This course is a general education offering in natural sciences (GN) and is open to all students regardless of academic major.

Bachelor of Arts: Natural Sciences
General Education: Natural Sciences (GN)

EARTH 107: Coastal Processes, Hazards and Society

3 Credits

Processes responsible for formation, diversity, and evolution of coastal landscapes; socioeconomic and policy responses to changes in coastal regions. EARTH 107 Coastal Processes, Hazards and Society (3) (GN) Ten percent of the world’s population or approximately 600 million people live on land that is within 10 meters of sea level. This low elevation coastal zone includes some of the world’s most populous cities including New York, London, Miami, Calcutta, Tokyo, and Cairo. This zone is threatened by a host of environmental challenges, none less daunting than sea level rise. The overarching goal of the proposed blended course is to provide students with a global perspective of coastal landscapes, the processes responsible for their formation, diversity and change over time, as well as socioeconomic and policy responses to current biophysical changes in the coastal zones around the world. Students will use real-world coastal data sets to evaluate hazards such as hurricanes and tsunamis and effects on coastal populations. Coastal processes to be considered include tectonic settings, effects of glaciation, sediment supply, and wave and tidal energy. The impacts of sea level rise and its local effects on communities will be a focus. Engineering solutions to projected sea level rise impacts such as coastal flooding and habitat loss in coastal areas will also be examined. The students taking the course will participate in a student-centered active learning process, including analyzing real data sets such as sea level rise records, shoreline erosion rates along barriers, comparison of wave data for Hawaii versus

the East Coast and other major influences affecting coastal evolution. Students will also be asked to apply critical thinking and problem solving skills to real-world coastal issues that affect human populations. An example is how communities can effectively plan for emergencies such as catastrophic flooding of densely populated low-lying areas such as the Ganges delta. Active learning elements include analyzing real data sets and applying critical thinking and problem-solving skills to real-world coastal issues that affect human populations. Students will complete a capstone project in which they consider a real-world coastal issue. The course will comprise twelve modules, each lasting 1-2 weeks. The course will initially be offered in blended format and later in 100% online format.

General Education: Natural Sciences (GN)

EARTH 109: The Fundamentals of Shale Energy Development

3 Credits

Energy is a critical component of modern society, yet we face significant challenges associated with balancing energy demands, energy security, environmental sustainability, and stable economics with sound regulations and policy. Unconventional energy development from shale formations has been a game changer for the fossil fuel industry over the past decade and is projected to continue to grow over the next several decades. But there are still many uncertainties on how to optimally develop these largely untapped resources to maximize the social benefits while minimizing environmental impacts. This course covers key topics needed to provide students with an overview of the science, engineering, environmental impacts, geopolitics, economics and societal impacts of shale energy development. These topics include geology, resource assessment, drilling technology, hydraulic fracturing methods, environmental impacts, economics, workforce needs, infrastructure, utilization trends, regulation, energy policy, energy exports, international geopolitics, societal considerations, and the future of unconventional energy and its relationship with other energy forms. The class is geared toward a broad audience of students to provide a big picture view of the shale energy landscape. The course is structured in four parts. The course begins with the geology of shale (part 1), then examines engineering and environmental aspects of shale energy production (part 2), then explores relevant economic, geopolitical and societal issues (part 3) and ends with a capstone project (part 4). Shale energy development in a key U.S. shale basin is used in parts 1 -3 to provide examples and illustrate concepts, impacts and problems. In the capstone project, students will learn about the shale energy development in another basin of their choosing and present their findings to the class, thereby developing further the students¿ understanding of the core course content while gaining an overview of shale energy development beyond the U.S. shale basin presented in the course.

General Education: Natural Sciences (GN)
GenEd Learning Objective: Effective Communication
GenEd Learning Objective: Crit and Analytical Think
GenEd Learning Objective: Key Literacies

EARTH 111: Water: Science and Society

3 Credits

Investigation of water behavior and occurence, its relevance to life, human activities, politics, and society. EARTH 111 Water: Science and Society (3) (GN;US) The Earth is often called "The Blue Planet", a reference to the fact that over two-thirds of its surface is covered by water. Despite its apparent abundance, water is a valuable and limited resource; less than 2.5% of the water on the planet is fresh, and only one third of that is potable. And that's not all - the small fraction of Earth's ware that is useable to humans is distributed very unevenly. As a result, conflicts over water occur from the local level, for example: pitting rancher against developer - to the global level, at which nations square off against one-another in war and use water as a mechanism for imposing sanctions. The dire situation in some regions has spurred numerous research and technological endeavors, such as water desalinization, genetic engineering of crops, and major overhauls of agricultural practice.In this course, we will explore the relationships between water and human populations, with emphasis on water resources and quality in the Western U.S., and how these have shaped history and modern politics. We will focus first on developing the scientific underpinnings of water's unique properties, behavior, movement, occurrence, and quality. With this background, we will then discuss key issues relating to modern and historical conflicts, human impacts on the natural world, and human engineering accomplishments driven by our thirst for this valuable resource. We will discuss historical examples from the American West, specifically the development of water resources in Colorado and California. We will also explore modern and historical conflicts between stakeholders. Major themes will include political and economic conflicts over (1) water resources - for example, balancing agricultural and urban demands in the American west in the Denver and Los Angeles metropolitan areas, (2) water quality - for example, considering the impact of economically profitable human activities on water quality and transmission of disease, and (3) human impacts on natural processes, specifically connecting human activity with our cultural history of water use and exploration in the American West. Our approach is to include a substantial component of student-initiated learning. The course will include critical evaluation and discussion of assigned reading and films, a series of laboratory exercises and field trips to illustrate concepts and stimulate discussion, and a major research paper.

United States Cultures (US)
General Education: Natural Sciences (GN)

EARTH 112: Climate Science for Educators

3 Credits

Concepts of climate sciences highlighted by evidence-based explanations and scientific discourse in preparation for K-6 science teaching. This introductory, multidisciplinary course will focus on the interactions among physical science concepts, earth science concepts, and scientific practices to develop understandings about Earth's climate system. The course is primarily intended for prospective elementary school teachers (Childhood and Early Adolescent Education, PK-4 and 4-8 majors), although it is available to other non-science majors. The development of models is an integral part of the course as a means to facilitate climate systems thinking by serving as a means to explain phenomena and predict outcomes. In addition, students in the course consider how what they are learning applies to teaching by offering opportunities to think about how they might extend their knowledge to teaching contexts. This course consists of integrated lectures and laboratory investigations in class meetings each week, with work on collaborative projects outside of class.

Cross-listed with: SCIED 112

EARTH 150: Dinosaur Extinctions and Other Controversies

3 Credits

Dinosaur extinctions and other major and controversial events in the history of life. EARTH 150 Dinosaur Extinctions and Other Controversies (3) (GN) (BA) This course meets the Bachelor of Arts degree requirements.One of the most dramatic developments in the Earth sciences is the suggestion that extinction of the dinosaurs was caused by a meteorite impact. Evidence for and against this controversial idea is just one of the subjects addressed by this course, dealing broadly with the history of our planet, the evolution of life upon it, and the sometimes rocky development of our understanding of Earth history. In addition to dinosaur extinction, we will discuss issues relating to catastrophic vs. gradual theories about the Earth's history, fossils and the history of life, and mass extinctions, including whether or not we're in the middle of one now. How are scientific discoveries made? What distinguishes a scientific argument from a non-scientific one? What roles do social and historical factors play in the construction and acceptance of scientific theories? Questions such as these will permeate the course. Readings will include selected texts by leading scientists, with supplements from the primary scientific literature, including current discoveries published in Science and Nature.

Bachelor of Arts: Natural Sciences
General Education: Natural Sciences (GN)

EARTH 155N: Scientific Controversies and Public Debate

3 Credits

EARTH 155N Scientific Controversies and Public Debate is an introduction to critical thinking about the messages consumers get from public relations (PR) on behalf of industry, and from scientists regarding environmental health risks. Because such messages may be contradictory, the course seeks to help students understand the extent to which message communication influences our perception of risk. The course is designed to familiarize students with science topics that, because of message manipulation, are (or historically were) perceived as controversial (e.g., smoking, secondhand smoke, flame retardants, nuclear energy, the ozone hole, global climate change, acid rain, junk science, rBGH milk, biosolids, pesticides, vaccines, and endocrine disrupting chemicals). Students will learn the science and environmental health risks underlying several controversial topics. They will be guided to consider how industry and science messaging has shaped their own perceptions of risk. Then, using tools for effective communication, and avoiding communication pitfalls and deceptive tactics, students will combine accurate science content with compelling storytelling in a professional-quality video to inform the public about a targeted environmental health risk and persuade the public to avoid that risk. EARTH 155N focuses on the intersection between science and communication in the realm of environmental health. The course guides students to closely examine controversial environmental health topics, learn the science to understand public health risks, learn strategies to identify false or misleading arguments, and then think critically about industry and science messaging, including the impact of such messaging on their own lives. EARTH 155N Scientific Controversies and Public Debate is an interdomain course that integrate GN environmental health topics with GH message evaluation. It has no prerequisites, and is designed for students who may be unfamiliar with, or have only introductory knowledge of controversial environmental health topics, the norms of science communication, and public relations techniques.

General Education: Humanities (GH)
General Education: Natural Sciences (GN)
General Education - Integrative: Interdomain
GenEd Learning Objective: Effective Communication
GenEd Learning Objective: Integrative Thinking

EARTH 240: Coral Reef Systems

4 Credits

The geography, geology, biology ecology and chemistry of coral reef ecosystems; threats to reef environments; and techniques for reef surveying and monitoring; with local geologic and distant modern field studies. EARTH 240 Coral Reef Systems (4) (GN) The course introduces students to coral reef environments, past and present. It describes the processes that control the distribution, growth, and morphology of reefs and introduces students to the complexity of the coral reef ecosystem. The course emphasizes the role that reefs play in the natural environment and examines their importance to society both globally (e.g. in terms of biodiversity and its potential benefits) and locally in terms of, for example, food supply and tourism. We then look at the natural disturbances (such as disease, storms, sea surface temperature variations) that affect the reef, as well as ways in which reefs are threatened from human impacts, with an emphasis on global climate change and the long-term outlook for reef survival. Students will work in groups to research elements of the system, first at a global scale, and then focusing specifically on one region -- the Bahamas platform. Students will look at the history of the Bahamas platform and its relationship to the present nature and distribution of coral reefs. They will then examine these in the context of their social, cultural, and economic importance to local communities. A third component of the course will concentrate on the identification of vertebrate and invertebrate species and substrate conditions that are important indicators of reef health. There will then be a one-week field trip to a coral reef system to conduct reef surveys. The surveys follow the Reef Check protocol (a volunteer, community-based monitoring protocol designed to measure the health of coral reefs on a global scale). Reef Check is administered out of the University of California at Los Angeles. The coral reef surveys will be conducted on scuba and the field trip and participation in the survey are required elements of the course. Students who are not scuba certified will be given the opportunity to obtain open water scuba certification as part of the course, through Penn State’s Science Diving Program (The PSU Science Diving Program is a member of the American Academy of Underwater Sciences). There will be an additional charge for the scuba certification course and the field trip. Student assessment will be through group presentations, term papers, 3 exams and their contribution to the field program. The course satisfies part of the field requirement for the University’s Marine Science Minor and serves as an introduction to the Science Diving Program.

Prerequisite: Prerequisite or concurrent: KINES045 or Nationally Recognized Scube Certification
General Education: Natural Sciences (GN)

EARTH 296: Independent Studies

1-18 Credits/Maximum of 18

Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses.

EARTH 297: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

EARTH 400: Earth Sciences Seminar

3 Credits

Interdisciplinary study of environmental problems in the earth sciences.

Prerequisite: seventh-semester standing in the Earth major

EARTH 402: Modeling the Earth System

3 Credits

Earth 402 is a course that focuses on modeling Earth systems with a focus on the climate system, including the economic and policy aspects of energy and carbon emissions. By building and experimenting with numerical models of these systems, students gain insight into the dynamics of these systems, including the future consequences of different policy decisions that impact the climate system.

Prerequisite: EARTH 2; EARTH 103 MATH 140; MATH 110; MATH 83; CHEM 110

EARTH 495: Internship

1-18 Credits/Maximum of 18

Supervised off-campus, nongroup instruction including field experiences, practica, or internships. Written and oral critique of activity required.

Prerequisite: prior approval of proposed assignment by instructor

EARTH 496: Independent Studies

1-18 Credits/Maximum of 18

Creative projects, including research and design, which are supervised on an individual basis and which fall outside the scope of formal courses.

EARTH 497: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

EARTH 498: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.