EARTH AND ENVIRONMENTAL SCIENCE (AS) {EESC}

ENVIRONMENTAL STUDIES (ENVS)-----Note: Listings for GEOL follow ENVS 999

SM 098. The Next Millenium: Would Technology Help Us Resolve the Environmental Dilemma?. (C) Distribution Course in Society. Class of 2009 & prior only. Bokreta / Santiago-Aviles.

Over the last century we have witnessed the dominance of man over nature. Technology, our understanding of our environment and our consumption habits have been the principal weapons used in this conquest. Now, at the beginning of a new millenium, questions and concerns about our actions and perceptions are being raised. Can today's technology and new knowledge about our environment and human nature assure our survival? How can we use the next hundred years to reconstruct and restore our future? These are the fundamental questions that the class will investigate.This course will rely on evidence,the use of hypotheses, theories, and logic as well as students' scientific inquiry and creativity. We will discuss systems, models, simulations, constancy, patterns of change, evolution, and scale.

L/R 200. Introduction to Environmental Analysis. (C) Physical World Sector. All classes. Plante.

Introduction to Environmental Analysis will expose students to the principles that underlie our understanding of how the Earth works. The goal of Earth Systems Science is to obtain a scientific understanding of the entire Earth system by describing its component parts (lithosphere, hydrosphere, atmosphere, biosphere) and their interactions, and describe how they have evolved, how they function, and how they may be expected to respond to human activity. The challenge to Earth Systems Science is to develop the capability to predict those changes that will occur in the next decade to century, both naturally and in response to human activity. Energy, both natural and human-generated, will be used as a unifying principle. Knowledge gained through this course will help students make informed decisions in all spheres of human activity: science, policy, economics, etc.

295. Maritime Science and Technology: Woods Hole Sea Semester. (C) Dmochowski. Prerequisite(s): Laboratory course in physical or biological science or its equivalent; college algebra or its equivalent. This set of courses requires special application procedures. Contact Dr. Giegengack for information and an application.

A rigorous semester-length academic and practical experience leading to an understanding of the oceans. The Sea Semester is composed of two intensive six-week components taken off-campus. The Shore Component is six weeks at Woods Hole, Massachusetts, with formal study in: Oceanography, Maritime Studies, and Nautical Science. This is followed by six weeks aboard a sailing research vessel, during which students conduct oceanographic research projects as part of the courses, Practical Oceanography I and II.

Maritime Studies. A multidisciplinary study of the history, literature, and art of our maritime heritage, and the political and economic problems of contemporary maritime affairs.

Nautical Science. The technologies of operation at sea. Concepts of navigation, naval architecture, ship construction, marine engineering systems, and ship management are taught from their bases in physics, mathematics, and astronomy.

Practical Oceanography I. Taken aboard SSV Westward or SSV Corwith Cramer. Theories and problems raised in the shore component are tested in the practice of oceanography at sea. Students are introduced to the tools and techniques of the practicing oceanographer. During two lectures daily and while standing watch, students learn the operation of basic oceanographic equipment, the methodologies involved in the collection, reduction, and analysis of oceanographic data, and the attendant operations of a sailing oceanographic research vessel. Practical Oceanography II. Taken aboard SSV Westward or SSV Corwith Cramer. Students assume increasing responsibility for conducting oceanographic research and the attendant operations of the vessel. The individual student is responsible directly to the chief scientist and the master of the vessel for the safe and orderly conduct of research activities and related operation of the vessel. Each student completes an individual oceanographic research project designed during the shore component.

299. Independent Study. (C) Staff. Prerequisite(s): Permission of department. May be repeated for credit.

Directed study for individuals or small groups under supervision of a faculty member.

301. Environmental Case Studies. (C) Doheny. Prerequisite(s): ENVS 200.

A detailed, comprehensive investigation of selected environmental problems. Guest speakers from the government and industry will give their acccounts of various environmental cases. Students will then present information on a case study of their choosing.

SM 399. (GEOL399) Environmental Studies Research Seminar for Juniors. (B) Dmochowski. Prerequisite(s): ENVS200.

This seminar is designed to help Juniors prepare for the Senior Thesis research. Topic selection, advisor identification, funding options, and basic research methods will be discussed.

SM 400. Environmental Studies Seminar. (C) Scatena. May be repeated for credit.

Application of student and faculty expertise to a specific environmental problem, chosen expressly for the seminar.

SM 404. (HSOC404) Urban Environments: Speaking About Lead in West Philadelphia. (B) Pepino. ABCS Course. Requires community service in addition to class time.

Lead poisoning can cause learning disabilities, impaired hearing, behavioral problems, and at very high levels, seizures, coma and even death. Children up to the age of six are especially at risk because of their developing systems; they often ingest lead chips and dust while playing in their home and yards.

In ENVS 404, Penn undergraduates learn about the epidemiology of lead poisoning, the pathways of exposure, and methods for community outreach and education. Penn students collaborate with middle school and high school teachers in West Philadelphia to engage middle school children in exercises that apply environmental research relating to lead poisoning to their homes and neighborhoods.

SM 405. (HSOC405) Urban Environment II. (A) Pepino. Prerequisite(s): ENVS 404 or permission of instructor. Requires community service.

An independent study where Penn undergraduates can explore the health, environmental, and natural resource issues of Philadelphia,with a focus on the specific needs of West Philadelphia. Current public health concerns impacting vulnerable populations such as children, especially lead poisoning and asthma, are potential topics. Environmental issues such as water supply, air quality, radon, brownfields, and sprawl would also be good areas of study. Community service can be a component of the study. Permission from the instructor is required.

SM 406. (HSOC406) Community Based Environmental Health. (A) Pepino. ABCS Course. Requires community service in addition to class time.

From the fall of the Roman Empire to Love Canal to the epidemics of asthma, childhood obesity and lead poisoning in West Philadelphia, the impact of the environment on health has been a continuous challenge to society. The environment can affect people's health more strongly than biological factors, medical care and lifestyle. The water we drink, the food we eat, the air we breathe, and the neighborhood we live in are all components of the environment that impact our health. Some estimates, based on morbidity and mortality statistics, indicate that the impact of the environment on health is as high as 80%. These impacts are particularly significant in urban areas like West Philadelphia. Over the last 20 years, the field of environmental health has matured and expanded to become one of the most comprehensive and humanly relevant disciplines in science.

This course will examine not only the toxicity of physical agents, but also the effects on human health of lifestyle, social and economic factors, and the built environment. Topics include cancer clusters, water borne diseases, radon and lung cancer, lead poisoning, environmental tobacco smoke, respiratory diseases and obesity. Students will research the health impacts of classic industrial pollution case studies in the US. Class discussions will also include risk communication, community outreach and education, access to health care and impact on vulnerable populations. Each student will have the opportunity to focus on Public Health, Environmental Protection, Public Policy, and Environmental Education issues as they discuss approaches to mitigating environmental health risks.

This honors seminar will consist of lectures, guest speakers, readings, student presentations, discussions, research, and community service. The students will have two small research assignments including an Environmental and Health Policy Analysis and an Industrial Pollution Case Study Analysis. Both assignments will include class presentations. The major research assignment for the course will be a problem-oriented research paper and presentation on a topic related to community-based environmental health selected by the student. In this paper, the student must also devise practical recommendations for the problem based on their research.

SM 407. (HSOC407) Urban Environments: Prevention of Tobacco Smoking in Adolescents. (B) Pepino. ABCS Course. Requires community service in addition to class time.

Cigarette smoking is a major public health problem. The Centers for Disease Control and Prevention Control reports that more than 80% of current adult tobacco users started smoking before age 18. The National Youth Tobacco Survey indicated that 12.8% of middle school students and 34.8% of high school students in their study used some form of tobacco products.

In ENVS 407, Penn undergraduates learn about the short and long term physiological consequences of smoking, social influences and peer norms regarding tobacco use, the effectiveness of cessation programs, tobacco advocacy and the impact of the tobacco settlement. Penn students will collaborate with teachers in West Philadelphia to prepare and deliver lessons to middle school students. The undergraduates will survey and evaluate middle school and Penn student smoking. One of the course goals is to raise awareness of the middle school children to prevent addiction to tobacco

smoke during adolescence. Collaboration with the middle schools gives Penn students the opportunity to apply their study of the prevention of tobacco smoking to real world situations.

SM 408. (HSOC408) Urban Environments: The Urban Asthma Epedemic. (B) Pepino. ABCS Course. Requires community service in addition to class time.

Asthma as a pediatric chronic disease is undergoing a dramatic and unexplained increase. It has become the number one cause of public school absenteeism and now accounts for a significant number of childhood deaths each year in the USA.The Surgeon General of the United States has characterized childhood asthma as an epidemic. In ENVS 408, Penn undergraduates learn about the epidemiology of urban asthma, the debate about the probable causes of the current asthma crisis, and the nature and distribution of environmental factors that modern medicine describes as potential triggers of asthma episodes.

Penn students will collaborate with the Childrens Hospital of Philadelphia (CHOP) on a clinical research study entitled the Community Asthma Prevention Program. The Penn undergraduates will co-teach with CHOP parent educators asthma classes offered at community centers in Southwest, West, and North Philadelphia. The CHOP study gives the Penn students the opportunity to apply their study of the urban asthma epidemic to real world situations.

450. Techniques in environmental accounting and system analysis. (C) Scatena. Prerequisite(s): One year of introductory calculus and statistics, working knowledge of spreadsheet software.

This course covers the development and analysis of environmental budgets and input-output models that are commonly used in earth and environmental science. The first part of the semester will concentrate on the physical laws, systems principles, and analytical tools used in developing and evaluating input-output models and environmental budgets. In the remainder of the semester, we will develop and analyze hydrologic, energy and nutrient budgets for a variety of systems.

452. Disturbances and Disasters. (A) Scatena.

This course covers the earth and environmental science of natural disturbances and disasters. Floods, tsunamis, snow and ice storms, hurricanes, earthquakes, fires, droughts, and meteor impacts will be discussed and covered with case studies and readings. The distribution and frequency, geologic and ecosystem level impacts, and risk management of each disturbance will be discussed.

SM 463. (ENVS643, URBS463, URBS663) Brownfield Remediation. (M) Keene. Offered through CGS - See current timetable.

This course gives an overview of the genesis of the so-called "Brownfield" problem and of the various efforts that our society is taking to try to solve, or at least ameliorate it. The course will place the "Brownfield" problem in the broader context of the growth and decline of industrial base cities like Philadelphia. Students will study the general constitutional and statutory framework within which we approach the problems of orphan, polluted sites and the disposal of contemporary solid wastes. They will also analyze the principal actions that have been taken by federal and state governments to address remediation and redevelopment of abandoned industrial sites. In addition, the course will explore environmental equity issues.

499. Senior Thesis. (F) Giegengack. Prerequisite(s): ENVS 400-level course (may be taken concurrently). The Environmental Studies major requires 2 semesters of ENVS 499.

The culmination of the Environmental Studies Major. Students write a thesis on a topic which combines their concentration with Environmental Studies. Students work with an advisor in their discipline.

501. (MUSA501) GIS, ArcGIS & NeoGeography. (L)

This distance learning course introduces students to the fundamental techniques for using Geographic Information Systems (GIS) to analyze neighborhood markets. GIS is a computer-based data processing tool used to manage, visualize and analyze spatial information. Using Arc GIS 9.2, this course provides a hands-on experience to create maps, integrate demographic and economic data to conduct analysis within students' field of interest, including geography, history, archaeology, engineering, real estate, sociology, architecture, and political science/ policy studies. Students will also be introduced to advanced geospatial analysis tools and intergrated online mapping environments using NeoGeography. The class will enable students to learn how to address research questions and problems specific to their fields through GIS; the focus throughout will be on professional and resarch applications of this technology. Students will have virtual lectures and GIS lab support throughout online meetings at least two times per week. One-on-One and small group work sessions will be scheduled as needed. Prior experience with GIS is not required. This is a PC-based progam, only.

SM 502. Environmental Chemistry. (M) Doheny and Andrews. Offered through CGS - See current timetable.

The chemistry of water, air, and soil will be studied from an environmental perspective. The nature, composition, structure, and properties of pollutants, their means of detection and methods of purification and remediation will also be studied.

504. Biogeochemical Cycles. (L) Gill. Offered through CGS - See current timetable.

The presence of life on Earth has had a profound effect on the chemistry of the planet. This course examines the major elemental cycles of the globe, studying how these cycles link the atmosphere, oceans, and land. We will analyze how life influences these cycles, particularly how human activity affects them. We will study nutrient cycles in soil, wetlands, lakes, rivers, estuaries, the sea and the atmosphere, integrating these interactions to global-scale processes. One semester of chemistry recommended as background.

507. Wetlands. (M) Willig. Offered through CGS - See current timetable.

The course focuses on the natural history of different wetland types including climate, geology, and,hydrology factors that influence wetland development Associated soil, vegetation, and wildlife characteristics and key ecological processes will be covered as well. Lectures will be supplemented with weekend wetland types, ranging from tidal salt marshes to non-tidal marshes, swamps, and glacial bogs in order to provide field experience in wetland identification, characterization, and functional assessment. Outside speakers will discuss issues in wetland seed bank ecology, federal regulation, and mitigation. Students will present a short paper on the ecology of a wetland animal and a longer term paper on a selected wetland topic. Readings from the text, assorted journal papers, government technical documents, and book excerpts will provide a broad overview of the multifaceted field of wetland study.

530. Rocky Mountain Field Geology and Ecology. (L) Giegengack/Bordeaux. Field work is done in and around Red Lodge, Montana. An additional fee for Room and Board applies. Permission of the Instructor is required for non-MES students. Offered through CGS - See current timetable.

Designed for the MES program (open to non-MES students by permission of the instructor). This is a two-week intensive field course in the geology, natural history, and ecology of the Greater Yellowstone Ecosystem, which comprises a range of environments from the mile-high semi-deserts of intermontane basins to the alpine tundra of the Beartooth Plateau above 12,000 feet. The program is based at the Yellowstone-Bighorn Research Association (YBRA) field station on the northeast flank of the Beartooth Mountains near Red Lodge, Montana. The course includes day trips from the field station as well as overnight visits to sites within Yellowstone National Park. Pre-trip classes will be held online before the trip to ensure that all students are adequately familiar with basic principles of field-based natural science.

SM 533. Research Methods in Environmental Studies. (M) Bordeaux.

This course is designed to prepare Master of Environmental Studies students to undertake their Capstone exercises. In this course, we discuss how to identify an appropriate research project, how to design a research plan, and how to prepare a detailed proposal. Each student should enter the course with a preliminary research plan and should have identified an advisor. By the end of the course, each student is expected to have a completed Capstone proposal that has been reviewed and approved by his/her advisor.

541. Modeling Geographical Objects. (M) Tomlin.

This course offers a broad and practical introduction to the acquisition, storage, retrieval, maintenance, use, and presentation of digital cartographic data with both image and drawing based geographic information systems (GIS) for a variety of environmental science, planning, and management applications. Its major objectives are to provide the training necessary to make productive use of at least two well known software packages, and to establish the conceptual foundation on which to build further skills and knowledge in late practice.

SM 575. (ENGL584, FOLK575, HSSC575) Environmental Imaginaries. (M) Hufford.

Behind struggles over resource use and patterns of development are collective fictions that relate people to their material surroundings. "Environmental imaginaries" refers to the contending discourses that arrange society around processes of development and change. What are the Cartesian fictions that enable the chronic separation of culture from environment? How are these fictions produced, enacted, and materialized in such diverse sites as Appalachian strip mines, Sea World, nature talks, and permit hearings? How might alternative ways of knowing and being be conjured through naming practices, narratives, and other speech genres, as well as yardscapes, protest rallies and other forms of public display? Drawing on theories of worldmaking and ethnographic works on culture and environment, this seminar examines the production of Cartesian-based environmental imaginaries and their alternatives across a range of such genres and practices.

580. Ecology of Health. (A) Sheehan.

Movements of people and populations in various historic periods have led to the introduction of diseases new to a population. The colonial period, for example, witnessed the introduction of smallpox to the Americas by European colonizers, resulting in the decimation of indigenous populations. Accompanying changes in agricultural practices, ecological destruction, and changes introduced by war, development, and trade often led to altered habitat, diet, and disease patterns that threatened both colonizers and the colonized. Today, rapid and easy movement of individuals and goods around the globe, as well as new technologies, continued status inequality between rich and poor nations, and sociopolitical conflicts, have created a condition of new, emergent, and reemerging diseases. In addition, the ability of microbes to alter in response to changed environments make identification and control of disease-causing agents a challenge to medical science.

This course will focus on the social, political, and economic sources and ramifications of world-wide disease patterns. Infectious diseases such as malaria, dengue fever, tuberculosis, and AIDS will be examined. Ecological changes and new technologies, often alter food resources, productive activities, and the environment resulting in new disease patterns; one example is arsenic poisoning in Bangladesh brought about by deeply bored wells. The The activities of national and international organizations to cope with disease outbreaks, to formulate strategies for disease surveillance and notification, and to create solutions are important to understanding the state of global health. Selected case studies will be used, placing them within a framework of sociological analysis of health and disease, medical research, poverty and disease, as well as national and international organizational and policy responses.

SM 601. Proseminar: Contemporary Issues in Environmental Studies. (M) Pfefferkorn & Gill. Offered through CGS - See current timetable.

A detailed, comprehensive investigation of selected environmental problems. This is the first course taken by students entering the Master of Environmental Studies Program.

604. (ENVS414) Conservation and Land Management. (M) Harper. Some Saturday field trips will be required.

Using protected lands in the Delaware Valley, this field-based course will explore various strategies for open-space conservation and protection. In addition, students will be introduced to land management techniques used on such sites to restore or preserve land trust proerties in accordace with goals set for their use or protection.Sustainable land uses such as community supported agriculture, ecovillages, and permaculture design will be covered. Emphasis will be placed on developing skills in "Reading the Landscape" to determine conservation and restoration priorities. Students will produce a site assessment report on sites that they visit.

608. Geology & Ecology of the Isle of Arran, Scotland. (L) Giegengack and Bordeaux. Prerequisite(s): An introductory Geology or Ecology course would be helpful. MES Summer Course.

The Isle of Arran, off the west coast of Scotland, might very well be called the birthplace of modern Geology. James Hutton, Scottish Physician and gentleman farmer, conceived of the concept of Uniformitarianism, while wandering about the Isle of Arran. Hutton's Theory of the Earth laid down this concept, which later became one of the foundation principles of modern geology and earned him the appellation "Father of Modern Geology". The island offers a wide variety of rock types and geological events that has drawn geologists and students from around the globe to this tiny island.

The position of the Isle of Arran off the west coast of Scotland, places it close to the warm waters of the Gulf Stream, allowing for a much milder and wetter climate than might be expected from the island's latitude. The distribution and types of plants and animals found on the island are a direct consequence of this milder and wetter climate. The proximity to ocean waters also gives the class a chance to examine near shore marine environments.

ENVS 688 is a two-week intensive field course in the geology, natural history, ecology, and culture of the Isle of Arran, Scotland. Pre-trip classes will be held online before the trip to ensure that all students are adequately familiar with basic principles of field-based natural science. Students will then meet in Glasgow and travel together to the Isle of Arran where they will be based for the duration of the two weeks. Students will participate in a number of field exercises that include: mapping of dikes, examination of raised beaches (causes and consequences), cave formation, and modern landscape formation based on underlying geology. The types of plants and animals found on the island will be examined in light of their position on the island and the underlying geology. Students will map floral distributions as part of a multi-day exercise, examine the red deer population and the effects of interbreeding with an introduced Japanese Sika deer, and the possible consequences of reintroducing the wolf. Students will also examine ancient standing stones, stone circles, runrig agricultural practice's effects on modern landscapes, and tour Brodick Castle as part of the cultural aspect of the course. Guest lectures from local historians are also planned.

610. Regional Field Ecology. (L) Willig. Offered through CGS - See current timetable. Some Saturday field trips required.

Over the course of six Saturday field trips, we will travel from the barrier islands along the Atlantic Ocean in southern New Jersey to the Pocono Mountains in northeastern Pennsylvania, visiting representative sites of the diverse landscapes in the region along the way. At each site we will study and consider interactions between geology,

topography, hydrology, soils, vegetation, wildlife, and disturbance. Students will summarize field trip data in a weekly site report. Evening class meetings will provide the opportunity to review field trips and reports and preview upcoming trips. Six all-day Saturday field trips are required.

SM 611. Environmental Law. (B) LeGros.

This course will provide an introduction to environmental law and the legal process by which environmental laws are implemented and enforced. The course will examine the common law roots of environmental regulation in tort principles such as nuisance, negligence and trespass. We will examine important Constitutional principles in substantive and procedural law as well as significant environmental laws and approaches. Finally, we will examine emerging theories of citizen's rights and the government's role in environmental law and regulation. Students will learn how to read and analyze course decisions and apply some of the elements of legal thinking to actual cases and current problems.

612. (ENVS412) Economics and the Environment. (M) Handy.

This course provides a comprehensive introduction to basic economic tools and methods, as they are applied to environmental issues -- including pollution control, resource depletion, the global commons, intergenerational equity, and policy decision-making. The course is designed for those with little or no prior economics background; disciplined sceptics are welcome.

SM 613. (ENVS413) Business and the Natural Environment. (B) Heller. Offered through CGS - See current timetable.

This course explores dramatic changes taking place at the interface of business, society, and the natural environment. Previously, business and environmental interests were believed to be adversarial. Now, some contemporary thinkers are suggesting that environmental capabilities can be a source of competitive advantage for corporations. A recent Harvard Business Review article refers to the sum of these changes as "The Next Industrial Revolution." In this course we will study examples on the cutting edge of these developments. We will look at corporations that are creating a "double bottom line" by strategizing about the ecological impact of their decisions, as well as the economic impact. We will learn about industrial designers who are rethinking everything from tennis shoes to corporate headquarters' buildings with the environment in mind. We will consider new alliances among business, environmental activists and government regulators -- all stakeholders in a sustainable society.

615. Professional Case Studies in Environmental Analysis and Management. (M) Laskowski.

This course is designed for students nearing the end of their MES program. It will provide students with hands-on experience working with local environmental professionals on projects in the Delaware Valley region. Each student will select a project made available by a local public or private agency. Among the tasks that students will perform are data collection and analysis, project planning, and documentation. Each student will prepare a detailed report under the direction of the agency representative that can be the basis for a Capstone project. Those interested in continuing on to the Capstone phase will use the report as the basis for a publishable document to be prepared in conjunction with the participating agency.

SM 617. Innovative Environmental Management Strategies. (M) Laskowski. Offered through CGS - See current timetable.

This course will evaluate innovative environmental management strategies used by corporations, governments, the public, and NGOs including approaches such as the concept of pollution prevention, environmental management systems, green buildings, green product design, product labeling, environmental education, the power of information, market-based techniques, and industrial ecology. Some professionals believe that these innovative approaches have the potential to result in more environmental improvement than will be realized by additional regulatory requirements. This course will address which approaches work best and identify critical elements needed to ensure the best approaches to specific problems. Students will be exposed to real-life situations through expert guest lecturers, case studies, and "hands on" projects.

SM 620. (AFST620) Topics on African Environmental Issues. (B) Fonjweng.

Africa is a land of great contrasts and possesses a rich mix of scenic beauty, impressive biodiversity, cultures, economies and history. Almost completely encircled by water and home to a network of some of the world's largest and longest rivers, Africa is also home to two vast and expanding hot deserts. While Africa contains enormous amounts of mineral wealth, it also has fifteen of the world's least developed countries. Its climate ranges from the harsh extremes in hot deserts to the Arctic Current dominated temperate climate of the southern tip of Africa and the pleasant Mediterranean climate of North Africa.

Africa's remarkable ecological diversity is unique and is an expression of the varied climates in the continent, with camels in Egypt, Goliath frogs (the largest frogs in the world) in Cameroon and the African penguins in Namibia and South Africa. Africa has extensive fertile grasslands and lush equatorial forests, yet many of its people suffer from

hunger and starvation. Despite possessing some of the most scenic and pristine landscapes in the world, poor resource management has resulted in serious environmental problems in various parts of Africa, including air and water pollution, deforestation, loss of soil & soil fertility and a dramatic decline in biodiversity through out the continent.

This course aims to explore Africa's natural environment and the impact of human activities on it. Each semester the course will offer an overview of Africa's environment as it relates to one of the following two topics 1) Water issues; 2)Environmental impact of development projects, natural resource extraction and consumption. Each semester, in addition to analyzing one of the above topics, we will pick a couple of case studies from within the US that can be used to show parallels between some of the issues discussed in the African case studies. The students will be asked to conduct research on a relevant topic in any region in Africa for a paper due at the end of the semester.

621. Public Voices, Private Rights: Perspectives on American Environmentalism. (A) Minott. Offered through CGS - See current timetable.

This course will address various aspects of American environmentalism. We will look at structural issues such as the foundations of environmental protection in common law, the constitutional limits on environmental protection, and the creation of bureaucratic environmental policy making. We will also look at philosophical issues such as American Conservationism and Preservationism, the anti-environmental backlash, and environmental justice. Finally, we will discuss scientific and legal issues such as the economics of risk, the question of who can speak for Nature, and voluntary actions/command and control.

SM 623. Crossing Borders: Policy, Regulatory and Management Issues in Transboundary Environmental Protection. (B) Feldman. Offered through CGS - See Current Timetable.

Transboundary issues arise at the local, regional, supra-national, and global levels. Pollution does not respect political boundaries; habitats are defined by ecosystems, not by regulation. This course will introduce the difficulties posed by cross-border issues and, using case studies, explore a range of policy, regulatory and management mechanisms employed to address these challenges. Among the topics to be covered include: interstate compacts (e.g. Chesapeake Bay), NAFTA Commission on Environmental Cooperation (e.g. biodiversity in North America), Regional Cooperation (e.g. Baltic Sea, international watercourses), European Union regulation (e.g. Hazardous Waste directives and the Basel Convention), and international conventions (e.g. The Kyoto Protocol on greenhouse gas emissions).

625. Overview of Environmental Justice: Issues, Actions and Visions for the Future. (B) Harris and Thompson. Offered through CGS-See current Timetable.

Many people refer to the Environmental Justice Movement as the most significant social rights movement to occur in this country since the Civil Rights Movement.Communities around the United States have expressed concerns related to the siting, permitting and clean up of hazardous waste sites in minority and low-income areas. Beginning with the protests in Warren County, North Carolina, Environmental Justice has become a most critical and controversial issue in this country. This course will provide an overview of the history, guiding principles, and issues of concern regarding Environmental Justice and will examine the approaches taken by communities, EPA, state and local government over the years to address these concerns. Students will be expected to evaluate and assess the various issues and case studies presented to them in a critical fashion, discuss these case studies, and make recommendations for appropriate action.

SM 627. The Delaware River: An Environmental Case Study. (B) Laskowski and Collier. Offered through CGS - See current timetable.

The Delaware River and Estuary offer an opportunity to examine efforts to protect the environment in a multi-state, economically and ecologically complex area. This case studey will review environmental protection efforts in and around the River, the stressors on the environment, and attempts to balance environmental protection with economic, employment, and other needs. Itwill address scientific issues, relationships between air and water quality transportation and sprawl issues, the balancing of water quality and water quantity. Students will learn about the institutions responsible for managing this complex system, and what goals and indicators of progress are used by these organizations. Students will be asked to research, in detail, one or more aspects of the environmental management systems. They will identify the key drivers in determining environmental quality, recommend inprovements to the system, and propose a vision for the future.

629. Global Environmental Politics. (A) Hunold. Offered through CGS - See current timetable.

Nation-states and multinational corporations are the most powerful actors in the global political economy. What does this mean for efforts to protect the global environment? Do environmental activists stand a chance? Drawing on insights from green political theory, international relations, and political economy, the field of global environmental politics may have the answer. Following a survey of relevant state and non-state actors in global environmental politics, and a review of major international environmental agreements, we will examine diverse theories of global environmental politics. Regime theory, global governance, green critiques of globalization, green theories of state sovereignty, and social movement theory offer competing accounts of the role of state, society, and economy in

creating and managing global environmental change. Our goal will be to assess these competing explanations and strategies for promoting global ecological sustainability.

SM 631. (ENVS431) Current EPA Regulatory Practices and Future Directions. (A) Laskowski.

The regulatory approach continues to be the foundation of environmental protection in the US. This course provides an overview of key environmental laws and regulations, and the processes used to write permits, conduct inspections and take enforcement actions. It is taught mainly from the perspective of the federal government and will also include perspectives from the states, NGOs, and the regulated community. Techniques used to set priorities, ensure fairness, and encourage compliance are included. Current issues in major regulatory programs will be reviewed and future directions will be discussed.

632. Energy and the Environment in the U.S. (M) Huemmler.

This is a survey course that will examine the current U.S. energy industry, from production to consumption, and its impacts on local, regional, and the global environment. The course will seek to provide a fuller understanding of existing energy systems, ranging from technical overviews of each, to an exploration of the well-established policy framework each operates within. Near-term demands upon each energy supply system will be discussed, with particular focus on environmental constraints. Policy options facing each energy industry will be reviewed. By semester's end, successful students will have developed an intellectual framework to understand the challenges facing the U.S. energy system.

SM 633. Community Involvement in Environmental Analysis and Management. (A) Pomponio and Esher. Offered through CGS - See current timetable.

This course will investigate the various community involvement and communication tools, venues, and practices used during the analysis and management of decisions affecting the environment. Students will be exposed to real-life situations through expert guest lecturers, case studies, and hands on projects. The course will investigate communication practices for project specific issues relative to the National Environmental Policy Act (NEPA), Superfund, and other local, state, and federal vehicles. Students can expect to learn, experience, and apply communication tools to ongoing proposals for major highway, impoundment, and other infrastructure proposals as well as for environmental clean up initiatives launched under various authorities. Students will also examine and contribute to citizen advisory and stakeholder forums for major watershed and estuary programs. Specific communication challenges to achieve environmental justice and the conveyance of technical information will be explored.

SM 635. Major Global Environmental Problems of Today and how we must deal with them tomorrow. (B) Laskowski. Offered through CGS - See current timetable.

Global environmental problems of today are some of the greatest challenges of the new millennium. Almost everyone is in some way part of the problem and increasingly will be asked to be a part of the solution. The problems that we face today often differ from those of the past because it is sometimes difficult for the international community to agree on the extent, causes, and impacts of the problem and how to allocate responsibility for the resolution of the problem. Governments, businesses and NGOs around the world have recognized the need to take the initiative and address these issues through regulation, voluntary approaches, and cooperation on an international level. How best to manage these problems is the constant challenge. This course will provide an overview of several of the major global environmental problems facing the world today, and how they are connected by common causes, underlying themes and concepts critical to the understanding and management of these issues. It will examine the over-arching concepts of sustainability and globalization as well as frameworks for assessing and managing the issues.

The course will also consider the role of the major players/stakeholders in the situation, including governments, non-government organizations, and private sector individuals/participants, and where appropriate, touch on such issues as intergenerational aspects and the potential long-term irreversibility. With the assistance of regional and national experts, we will address specific problems, such as: human populations and their environmental impact; issues surrounding resources such as food, water, habitats, and energy; global climate change; the ozone layer; and problems of international/environmental terrorism, catastrophes, and disease. Each student will prepare a report and presentation on some aspect of a topic discussed during the term.

637. (ENVS437) Global Water Issues. (A) Laskowski. Offered through CGS - See current timetable.

Water- related illnesses are estimated by some to kill up to 5000 people per day worldwide and many of these casualties are children. This course will explore the causes of this global crisis and what is being done to address the issue. It will provide an overview of international agreements, wastewater and water supply issues, technological advances, political/financial/cultural and other barriers to success, and what students can do to become involved in resolving the issues. Guest lecturers and case studies will provide insights to problems in problem areas around the world. Students will be asked to evaluate specific problems and suggest improved approaches to improving access to clean water.

SM 638. Topics in Global Water Management Governance and Finance. (A) Laskowski.

This course will focus on the governance and finance issues surrounding the efforts to meet the UN Millennium Goal [MDG] for water supply and sanitation. Every twenty seconds someone in the world, usually a child, dies from a water-related problem. The MDG aims to halve the percentage of the world's population without access to safe drinking water and basic sanitation". Inadequate organization, corruption, poor educational systems are some of the critical barriers relating to good governance. Finding sufficient funding, promoting public-private partnerships, and establishing needed legal/financial systems are some of the financial challenges. Using case studies, guest speakers, and the latest information available this course will provide insights to students on how to address these issues.

641. Water in Environmental Planning. (M) Curley.

This course will present a combination of technical and non-technical material. Its purpose is to introduce the people who are not engineers or scientists to the practices that engineers and scientists use to study water and watersheds. It will present the following concepts: Hydrology, Water Treatment, and Waste Water.

SM 643. (ENVS463, URBS463, URBS663) Brownfield Remediation. (M) Keene. Offered through CGS - See current timetable.

This course is intended to give students an overview of the genesis of the so-called "Brownfield" problem and of the various efforts our society is taking to solve or, at least, ameliorate it. The course will place the "Brownfield" problem in the broader context of the growth and decline of the industrial base of cities like Philadelphia. Students will study the general constitutional and statutory framework within which we approach the problems of orphan, polluted sites and the disposal of contemporary solid wastes. They will also analyze the principal actions that have been taken by Federal and state government to address remediation and redevelopment of abandoned industrial sites. The course will also explore environmental equity issues.

The students will collaborate with high school students at the West Philadelphia High School to identify sites in their neighborhoods and to learn how to determine the sites ownership and land use history. The students will study ways of determining environmental risk and the various options that are available for remediation in light of community ideas about re-use. Students will be expected to participate actively in the seminar and the sessions with high school students. Students in the course are required to prepare and present a term paper on a topic in the general area of "Brownfield" analysis and remediation.

645. (CPLN764) Planning for Land Preservation. (B) Daniels. Offered through CGS - See current timetable.

An introduction to the tools and methods for preserving private lands by government agencies and private non-profit organizations. Topics include purchase and donation of development rights (also known as conservation easements), land acquisition, limited development, land swaps, and the preservation of urban greenways, trails, and parks. Preservation examples include: open space and scenic areas, farmland, forestland, battlefields, and natural areas.

646. A Primer on Stream and River Ecology. (M) Blain.

This class explores streams and rivers from the perspectives of both the natural and social sciences. Students will get a solid grounding in the hydrology, geology, physics, chemistry, and biology of streams and rivers, and they will learn how all these fit together in a watersheds ecosystem. They will also examine the impacts that human development has had on such ecosystems over time -- how rivers have become polluted, what mechanisms they have to fight pollution, and what we need to do to protect, maintain and restore them now and in the future.

In addition to considering such questions within a theoretical framework, the class will look at issues in the real world. Students will set up an actual monitoring system, in which they will process samples taken from above and below a sewage treatment plant in a local stream, and then analyze and interpret the sample data. They will also learn about ongoing research projects in the watersheds that supply New York City its drinking water and in the streams and rivers of developing nations. In both cases, they will not only study the science but also the politics of streams, rivers, and the water that they convey.

652. God, Gold & Green: Themes and Classics in American Environmental Thought. (C) Blaine. Offered through CGS - See current Timetable.

Through an exploration of enduring themes and classics, this course traces environmental thought in America from the first European settlements to the present. We begin by considering the preconceptions that Europeans brought to the New World and the realities they found when they arrived. We look at the issues raised by the unprecedented industrial and urban expansion of the 19th century and the accompanying westward migration that filled the continent. We examine how the conflict between economic growth and environmental limits created competing models of prosperity, equality and justice. And finally, we look at ways to transcend those divides and build a sustainable and equitable future. The primary vehicles for understanding the evolution of environmental thinking across several centuries are some of the classic texts of environmental thought - from The Book of Genesis to Henry Thoreau's Walden to Rachel Carson's Silent Spring to Al Gore's An Inconvenient Truth. The course seeks to provide a theoretical and historical framework that will help students understand current issues and address real problems.

SM 656. Environmental Sociology. (B) Sheehan.

The context in which debates take place and decisions and laws about the environment are made, leads to a focus on the community, defined here as workers and residents. Members of urban and rural communities, situated near polluting factories, hazardous sites or landfills, are affected by these contaminants. Using a sociological framework, this course will study the community and its relationship to environmental issues. Community members often first identify local hazards; they form organizations, map polluted sites, and enumerate residents with diseases that may originate from contaminanants. Sociologists identify these grassroots initiatives as community epidemiology. Social justice concepts highlight the intersection of race, poverty, and environmental hazards. Major social institutions corporations, government agencies, health care providers have played a role in covering over occupational and environmental hazards. Worker and community action has forced these institutions to take a role in identification and remediation of hazardous sites, and of continuous monitoring of neighborhoods and residents. In terms of health effects, among citizens, experts, and major institutions, and debates about both the local and global consequences of environmental hazards, will be among the topics covered.

The emergence of institutional structures at the local, state, national, and international levels, to deal with environmental protection, identification and testing of hazards, and establishing limits for exposure, will be examined. The course will include readings on significant contemporary and historical occupational and environmental events in the United States. In addition, selected, international case studies of occupational and environmental issues will be undertaken.

SM 658. Violence and the Environment. (B) Minott. Offered through CGS - See Current Timetable.

Governments, corporations, environmental organizations, anti-environmental organizations, and individuals have resorted to violence as a means to achieving an environmental end. Although some defend such violence as the only way to achieve specific goals, do the ends ever really justify the means? Does violence have a place in the environmental movement? How should environmentalists respond to pro- or anti-environmental violence? This course will study instances of such violence,and explore why violence has been seen as an acceptable or sometimes the only way to achieve a desirable end.

662. Green Design and the City. (B) Berman. Offered through CGS - See current timetable.

Can our cities become examples of sustainable design? Does inner city revitalization tie into sustainability? Are there successful examples to learn from? This seminar will focus on how existing cities attempt to integrate green design principles within them. It will look at case studies, both in the US and abroad.

Urban design and transportation will be examined within this context, including how to create pedestrian friendly spaces. Infill construction and the adaptive use of existing buildings will be discussed, as well as the reuse of brownfield sites. We will also look at what types of construction actually constitute green buildings.

We will take advantage of our local resources within Philadelphia, and include visits to nearby sites, along with talks by local experts. There will be a series of short projects given throughout the term. They will usually include both a written component and a presentation to the class. The energetic execution of these projects, their presentations and the subsequent discussions, will be a key part of this seminar.

SM 664. Sustainable Design. (C) Berman. Offered through CGS - See current timetable.

This seminar will focus on how physical design can improve sustainability. It will be broken down into 3 parts: Green Buildings, Green Urbanism, and Smart Growth Planning. Starting small, we will begin by looking at which types of construction actually constitute Green Buildings and which of these are the most effective. Our look at Green Urbanism will focus on existing cities and towns. They will be examined in terms of how urban design and transportation can promote sustainability. Finally, Smart Growth planning concepts for new developments will be discussed. This will include a survey of New Urbanism. Both these closely allied approaches are recent attempts to guide new growth in a more sensitive manner. We will also take advantage of local resources within our region, and include visits to nearby sites, along with talks by local experts.

668. Selected Topics in Environmental Health. (C) Pepino.

From the fall of the Roman Empire to Love Canal to today's epidemics of asthma and childhood obesity, the impact of the environment on health has been a continuous challenge to society. This course will examine how environmental factors have contributed to chronic disorders and diseases. Selected topics will include cancer clusters, COPD, radon and lung cancer, lead poisoning, environmental tobacco smoke and the aforementioned obesity and asthma,epidemics.students will be contrasting priority environmental health issues internationally with those in their local communities. Class discussions will also focus on risk communication, community outreach and education, access to health care and vulnerable populations. Students will be asked to research one environmental health topic in detail, to present their findings to the class, and to propose recommendations for future action.

674. Assessment and Remediation of the Environment Using Biological Organisms. (M) Vann.

This course is an introduction to current and emerging techniques for analyzing environmental contamination and remediation of damaged environments. Knowledge of these options will be important for both students interested in policy/law options, as well as providing a starting point for those pursuing a more science-oriented understanding of environmental issues. The first portion of the course will address bioindicators--the use of living systems to assess environmental contamination. Many new methods of rapidly-analyzing environmental samples are becoming available. These include systems ranging from biochemical assays to monitoring of whole orgainsms or ecosystems, as well as techniques ranging from laboratory to field and satellite surveys. The course will survey these approaches to familiarize the student with this rapidly developing field. The second portion of the course will introduce techniques for bioremediation--the use of living organisms to restore contaminated environments. Several case studies will be provided (perhaps with external speakers). Students will be expected to prepare a final paper examining a particular technique in detail.

678. Advanced Biogeochemistry. (B) Vann. A soils course would be helpful, but not required.

The course will cover nature of the field of biogeo chemistry and its application. Topics include, elemental cycling at various scales,from global to watershed level,the interaction between geology and biology in controlling how these relationships have changed over the Earth's history and man's influence on these cycles.

The course will include an examination of the CENTURY computer model, a popular model for examining nutrient cycling in terrestrial ecosystems. Students will submit a term paper on a related subject, such as comparing the functioning of two watersheds or summarizing current understanding of a particular cycle, etc.

680. Advanced Environmental Chemistry. (M) Nemeroff. Offered through CGS - See current timetable.

This course will examine the environmental contamination of water, air, and soil. Students will continue the evaluation of composition, structure and properties of pollutants, their means of detection and methods of purification and remediation. Successful completion of Envs 502 or a thorough knowledge of general and organic chemistry is recommended.

681. Modeling Geographical Space. (M) Tomlin. Offered through CGS - See current timetable.

This course explores the nature and use of digital geographic information systems (GIS) for the analysis and synthesis of spatial patterns and processes through 'cartographic modeling'. Cartographic modeling is a general but well defined methodology that can be used to address a wide variety of analytical mapping applications in a clear and consistent manner. It does so by decomposing both data and data-processing tasks into elemental components that can then be recomposed with relative ease and with great flexibility.

SM 699. (GEOL699) Masters of Environmental Studies Capstone Seminar. (C) Riebling. Permission of instructor required. Offered through CGS - See current timetable.

999. Independent Study. (C) Staff. Permission of instructor required.

Directed study for individuals or small groups under supervision of a faculty member.

GEOLOGY (GEOL)

L/R 003. (PHYS003) Evolution of the Physical World. (A) Physical World Sector. All classes. Pfefferkorn/Segre.

The big bang, origin of elements, stars, Earth, continents and mountains.

SM 096. Field Approaches to Understanding the Earth & Environmental Science. (A) Scatena. Corequisite(s): GEOL 100 or GEOL 109 highly recommended. This is a field based course. Weekend fieldtrips are required.

Understanding landscapes and the relationships between the natural world and society is fundamental to the natural sciences, architecture, medicine and public health, real estate and finance, urban studies and a range of other disciplines. The primary goal of this course is to expose students to the science of reading landscapes and disciplines that are founded in observation and hypothesis testing in the field. In addition, the course will orient incoming students to the physical environment in which they will be living while they are at Penn.

The course will be centered around lectures and discussions that are based on ten or more field trips that will take place on weekends and afternoons throughout the semester. The trips will be led by faculty members and will cover topics of plate tectonics, bedrock and surficial geology, geomorphology, hydrology, environmental geology, pollution and field ecology.

L/R 100. Introduction to Geology. (A) Physical World Sector. All classes. Omar. Field trips required.

An introduction to processes and forces that form the surface and the interior of the Earth. Topics include, changes in climate, the history of life, as well as earth resources and their uses.

103. Natural Disturbances and Human Disasters. (B) Natural Science & Mathematics Sector. Class of 2010 and beyond. Scatena. Also fulfills General Requirement in Physical World for Class of 2009 and prior.

Natural disturbances play a fundamental role in sculpturing landscapes and structuring natural and human-based ecosystems. This course explores the natural and social science of disturbances by analyzing their geologic causes, their ecological and social consequences, and the role of human behavior in disaster reduction and mitigation. Volcanoes, earthquakes, floods, droughts, fires, and extraterrestrial impacts are analyzed and compared.

L/L 109. Introduction to Geotechnical Science. (A) Physical World Sector. All classes. Omar.

Open to architectural and engineering majors as well as Ben Franklin Scholars. Field trips. Relations of rocks, rock structures, soils, ground water, and geologic agents to architectural, engineering, and land-use problems.

111. Geology Laboratory. (C) Omar. Prerequisite(s): GEOL 001 or 100, preferably taken concurrently. Field trips required.

Hands-on study of earth materials and processes. Identification and interpretation of rocks, minerals and fossils. Topographic and geologic maps. Evolution of landscapes. Field trips lead to a synthesis of the geologic history of southeastern Pennsylvania.

L/R 125. Earth and Life Through Time. (C) Physical World Sector. All classes. Pfefferkorn.

Origin of Earth, continents, and life. Continental movements, changing climates, and evolving life.

L/R 130. Oceanography. (B) Natural Science & Mathematics Sector. Class of 2010 and beyond. Horton. Also fulfills General Requirement in Physical World for Class of 2009 and prior.

The oceans cover over 2/3 of the Earth's surface. This course introduces basic oceanographic concepts such as plate tectonics, marine sediments, physical and chemical properties of seawater, ocean circulation, air-sea interactions, waves, tides, nutrient cycles in the ocean, biology of the oceans, and environmental issues related to the marine environment.

L/L 201. (GEOL521, GEOL531) Mineralogy. (A) Omar. Prerequisite(s): GEOL 100 and CHEM 001 or 101.

Crystallography, representative minerals, their chemical and physical properties. Use of petrographic microscope in identifying common rock-forming minerals in thin section.

L/L 205. (GEOL406) Paleontology. (B) Living World Sector. All classes. Bordeaux. Prerequisite(s): GEOL 100 or permission of instructor. Two field trips required.

Geologic history of invertebrates and their inferred life habits, paleoecology, and evolution. Introduction to paleobotany and vertebrate paleontology.

L/L 206. (GEOL506) Stratigraphy. (A) Horton. Prerequisite(s): GEOL 100 or permission of instructor. Two field trips, field project.

Introductory sedimentary concepts, stratigraphic principles, depositional environments, and interpretation of the rock record in a paleoecological setting.

L/L 208. (GEOL630) Structural Geology. (B) Phipps. Prerequisite(s): GEOL 100 and 111; PHYS 150 strongly recommended. Three field trips required.

Introduction to deformation as a fundamental geologic process. Stress and strain; rock mechanics. Definition, measurement, geometrical and statistical analysis, and interpretation of structural features. Structural problems in the field. Maps, cross-sections, and three-dimensional visualization; regional structural geology.

299. Independent Study. (C) Staff. Prerequisite(s): Permission of department. May be repeated for credit.

Directed study for individuals or small groups under close supervision of a faculty member.

305. (GEOL545) Earth Surface Processes. (B) Physical World Sector. All classes. Jerolmack. Prerequisite(s): ENVS 200, GEOL 100, or permission of the instructor. This course includes two required weekend field trips, and a hands-on laboratory.

Patterns on the Earth's surface arise due to the transport of sediment by water and wind, with energy that is supplied by climate and tectonic deformation of the solid Earth. This course presents a treatment of the processes of erosion and deposition that shape landscapes. Emphasis will be placed on using simple physical principles as a tool for (a)

understanding landscape patterns including drainage networks, river channels and deltas, desert dunes, and submarine channels, (b) reconstructing past environmental conditions using the sedimentary record, and (c) the management of rivers and landscapes under present and future climate scenarios. The course will conclude with a critical assessment of landscape evolution on other planets, including Mars.

L/L 317. Petrology and Petrography. (B) Omar. Prerequisite(s): GEOL 201. Two field trips.

Occurrences and origins of igneous and metamorphic rocks; phase equilibria in heterogeneous systems. Laboratory study of rocks and thin sections as a tool in interpretation of petrogenesis.

SM 390. Geology Field Work. (C) Giegengack. 4-8 weeks, usually during the summer.

401. Environmental Geology. (M) Willig.

The purpose of this course is to better understand the interactions of humans and the environment through an examination of geologic processes and features as they influence, and are influenced, by human activities. the ultimate goal of such study is to make better land use decisions. Following a review of some basic geologic concepts, we will study hazardous geologic processes including; volcanic eruptions, earthquakes, river floding, coastal flooding and erosion, landslides, and subsidence. Next, we will discuss environmental impacts associated with the use of fossil fuels, water, and soils. The course will conclude with student presentations of selected topics in environmental geology.

SM 405. Paleoecology. (M) Bordeaux. Prerequisite(s): GEOL 205 or permission of instructor.

Relationship of fossil assemblages to life assemblages; structure of ancient communities, and interaction of organisms with each other and with the physical environment; evolution of communities.

L/L 415. Paleobotany. (M) Pfefferkorn. Prerequisite(s): Basic course in Geology or Biology or permission of instructor. Two field trips.

Fossil record and evolution of plants. Methods and application of paleobotanical research.

L/L 417. Advanced Petrology. (A) Omar. Prerequisite(s): GEOL 317.

Chemistry, physics, phase equilibria, microscope study in igneous and metamorphic petrology.

418. Geochemistry. (M) Omar. Prerequisite(s): GEOL 201. May be taken concurrently.

This course provides a comprehensive introduction to theory and applications of chemistry in the earth and environmental sciences. Theory covered will include nucleosynthesis, atomic structure, acid-base equilibrium, thermodynamics, oxidation-reduction reactions. Applications will emphasize oceanography, atmospheric sciences and environmental chemistry, as well as other topics depending on the interests of the class. Although we will review the basics, this course is intended to supplement, rather than to replace, courses offered in the department of Chemistry. It is appropriate for advanced undergraduate as well as graduate students in Geology, Environmental Science, Chemistry and other sciences, who wish to have a better understanding of these important chemical processes

420. Introduction to Geophysics. (M) Doheny. Prerequisite(s): GEOL 100 or 109, two semesters Math and Physics, and/or instructor's permission.

This course will cover the application of geophysical investigation techniques to problems of the earth's plantary structure, local subsurface structure and mineral prospecting. The topics will include principles of geophysical measurements and interpretation with emphasis on gravity measurement, isostasy, geomagnitism, sesmic refraction and reflection,electrical prospecting, electromagnetics and groung radar.

L/L 421. Elemental Cycling in Global Systems. (B) Plante. Prerequisite(s): ENVS 200, GEOL 100, or permission of the instructor.

Humans have an enormous impact on the global movement of chemical materials. Biogeochemistry has grown to be the principal scientific discipline to examine the flow of elements through the global earth systems and to examine human impacts on the global environment. This course will introduce and investigate processes and factor controlling the biogeochemical cycles of elements with and between the hydrosphere, lithosphere, atmosphere and biosphere. Students will apply principles learned in lectures by building simple computer-based biogeochemical models.

428. Introduction to Isotope Geochemistry. (A) Omar.

This course is for advanced undergraduate students interested in learning about or pursuing applications of isotope geochemistry, with an emphasis on biological and climatic processes (e.g. plant physiology, soils, nutrient cycling, and atmospheric chemistry).

477. Introduction to Vertebrate Paleontology. (M) Dodson. Prerequisite(s): GEOL 100 and 205 or by permission of Instructor.

SM 480. Senior Seminar. (M) Giegengack.

Discussion of major current issues in geology.

499. Senior Thesis. (F) Giegengack.

Students write a thesis on a geologic topic. Students work with an advisor in their discipline.

501. Pleistocene Geology. (M) Giegengack. Prerequisite(s): GEOL 100 or equivalent.

Origin, extent in space and time, and effect on geologic processes of Late Cenozoic climatic change; Pleistocene stratigraphy in different parts of the world.

L/L 502. Data Analysis and Computer Modeling in Geology. (M) Phipps. Prerequisite(s): GEOL 100 or 109 and the instructor's permission.

Data analysis from simple parametric statistics to multivariate statistics, including cluster and factor analysis. Additional topics include: Bootstrapping, Markov chains, runs tests, spectral analysis, and other general techniques to analyze data sequences and time-series. Map studies include: analysis of distributions of points and lines, directional data, spherical distributions, shape and trends surfaces.

503. Earth Systems and Earth Hazards. (B) Phipps. Prerequisite(s): Geology 100 (introductory physical geology,) or permission of the instructor. The course is intended for Masters' students in Environmental Studies and Applied Geology, as well as upperclass geology majors.

This course will examine the hazards that arise from living on an active planet from a large-scale systems standpoint. We will briefly survey the Earth's major systems, emphasizing energy generation, storage, and flow within the Earth, and then proceed to an examination of the hazards that result. This will include earthquakes and tsunamis, volcanic eruptions, river and coastal flooding, and hurricanes, tornadoes, and other major storms. We will touch briefly on global warming and other current topics.

511. Geology of Soils. (A) Johnson. Prerequisite(s): GEOL 100 or equivalent. Field trips.

Nature, properties, genesis, and classification of soils; soils of the United States.

515. Evolution/Revolution of Land Ecosystems. (M) Dimichele/Wing. Permission of instructor needed.

Origin and diversification of land ecosystems. Interaction between plants and animals. Effects of past climatic change and other external factors. The importance of past changes in land ecosystems to our understanding of current global change.

517. Igneous and Metamorphic Petrology. (M) Omar.

L/L 521. (GEOL201, GEOL531) Mineralogy of Rock Preservation. (A) Omar. Graduate School of Fine Arts students only.

Advanced crystallography, representative minerals, their chemical and physical properties, with emphasis on building stone preservation. Use of petrographic microscope in identifying common rock-forming minerals in thin section.

525. Plant Paleoecology. (M) Pfefferkorn.

Deciphering the ecology of fossil plants, ecosystems, and landscapes through quantitative and qualitative methods.

528. Aqueous Geochemistry. (M) Johnson. Prerequisite(s): GEOL 100 and 511 and permission of instructor.

Chemical composition and interactions of soils and soil water with applications to current problems.

530. Hydrogeology. (B) Mastropaolo.

Flow of water (and associated contaminants) in natural porous media.

L/L 531. (GEOL201, GEOL521) Advanced Mineralogy. (A) Omar.

Advanced crystallography, representative minerals, their chemical and physical properties. Use of petrographic microscope in identifying common rock-forming minerals in thin section.

540. Geotectonics. (M) Phipps. Prerequisite(s): GEOL 205, 206, 208, 317 and 420, or permission of instructor. Field trip.

Bulk structure of the Earth. Plate tectonics and plate boundaries. Plumes, rifting, and intraplate tectonics. Geotectonics and seismicity.

SM 546. Basin Analysis. (M) Phipps/Scatena. Undergrads need permission of instructor.

An in-depth study of selected depositional basins using petrologic, stratigraphic, sedimentologic, and seismic techniques. Aspects of the depositional processes and basin architecture will be considered in light of the tectonic regime associated with basin formation.

SM 555. Problems in the Early Evolution of Vertebrates. (M) Staff. Prerequisite(s): GEOL 100, GEOL 205. Short paper based on fossil vertebrate materials.

An analysis of key problems in the paleontology and evolutionary biology of early vertebrates, including: origins of chordates, origins of bone and other hard tissues, organization of the vertebrate head, origins of the major vertebrate classes, environmental contexts of key vertebrate transitions, diversifications of Paleozoic fishes, origin and diversifications of tetrapods, extinctions.

599. Independent Study. (C) Staff.

Directed study for individuals or small groups under supervision of a faculty member.

602. Geotechnics: Introduction to Geotechnical Engineering. (B) Doheny. Prerequisite(s): Permission of Instructor.

The course begins with a study of the Earth's composition, the formation of soil materials by the weathering process (Physical and Chemical), and a discussion of soil mineralogy, with particular emphasis on the clay minerals. Following this introduction, soil classification systems and physical properties of soils will be presented, as well as the State of Stress in a Soil Mass together with Seepage Theory and Groundwater Flow. The technical portion of the course will conclude with the development of Consolidation Theory and Analyses, Shear Strength Theory, Lateral Earth Pressure Theory and Application, and Slope Stability Analysis.

The course will conclude with the presentation of two Case History Sessions, presenting applications of Geotechnical Engineereing Practice and the influence of the Geologic setting.

604. Geostatistical Analysis. (A) Vann. Prerequisite(s): Bio 446 or equivalent statistics course; Bio 556 suggested or other Inferential Statistics courses, covering uni- and multi-variate techniques.

Univariate and multivariate approaches to the analysis of spatial correlation and variability. Many disciplines, including geology, ecology and the environmental sciences regularly need to analyze and make predictions from data that is spatially autocorrelated. Mine reserve estimation, pollutant dispersal and the use of randomization tests in ecology are examples of where spatial statistics may be applied.

SM 606. Topics in Sedimentary Petrology and Stratigraphy. (M) Pfefferkorn. Prerequisite(s): GEOL 205, 206, 706 or permission of instructor.

Analysis of selected paleoenvironmental, stratigraphic, and sedimentological problems in the field and laboratory.

ADVANCED STRATIGRAPHY: In-depth study of sedimentology, stratigraphic principles, and paleoecological interpretation based on the rock record.

SEDIMENTARY PETROLOGY: Interpretation of rocks using microscopic techniques. Students will make thin-sections of various sedimentary rock types collected from regional depositional basins (Geol 706). Diagenetic, syn- and post-depositional processes will be investigated.

SM 611. Field Study of Soils. (B) Johnson. Prerequisite(s): GEOL 511 or permission of instructor. All day field trips.

Processes of soil development in a variety of temperate environments. Effects of lithology and climate on soil properties.

613. (LARP513) Hydrology. (M) Johnson.

Emphasis on basic concepts and principles of hydrology. Framework will be the concept of the continuous natural movement of water in the hydrological cycle.

SM 615. Advanced Vertebrate Paleontology Seminar. (C) Dodson. May be repeated for credit.

Topics in vertebrate paleontology and paleoecology.

616. Geology of the Carboniferous Period. (M) Pfefferkorn.

Paleogeography, biogeography, stratigraphy, paleoclimatology, flora, and fauna of the Carboniferous Period.

SM 617. Topics in Sedimentology. (M) Prerequisite(s): GEOL 206 or permission of instructor.

CLIMATE CHANGES THRU TIME: Issues of anthropologenically-induced climate changes are hotly debated. However, it is not possible to make meaningful predictions of future climates without understanding the forces that have controlled past climates. This course will review the geologic evidence for past climate changes and discuss processes that affect global climate changes. It will involve analysis and modeling of various sedimentary environments, systems, and processes.

ANCIENT TERRESTRIAL ENVIRONMENTS: Multi-disciplinary approaches and techniques that enable the extraction of comprehensive information (weathering, deposition, diagenisis, tectonics) from ancient continental deposits. The goal is the reconstruction of integrated environmental, geographic, and climatic conditions for selected time slices.

SM 618. Geochemistry Seminar. (C) Staff.

Topics in geochemistry.

SM 620. Geophysics Seminar. (M) Staff.

Topics in solid Earth geophysics.

SM 625. Advanced Paleobotany Seminar. (M) Pfefferkorn. May be repeated for credit.

Topics in paleobotany, paleoecology and evolution.

SM 628. Seminar in Isotope Geochemistry. (M) Staff. Prerequisite(s): Intermediate background in chemistry, physics, biology, or geology.

This course is for advanced undergraduates and graduate students interested in learning about or pursuing applications of isotope geochemistry, with an emphasis on biological and climatic processes (e.g. plant physiology, soils, nutrient cycling, and atmospheric chemistry).We will meet to discuss readings both from the literature and textbook chapters where necessary for backround. Grading will be on the basis of class participation and short weekly writing assignments. The latter will be completed prior to the class by both students and professor to ensure thorough discussion of each topic.

SM 630. (GEOL208) Advanced Structural Geology Seminar. (M) Phipps. May be repeated for credit. Four-day field trip.

Topics in tectonophysics and/or regional structural geology.

636. Quantitative Paleoclimatology. (M) Staff.

This course provides a comprehensive, rigorous survey of our knowledge of the Earth's climate system from ancient to modern.Topics to be covered will include geological evidence for past climate changes, with an emphasis on quantitative methods using geochemistry and geophysics; the basis of earth system modeling; statistical climatology; climate change detection; time-series analysis in climatology.

SM 637. Recent Climate Change. (A) Staff.

Increases in "greenhouse gases" produced through human activity appear to be affecting the Earth's climate. This course will examine climate change over the last 500 years. We will examine the available instrumental records over this time period as well as proxy climate records such as ice core, tree ring, sediment cores, coral cores and others. Students will research individual topics and present them regularly, review published articles, and attend some seminars.

SM 639. Isotopes in Paleoclimatology. (A) Staff .

Isotope records in tree rings, ice cores, corals, and sediments can be used to reconstruct past climate variables such as temperature, salinity, atmospheric CO2, El Nino events, cloud cover and precipitation. This course focuses on isotope techniques and applications in paleoclimatology. Special emphasis will be placed on stable carbon, stable oxygen and radiocarbon. This course is suitable for upper level undergraduates and graduate students.

SM 640. Digital Mapping. (M) Scatena.

Global positioning systems (GPS) and geographic information systems (GIS) have greatly changed the way cartographic data is collected and analyzed. This course will discuss design strategies for mapping projects involving GPS, differential GPS, and GIS, and provide a hands-on introduction to the use of these technologies. The principal emphasis of the course will be on learning to choose appropriate and efficient data acquisition techniques and to

develop data collection protocols suited to the aims of any given project. Though the mechanics of importing digital data into GIS will be discussed, and the analytical capabilities of GIS will be an important factor in project design, actual data analysis through GIS will not be taught.

SM 646. First Billion Years: The Early History of Earth and Life. (A) Phipps.

The course will cover the origin of the Earth. Topics will range constituent atoms to planetesimals; the formation of the Earth including its accretion and differentiation; the early bombardment history of the earth and the formation of the Moon; the cooling of the Earth and the origins of continents and oceans. additionally variour theries for origin of life will be covered including the Archean world, tectonics, the evolution of the atmosphere and oceans, and early life.

651. (GEOL451) Geocomputations I. (M) Mastropaola. Offered through CGS - See current timetable.

Review and applications of selected methods from differential equations, advanced engineering mathematics and geostatistics to problems encountered in geology, engineering geology, geophysics and hydrology.

652. Physical Geology for Environmental Professionals. (A) Doheny. Offered through CGS - See current timetable.

Study of the genesis and properties of earth materials (minerals,rocks,soil, water); consideration of volcanic,erosional, glacial, and earthquake processes along with the characterization of the earth's deep interior crustal and near-surface structure.Classroom study of minerals, crystals, fossils, and rocks as time permits.

653. (GEOL453) Introduction to Hydrology. (A) Conaboy. Offered through CGS - See current timetable.

Introcudction to the basic principles of the hydrologic cycle and water budgets, precipitation and infiltration, evaporation and transpiration, stream flow, hydrograph analysis (floods), subsurface and groundwater flow, well hydraulics, water quality, and frequency analysis.

SM 654. Geomechanics. (A) Duda. Offered through CGS - See current timetable.

Mechanical properties of solid and fluid earth materials, stress and strain, earth pressures in soil and rock, tunnels, piles, and piers; flow through gates, wiers, spillways and culverts, hydraulics, seepage and Darcy's law as applied to the hydrologic sciences.

655. Engineering Geology I. (B) Calabria. Offered through CGS - See current timetable.

Engineering properties of earth materials; engineering testing, classification and use of earth materials; geologic and geophysical investigations and monitoring; geologic hazards; planning and use of the geologic environment.

656. Fate and Transport of Pollutants. (A) Ruga.

This course covers basic groundwater flow and solute transport modeling in one-,two- and three-dimensions. After first reviewing the principles of modeling, the student will gain hands-on experience by conducting simulations on the computer. The modeling programs used in the course are MODFLOW (USGS), MT3D, and the US Army Corps of Engineers GMS (Groundwater Modeling System).

657. Field Geophysics. (B) Doheny. Prerequisite(s): GEOL 420: Introduction to Geophysics.

Use of geophysics field equipment (gravity, magnetic, seismic, electrical,electromagnetic, and radar) to collect geologic site investigation data. Theoretical analysis of collected geophysical and geological data to interpret subsurface conditions.

SM 658. (GEOL458) Geostatistics. (C) Mastropaolo.

Statistical analysis of data from geological, geotechnical, and geohydrologic sources.

659. Surface Water Hydrology. (B) Conaboy.

This course will focus on various aspects of surface water hydrology. Topics covered include: study of all aspects of precipitation and runoff; study of the natural occurrences of floods and droughts; the establishment of design floods; methods of preventing or alleviating damages due to floods; water losses through evaporation, transpiration, and infiltration; storm water management; and hydrologic considerations in environmental issues.

661. Environmental Groundwater Hydrology. (B) Mastropaola.

This course is designed to introduce the major definitions and concepts regarding groundwater flow and contaminant transport. The theory underlying concepts, including mathematical derivations of governing equations used to model groundwater flow and contaminant transport, will be discussed and applications to environmental problems addressed.

663. Groundwater Modeling. (B) Doheny / Freed. Offered through CGS - See current timetable.

665. Engineering Geology & Geotechnics. (A) Hunt. Engineering Geology I is NOT a prerequiste for this course.

Based on numerous case histories, the theme of this course is characterization of the geologic environment for engineering and environmental investigations. Covered are the various exploration tools and methods, including interpretation of remotely sensed imagery; field and laboratory measurments of material properties; and instrumentation monitoring. Rock masses and the significance of discontinuities are discussed as are soil formations in terms of occurrence and mode of deposition, and their typical physical properties. The latter half of the course is dedicated to the geologic hazards; i.e. ground subsidence and collapse, landslides and earthquakes, with emphasis on prediction, prevention and damage control.

666. Geology Field Work. (C) Giegengack. 4-8 weeks during the summer.

SM 677. Seminar in Environmental Geology. (M) Giegengack.

706. Topics in Regional Geology. (M) Phipps. Prerequisite(s): GEOL 208 &/or 206, preferably both; GEOL 390. Field Trips required.

Topics in sedimentology, stratigraphy, petrology, and/or structural geology of selected regions. Regional geologic synthesis and tectonics.

FORELAND BASINS: Structure, sedimentology, and biology/paleobiology of forelandbasins, based on the study of modern and ancient examples. These will include the modern Persian Gulf region, and the ancient Carboniferous Appalachian basin. There will be at least one field trip.

DEPOSITIONAL BASINS: Investigation and interpretation of a number of different tectonically-controlled basins throughout the region. Field work essential. All-day and weekend field trips required. Students will integrate stratigraphic, sedimentological, structural, and tectonic principles within various basinal settings.

SM 715. Paleobiology Seminar. (M) Staff.

SM 777. Seminar in Quaternary Environments. (M) Giegengack.

Interdisciplinary approach to selected environmental problems of the Pleistocene.

999. Independent Study and Research. (C) Staff. Prerequisite(s): Permission of departmental committee. Hours and credits to be arranged.

Directed study for individuals or small groups under supervision of a faculty member.