

## Allowed courses for QP (as of Fall 2011).

### Anthropology

ANTH 4077 - **Neanderthals: Biology and Culture of Humanity's Nearest Relative** (3.0 cr; Prereq-1001 or 3001 or 3002 or #; fall, alternate spring)

Paleontological/archaeological record. Students reconstruct behavioral similarities/differences between Neanderthals and modern humans. Why humans alone survived end of Pleistocene.

ANTH 4329 / EEB 4329 - **Primate Ecology and Social Behavior** (3.0 cr; Prereq-BIOL 1009 or BIOL 2002 or BIOL 3411 or ANTH 1001 or #; A-F or Aud, every fall)

Primates as model system to explore animal/human behavior. Factors influencing sociality/group composition. Mating systems. Prevalence of altruistic, cooperative, and aggressive behavior. Strength of social bonds in different species. Evolution of intelligence/culture.

ANTH 5009 - **Human Behavioral Biology** (3.0 cr; A-F or Aud, spring, every year)

In-depth introduction to, and critical review of, human behavioral biology, examining the approaches in anthropology and related fields. Classic texts/recent empirical studies of humans and other species.

Theoretical underpinnings of this new discipline/how well theoretical predictions have been supported by subsequent research.

ANTH 5015W - **Biology, Evolution, and Cultural Development of Language** (3.0 cr; =[ANTH 3015W]; spring, every year)

Language in pre-historic humans. Brain/vocal tract structure. How gossip/music shaped human communication.

ANTH 5041 - **Ecological Anthropology (C/PE, ENVT)**

(3.0 cr; =[ANTH 3041, ANTH 8213]; Prereq-grad or #)

Concepts, theories, and methods of ecological anthropology (cultural ecology) show how humans interact with the biophysical environment. Compare biological and cultural interactions with the environment; examine adaptive strategies cross-culturally.

ANTH 5402 – **Zooarchaeology laboratory**

(4.0 cr; =[ANTH 8244]; Prereq-1001; A-F or Aud, fall, every year)

How anthropologists use fossil bones to answer questions of past human diet, behavior, and environments. Basics of skeletal-element/species identification of humans and large mammals. Project where students analyze a small assemblage of bones. Emphasizes scientific method, data analysis using computers.

ANTH 5269 - **Analysis of Stone Tool Technology**

(4.0 cr; Prereq-1001 or 3001 or #; A-F or Aud)

Practical lab experience. How to analyze archaeological collections of stone tools to learn about human technological behavior in past. Students analyze archaeological/experimental collections, make stone tools themselves.

ANTH 5401 - **The Human Fossil Record**

(3.0 cr; =[ANTH 3401]; Prereq-1001 or #; A-F only, fall)

Fossil evidence paleoanthropologists use to reconstruct human evolutionary history. Taxonomy, phylogeny, behavior, ecology, tool use, land use, and biogeography. Examination of fossil casts, readings from primary/secondary professional sources.

### **ANTH 5403 - Quantitative Methods in Biological Anthropology**

(3.0 cr; Prereq-Basic univariate statistics course or #; A-F only, spring, even years)

Quantitative methods used by biological anthropologists. Applying these methods to real anthropometric data. Lectures, complementary sessions in computer lab.

### **ANTH 5405 - Human Skeletal Analysis**

(3.0 cr; =[ANTH 3405]; Prereq-1001 or #; A-F only, spring, every year)

Structure, design, and variability of modern human skeleton. Anatomy, functional morphology, development, evolutionary history. Bone histology/biology, excavation, preservation, taphonomy, pathology, forensic analyses. Differentiating between males/females, adults/sub-adults, and humans/non-humans. Quizzes, exams, research paper, project.

### **ANTH 5442 - Archaeology of the British Isles**

(3.0 cr; A-F only, fall, every year)

Material evidence of prehistoric/historical past. Archaeological study of recent and modern times in Britain. Approaches/interpretations of materials. Issues of preservation/presentation.

## **Civil Engineering**

**CE 4341. Engineering Geostatistics.** (3 cr; A-F or Aud. §GEOE 4341. Prereq-CE, GeoE or upper div Geo or grad, Stat 3021 or #) Problem solving and decision making in civil and geological engineering using applied statistics. Emphasizes spatially correlated data, e.g., geologic site characterization, spatial sampling design.

**CE 5541. Environmental Water Chemistry.** (3 cr [max 4 cr]; A-F or Aud. Prereq-3501, Chem 1021, Chem 1022) Introduction to water chemistry. Physical chemical principles, geochemical processes controlling chemical composition of waters, behavior of contaminants that affect the suitability of water for beneficial uses.

**CE 5551. Environmental Microbiology Laboratory.** (4 cr; A-F or Aud. Prereq-3501, [upper div or grad] student) Role of microorganisms in environmental bioremediation, pollution control, water/wastewater treatment, biogeochemistry, and human health. Basic microbiological techniques: isolation, identification/enumeration of bacteria, BOD, biodegradation kinetics, disinfection. Lecture, lab.

**CE 5581. Water Resources: Individuals and Institutions.** (3 cr; A-F or Aud) Control of water resources by natural system functions, user actions, and influence of social, economic, and political institutions. Water resource policy in the United States. Case studies (e.g., flood/drought management).

**CE 8508. Ecofluid Dynamics.** (4 cr; A-F or Aud. Prereq-3502 or equiv) Theoretical principles underlying environmental fluid dynamics of biochemical processes in lakes, rivers, wetlands, coastal ocean. Emphasizes small-scale fluid motion, dominant flux path, growth kinetics, thin layers, microstructure measurements.

**CE 8511. Mechanics of Sediment Transport.** (3 cr; A-F or Aud. Prereq-3502 and 4501 or #) Particle motion in fluids. Criteria for incipient motion. Formulations for bedload and suspended load. Bedform mechanics and hydraulic resistance relations. Channel stability, aggradation and degradation, alluvial stream morphology.

**CE 8551. Environmental Microbiology: Molecular Theory and Methods.** (4 cr; A-F or Aud) Introduction to microbial genetics and molecular phylogeny. Application of nucleic-acid techniques in environmental microbiology and microbial ecology.

CE 8552. **Groundwater Microbiology: Laboratory.** (4 cr; A-F or Aud. Prereq—grad CE major or #, exposure to basic environ engr and microbiol) Subsurface microbial ecology, biogeochemical cycling, metabolic classification of subsurface bacteria, modeling bacterial transport, diagnosis of microbial induced fouling (MIF) events, bioremediation of contaminated aquifers. Lectures and four lab hours per week.

CE 8553. **Biofilms.** (3 cr; A-F or Aud. Prereq—4551 or #) Science/engineering concepts to investigate formation/function of biofilms. Properties/composition of biofilms, transport/transformation processes in biofilms, communication in biofilms, mathematical modeling. Applications in environmental engineering.

CE 8561. **Analysis and Modeling of Aquatic Environments I.** (3 cr; A-F or Aud. Prereq—One sem grad work or #) Introduction to hydrologic transport and water quality simulation in natural water systems. Deterministic, process-oriented water quality model development. Mixed cell models, advection, turbulent diffusion/ dispersion. Chemical/biological kinetics in water quality models. Application of water quality models to management problems.

CE 8562. **Analysis and Modeling of Aquatic Environments II.** (3 cr [max 6 cr]; Prereq—One sem grad work or #) Models for transport/transformation of pollutants, nutrients, particulates, ecosystems, etc., from recently completed theses, articles, or research in progress. Students review assigned recent papers, make presentations, and analyze a topic of their choice.

CE 8581. **Research and Professional Ethics in Water Resources and Environmental Science.** (.5 cr; S-N or Aud. §WRS 8581. Prereq—[Environmental engineering or water resource science] grad student or #) Ethics of water resources science and environmental engineering research/practice. Societal responsibility, plagiarism, recording-keeping, authorship, confidentiality, conflicts of interest, professional relationships, fraud, reporting misconduct. Meets during first eight weeks of spring semester.

CE 8601. **Introduction to Stream Restoration.** (3 cr; A-F or Aud) Background material required to participate in a stream restoration project. How to assimilate geologic, hydrologic, and ecological data at watershed and reach scales to plan a restoration project and evaluate/ critique existing stream restoration projects.

CE 8602. **Stream Restoration Practice.** (2 cr; S-N only. §EEB 8602, GEO 8602. Prereq—8601 or Geo 8601) Field experience, group design project. Students provide a stream restoration context for each other s elective coursework, complete critical assessments of stream restoration projects, and design a stream restoration site.

## Earth Sciences

ESCI 4102W. **Vertebrate Paleontology: Evolutionary History and Fossil Records of Vertebrates.** (4 cr; A-F or Aud. Prereq—1001 or 1002 or Biol 1001 or Biol 1002 or Biol 1009 or #) Vertebrate evolution (exclusive of mammals) in phylogenetic, temporal, functional, and paleoecological contexts. Vertebrate anatomy. Methods in reconstructing phylogenetic relationships and origin/history of major vertebrate groups, from Cambrian Explosion to modern diversity of vertebrate animals.

ESCI 4103W. **Fossil Record of Mammals.** (3 cr; A-F or Aud) Evolutionary history of mammals and their extinct relatives. Methods in reconstructing phylogeny. Place of mammals in evolutionary history of vertebrate animals. Major morphological/ecological transitions. Origins of modern groups of mammals. Continuing controversies in studying fossil mammals.

ESCI 4401. **Aqueous Environmental Geochemistry.** (3 cr; Stdnt Opt. Prereq—Chem 3501 or #) General principles of solution chemistry applied to geology. Solution-mineral equilibria. Redox processes in natural waters. Geochemistry of hydrothermal fluids. Environmental geochemistry.

ESCI 4402. **Biogeochemical Cycles in the Ocean.** (3 cr; Stdnt Opt. Prereq—[Chem 3501, 1 yr of calculus] or #) Introduction to marine biogeochemistry and chemical oceanography. Processes controlling chemical composition of oceans past/present. Cycles of major/minor constituents, including carbon, nitrogen, phosphorus, silicon, and oxygen and their isotopes. Role of these cycles in climate system.

ESCI 4602. **Sedimentology and Stratigraphy.** (3 cr; Stdnt Opt. Prereq—[3402, [IT upper div major in [geology or geophysics or geo-engineering or mining engineering] or CLA [jr or sr] major in geology]] or #) Interpretation of origin of sedimentary rocks through application of basic physical/chemical principles. Modern depositional environments, petrographic microscopy, basin dynamics, stratigraphy.

ESCI 4631W. **Earth Systems: Geosphere/Biosphere Interactions.** (3 cr; Stdnt Opt. Prereq—3401) – **(Fall 2011 is the last time this will be offered.)**

Interdisciplinary study of global-change forcing mechanisms, feedbacks, dynamics on various time scales, using paleorecord to illustrate processes.

ESCI 4703. **Glacial Geology.** (4 cr; Stdnt Opt. Prereq—1001 or 1004 or #, every other year in fall) Formation and characteristics of modern glaciers; erosional and depositional features of Pleistocene glaciers; history of quaternary environmental changes in glaciated and nonglaciated areas. Field trips and labs.

ESCI 5102. **Climate Change and Human History.** (3 cr; §ESCI 3002. Prereq—1001 or equiv or #, odd years in spring) Causes of long-/short-term climate change. Frequency/magnitude of past climate changes, their geologic records. Relationship of past climate changes to development of agrarian societies and to shifts in power among kingdoms/city-states. Emphasizes last 10,000 years.

ESCI 5201. **Time-Series Analysis of Geological Phenomena.** (3 cr; A-F or Aud. Prereq—Math 2263 or #) Time-series analysis of linear and nonlinear geological and geophysical phenomena. Examples drawn from ice age cycles, earthquakes, climatic fluctuations, volcanic eruptions, atmospheric phenomena, thermal convection and other time-dependent natural phenomena. Modern concepts of nonlinear dynamics and complexity theory applied to geological phenomena.

ESCI 5204. **Geostatistics and Inverse Theory.** (3 cr; Prereq—Stat 3011 or #) Statistical treatment of geological and geophysical data. Statistical estimation. Stochastic processes/fields. Non-linear/non-assumptive error analysis. Cluster analysis. Eigenvalue-eigenvector methods. Regional variables. Correlograms and kriging. Theoretical framework of linear geostatistics and geophysical inverse theory.

ESCI 5302. **Isotope Geology.** (3 cr; A-F or Aud. Prereq—2303 or #, even years, fall) Theory and uses of radioactive, radiogenic, and stable isotopes in geology. Radioactive dating, geothermometry, and tracer techniques in geologic processes.

ESCI 5601. **Advanced Sedimentology.** (4 cr; Prereq—4602 or Modern techniques of sedimentary basin analysis focusing on interactions among the lithosphere, atmosphere, and hydrosphere. Sedimentary facies of modern and ancient systems, petrology of clastic and carbonate deposits, tectonic and paleoclimatic interpretations, paleocurrent analysis, diagenetic effects on subsurface fluid flow, and volcanic sedimentation.

ESCI 5602. **Depositional Mechanics.** (3 cr; Prereq—4602, Math 2243 or #) Elementary mechanics of sediment transport applied to quantitative interpretation of sedimentary rocks.

ESCI 5701. **General Hydrogeology.** (3 cr [max 4 cr]; Prereq—Chem 1022, Math 1271, PHYS 1201, Geo majors-core curriculum through 2402 or #) Theory of groundwater geology, hydrologic cycle, watershed hydrology, Darcy's law, governing equations of groundwater motion, flow net analysis, analog models, and groundwater resource evaluation and development. Applied analysis of steady and transient equations of groundwater motion and chemical transport. Chemistry of natural waters.

ESCI 5705. **Limnogeology and Paleoenvironment.** (3 cr; Prereq—#) Within-lake, hydrogeologic, and landscape (geological/biological) processes that lead to formation of various proxy records of paleoenvironment. Systems approach to physical, geochemical, biogeochemical, and biotic proxies. Basic principles, case studies. Emphasizes how proxy records relate to paleoclimate.

ESCI 5713. **Tracers and Karst Hydrogeology.** (3 cr; Prereq—5701, #) Karst hydrogeology and application of tracers to determine source, age, and mixing parameters of water in various natural reservoirs. Physical and chemical principles and processes operating in karst hydrogeology; use of natural and synthetic chemical and isotopic labels or tracers to follow movement and mixing of water through hydrologic cycle.

ESCI 8243. **Principles of Rock Magnetism.** (1-3 cr [max 3 cr]; Prereq—4204 or #) Remanent magnetizations, their classification and origins. Fundamentals of fine particle magnetism; magnetic minerals; separation of multicomponent magnetizations; effects of chemical change on magnetization; magnetic proxies of climatic and environmental change; biomagnetism.

ESCI 8511. **Mechanics of Sediment Transport.** (3 cr; A-F or Aud) Particle motion in fluids. Criteria for incipient motion. Formulations for bedload and suspended load. Bedform mechanics, hydraulic resistance relations. Channel stability, aggradation/degradation, alluvial stream morphology.

## **Ecology, Evolution and behavior**

### **EEB 4611 - Biogeochemical Processes**

(3.0 cr; Prereq—[CHEM 2301, PHYS 1201] or #; spring, offered periodically)

Application of biochemistry, ecology, chemistry, and physics to environmental issues. Issues in biogeochemistry. Impact of humans on biogeochemical processes in soils, lakes, oceans, estuaries, forests, urban/managed ecosystems, and extreme environments (e.g., early Earth, deep sea vents, thermal springs).

### **EEB 5033 - Population and Quantitative Genetics**

(4.0 cr; Prereq—[[BIOL 4003 or GCD 3022], intro statistics] or #; A-F or Aud, fall, every year)

Fundamentals of quantitative genetics. Genetic/environmental influences on expression of quantitative traits. Approaches to characterizing genetic basis of trait variation. Processes that lead to change in quantitative traits. Applied/evolutionary aspects of quantitative genetic variation.

### **EEB 5146 - Science and Policy of Global Environmental Change**

(3.0 cr; =[FR 5146]; Prereq—Biol 3407 Biol 5407 or equiv; A-F or Aud)

Critical issues underpinning global change and its biological implications. Current scientific literature in exploring evidence for human-induced global change and its potential effects on a wide range of biological processes. Emphasizes terrestrial ecosystems. Economic drivers, economic consequences. Local, national, and international laws and policies.

### **EEB 5221 - Molecular and Genomic Evolution**

(3.0 cr; Prereq—[[Biol 4003 or GCD 3022], grad student]] or #; A-F or Aud, spring, offered periodically)

Molecular basis of evolutionary change. Current studies of selection and neutral evolutionary processes at

molecular level. Evolution from gene to genome level: protein structure and function, multigene families, organelle genomes, genome organization. Lectures, discussions of current literature, and workshops where students practice analyses.

#### **EEB 5371 - Principles of Systematics**

(3.0 cr; Prereq-Grad student or #; spring, even years)

Theoretical/practical procedures of biological systematics. Phylogeny reconstruction. Computer-assisted analyses, morphological and molecular approaches, species concepts/speciation, comparative methods, classification, historical biogeography, nomenclature, use/value of museums.

#### **EEB 5601 - Limnology**

(3.0 cr; Prereq-Grad student or #; spring, every year)

Advanced introduction to description/analysis of interaction of physical, chemical, and biological factors that control functioning of life in lakes and other freshwater aquatic environments.

#### **EEB 5605 - Limnology Laboratory**

(2.0 cr; Prereq-3603 or #; A-F or Aud, fall, every year)

Field/lab methods to obtain information on environmental conditions in aquatic environments and measure abundance of aquatic organisms, especially plankton. Field/lab instruments, sampling devices, microscopy, water chemistry, data analysis.

#### **EEB 5609 - Ecosystem Ecology**

(3.0 cr; Prereq-[Biol 3407 or Biol 5407] or #; spring, every year)

Regulation of energy and elements cycling through ecosystems. Dependence of cycles on kinds/numbers of species within ecosystems. Effects of human-induced global changes on functioning of ecosystems.

## **Forest Resources**

#### **FR 5146 - Science and Policy of Global Environmental Change (ENVT)**

(3.0 cr [max 4.0 cr]; =[EEB 5146]; Prereq-3104 or Biol 3407 or equiv; spring, offered periodically)

Intro to critical issues underpinning global change and its biological implications. Current scientific literature on evidence for global change and potential effects on a wide range of biological processes.

Economic/political impact on global change.

#### **FR 5131 - Geographical Information Systems (GIS) for Natural Resources**

(4.0 cr; =[FR 3131]; Prereq-Grad student or #; A-F only, fall, spring, every year)

Introduction to GIS. Focuses on natural resources. Data structures, sources, collection, and quality. Lab exercises introduce geodesy, map projections, spatial analyses, and cartographic modeling.

#### **FR 5153 - Forest and Wetland Hydrology**

(3.0 cr; Prereq-[Basic hydrology course, [upper div or grad student]] or #; spring, every year)

Current topics, methods/models in forest/wetland hydrology. Hydrologic role of forests, wetlands, riparian systems in snowfall/rainfall regimes. How activities such as deforestation, wetland drainage, and stream channel alterations, affect hydrologic response of watersheds. Runoff/streamflow response from undisturbed/altered forest/wetland watersheds. Problem-solving exercises.

#### **FR 5203 - Forest Fire and Disturbance Ecology**

(3.0 cr; =[FR 3203]; Prereq-[Grad student or #], course fee; A-F or Aud, spring, every year)

Ecology, history, management, and control of fire, wind, insect infestation, browsing, and other disturbances in forests. Disturbance regimes of boreal, northern hardwood, and other major forest types of North America.

Influence of disturbance on wildlife habitat, urban/wildland interfaces, forest management, and stand/landscape dynamics. Guest speakers on fire organization, training, and operations. Two-day field trip.

**FR 5204 - Landscape Ecology and Management**

(3.0 cr; =[FR 3204]; Prereq-Grad student or #; A-F or Aud, fall, every year)

Introduction to landscape ecology at different scales in time/space. Development/implications of broad-scale patterns of ecological phenomena, role of disturbance in ecosystems. Characteristic spatial/temporal scales of ecological events. Principles of landscape ecology as framework for landscape research, analysis, conservation, and management.

**FR 5205 - Productivity and Ecology of Forest Soils**

(3.0 cr; =[FR 3205]; Prereq-Forest ecology, silviculture)

Soil-site factors affecting plant /wildlife communities. Site quality estimation, site modification/enhancement. Effects of forest management and other human-related disturbances on forest site quality.

**FR 5218 - Measuring and Modeling Forests**

(3.0 cr; =[FR 3218]; Prereq-Grad student or #; A-F or Aud, spring, every year)

General sampling design and survey techniques to assess current resource conditions. Application of metrics/sampling methods to forest vegetation. Calculation of tree/stand volume, selection of modeling approaches. Case studies of modeling to project future growth. Landscape processes, characterization, and modeling.

**FR 5262 - Remote Sensing of Natural Resources and Environment**

(4.0 cr; =[FR 3262]; Prereq-Grad student or #; fall, spring, every year)

Principles/techniques of remote sensing. Mapping/monitoring land/water resources from local to global scales. Forest and natural resource inventory. Forest cover and soil mapping. Landuse/global change analysis. Lab provides hands-on experience working with aerial photography and digital sensing imagery.

**FR 5412 - Digital Remote Sensing**

(3.0 cr; Prereq-3262 or grad student or #; fall, every year)

Physical basis and practical applications of digital remote sensing. Energy-matter interactions. Measurements and sensors. Digital image processing/analysis. Experience working with remote sensing data, image processing, and models.

## **Geography**

**GEOG 5401 - Geography of Environmental Systems and Global Change**

(4.0 cr; =[GEOG 3401]; Prereq-grad student or #)

Processes that create/change the spatial patterns of climate, vegetation, and soils. Potential of humans to alter climate, vegetation, and soil processes. Possible impacts of human-altered environmental conditions.

**GEOG 5423 - Climate Models and Modeling (irregular offering)**

(3.0 cr; Prereq-3401 or #)

Survey of development and research with simple and complex (three-dimensional) climate models. Environmental processes and their numerical representation in climate models; evaluation of model sensitivity and accuracy; coupling between atmosphere, biosphere, hydrosphere, and cryosphere; assessment of model predictions for climate change.

**GEOG 5426 - Climatic Variations**

(3.0 cr; Prereq-1425 or 3401 or #)

Theories of climatic fluctuations and change at decadal to centuries time scales; analysis of temporal and spatial fluctuations especially during the period of instrumental record.

*“In this seminar course, we will examine these questions through the lens of paleoclimatology, which uses physical and cultural evidence to make inferences about climates of the past. We will review the processes that govern our modern climate and explore what paleoclimate records tell us about how these systems respond to (and express) climate change. In the process, we will learn how insights drawn from the past can help inform discussions of contemporary issues linked to climate change, hazards and the management of natural resources. Case studies will be selected to focus on the Holocene (the last 10 ka) and, to a lesser degree, the climate of North America.”* from Instructor’s course flyer

### **GEOG 5431 - Plant and Animal Geography (ENVT)**

(3.0 cr; =[GEOG 3431])

This course investigates the role of evolution, extinction, and dispersal in the development of the spatial and temporal patterns of biodiversity. The course examines how the abiotic and biotic environment interact to lead to the general patterns of life on earth have arisen, while paying particular attention to the role of people in modifying these relationships. The course includes hands-on exercises and readings of classic biogeography papers alongside emerging research

### **GEOG 5531 - Numerical Spatial Analysis**

(4.0 cr; =[GEOG 3531]; fall, every year)

Applied/theoretical aspects of geographical quantitative methods for spatial analysis. Emphasizes analysis of geographical data for spatial problem solving in human/physical areas.

### **GEOG 5561 - Principles of Geographic Information Science**

(4.0 cr; Prereq-grad; fall, spring, every year)

Introduction to the study of geographic information systems (GIS) for geography and nongeography students. Topics include GIS application domains, data models and sources, analysis methods and output techniques. Lectures, reading, and hands-on experience with GIS software.

### **GEOG 5565 - Geographical Analysis of Human-Environment Systems**

(3.0 cr; Prereq-3561 or 5561 or FR 4131 or LA 5573 or one intro GIS course or grad student or #; spring, offered periodically)

Applications of geographic information systems and other spatial analysis tools to analysis of environmental systems patterns, dynamics, and interactions. Focuses on global to landscape databases developed to analyze atmospheric, hydrospheric, geomorphic, pedologic, biologic, and human land-use systems.

### **GEOG 5839 – Introduction to Dendrochronology**

(3.0 cr; =[GEOG 3839]; Prereq-1 course in introductory biology/ecology/geology or permission of the instructor; fall)

Tree-rings are an important source of information concerning past variations in climate and ecosystem processes. This course examines the foundations of tree-ring analysis (dendrochronology) to provide students with a working knowledge of the principles and practice used to analyze tree rings.

## **Microbiology**

### **MICB 4121 - Microbial Ecology and Applied Microbiology**

(3.0 cr; =[ES 4121, SOIL 4121]; Prereq-3301; A-F or Aud, spring, every year)

Evolution/structure of microbial communities. Population interaction within ecosystems. Quantitative/habitat ecology. Biogeochemical cycling. Molecular microbial ecology, gene transfer in the environment. Molecular phylogeny of microorganisms. Application of microbes in agriculture. Production of commodity chemicals, drugs, and other high-value products.



## **Soil, Water and Climate (Land and Atmospheric Science)**

### **SOIL 4505 - Soil Geography: Soil Variability on Planet Earth**

(2.0 cr; Prereq-1125 or 2125 or equiv; spring, every year)

Distribution/formation of soils on earth's surface. Soil variability/taxonomy. How various soils interact with water, plants, microorganisms, and pollutants. Use/management of land via appreciation of earth's varied soil resources.

### **SOIL 4511 - Field Study of Soils**

(2.0 cr; Prereq-2125; A-F or Aud, fall, spring, summer, every year)

Learn to write soil profile descriptions in the field. Class requires hands-on experience to determine soil texture, color, and horizon designations in the field.

### **SOIL 5311 - Soil Chemistry and Mineralogy**

(3.0 cr; Prereq-[[Chem 1022 or equiv], Phys 1102, grad] or #; spring, every year)

Structural chemistry, origin/identification of crystalline soil clay minerals. Structure of soil organic matter. Chemical processes in soil: solubility, adsorption/desorption, ion exchange, oxidation/reduction, acidity, alkalinity. Solution of problems related to environmental degradation, plant nutrition, and soil genesis.

### **SOIL 5515 - Soil Genesis and Landscape Relations**

(3.0 cr; Prereq-2125 or #; A-F or Aud, spring, every year)

Basic soil morphology and soil profile descriptions; pedogenic processes and models of soil development; soil geomorphology, hydrology, and hillslope processes; digital spatial analysis; soil classification; soil surveys and land use; soil geography.

### **SOIL 5555 - Wetland Soils**

(3.0 cr; =[ESPM 5555]; Prereq-1125 or 2125 or equiv or #; & 4511 recommended; A-F or Aud, fall, every year)

Morphology, chemistry, hydrology, formation of mineral/organic soils in wet environments. Soil morphological indicators of wet conditions, field techniques of identifying hydric soils for wetland delineations. Peatlands. Wetland benefits, preservation, regulation, mitigation. Field trips, lab, field hydric soil delineation project.

*[This course will be taught fall 2011 and then it will be drastically altered. The lecture portion of this course will be merged with ESPM 3575/5575, Wetlands Conservation, to produce a new course with a title yet to be determined, possibly Wetland Science. ESPM 3575/5575 will be first offered in Spring 2012 and every year thereafter. A new 1 or 2 credit course on Wetland Delineation will be offered in Fall semesters with focus mainly on the practice of wetland delineation with a heavy field component.]*

### **SOIL 8541 - Aquatic and Soil Chemistry**

(3.0 cr; Prereq-=: CE 8541; 5311 or CE 4541; A-F or Aud, spring, odd years)

Physical chemical principles, geochemical processes controlling chemical composition of natural waters, soil-/sediment-water interactions. Emphasizes behavior of inorganic contaminants in natural waters, engineered systems, dissolved natural organic matter.

### **SOIL 8510 - Advanced Pedology.**

(2.0 - 4.0 cr [max 12.0 cr]; Prereq-5515; A-F or Aud, fall, odd years)

Sample topics: soil-landscape relations, clay mineralogy, soil genesis, landscape evolution, land use and management, digital terrain modeling, forest soils.

*[The topic in Fall 2011 will be Clay Mineralogy for 3 credits. I may continue to offer this every other year if I can get enough students, or Kyungsoo Yoo and I may offer it in alternating years.]*

### **LAAS 5050 - Integrated Topics in Land & Atmospheric Science**

(3.0 cr; A-F or Aud, fall, every year)

Earth system science. Interactions between the land and atmosphere. Biogeochemistry, human-environment interactions, environmental biophysics, and global environmental change.

**LAAS 5425 - Atmospheric Processes I: Thermodynamics and Dynamics of the Atmosphere**

(3.0 cr; Prereq-One yr college-level [calculus, physics]; A-F or Aud, fall, odd years)

Basic laws governing atmospheric motion through analysis of atmospheric dynamics and thermodynamics at the micro, synoptic, and global scales. Fundamental thermodynamic and dynamical processes/equations governing the behavior of the atmosphere/apply to larger-scale geophysical situations.

**LAAS 5426 - Atmospheric Processes II: Radiation, Composition and Climate**

(3.0 cr; Prereq-[one yr college-level [calculus, physics, chemistry]]; Laas 5425 recommended; A-F or Aud, spring, even years)

Atmospheric radiation, composition/chemistry, climate change. Radiative transfer in Earth's atmosphere. Changing chemical makeup of troposphere/stratosphere. Interplay between natural processes and human activities in air pollution, stratospheric ozone depletion, and chemical forcing of climate. Anthropogenic contribution to climate change/role of land-atmosphere feedbacks affecting atmosphere's energy budget and cycling of greenhouse gases. Application to numerical modeling.

**ESPM / LAAS 5402 - Biometeorology**

(3.0 cr; Prereq-Math 1271, Phys 1201, Stat 3011, [Grad or #]; fall, even years)

Calculus-based introduction to atmospheric boundary layer (ABL), interface between earth's surface and the atmosphere. ABL development/turbulence, surface energy balance, ABL clouds, air quality, microclimate, observational/modeling methods.

**ESPM 5131 - Environmental Biophysics and Ecology**

(3.0 cr; Prereq-[[Biol 1009 or equiv], Math 1271, Phys 1101, [upper div or grad student]] or #; A-F or Aud, spring, odd years)

Basic concepts of environmental variables such as temperature, humidity, wind, and radiation. Mechanics of heat/mass transfer between a living organism and its surrounding environment. Set of practical examples to integrate concepts and transport processes.