

Subject	Cat #	Full Title	Component	Units	Course	Description
ECOL / EIS / PSIO	501	ECOL 501 / EIS 501 / PSIO 501	Lecture	3	Ecological Physiology	During ontogeny, organisms constantly have to adjust their physiology in response to the environment they encounter. This course will provide an integrative understanding of life history evolution from the perspective of the constraints imposed by their underlying physiology. We will emphasize how physiological tradeoffs at the level of the whole organism ultimately define an organism's life history and fitness. The course will provide students with a conceptual approach to the integration of whole-organism physiology underlying life history traits. Relevant physiological, evolutionary and ecological background necessary to understand the concepts discussed will be given in lecture. Course will focus primarily on insects and will also use examples from other animals. Graduate-level requirements include a 5 page essay requiring independent reading and development of a conceptual framework of how the topics discussed in the course tie into the natural life history of their organism. Grades are based on sophistication and logical structure of thinking.
ENVS	501	ENVS 501	Lecture	3	Sustain Mgmt Arid Lands	[Usually offered Spring, even numbered years] Principles and practices of soil, water and crop management under arid and semiarid conditions; the use of diagnostic procedures for evaluating soils and waters, reclamation, and economics of irrigation project development. Graduate-level requirements include an in-depth research paper on a single aspect of a current topic.
RNR	503	RNR 503	Lecture	3	Appl Geog Info Sys	Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest
ENVS / HWRS	506	ENVS 506 / HWRS 506	Lecture	3	MdIng Mass+Energy Soils	Water flow in soils; closely related problems of solute, pollutant, and heat transfer; emphasis on current concepts and research.
ACBS	510	ACBS 510	Lecture	3	Animal Toxicology	This course is focused on how animals are affected by toxic substances. The lectures will cover the principles of toxicology, factors affecting response to chemicals, common mechanisms of toxicity, toxicity to key organs, and the toxicity of substances relevant to small and large domestic to animals. In addition to the evaluations above, graduate students will complete three written assignments that will be counted within the exams (60%) component.
HWRS	517A	HWRS 517A	Lecture	3	Fndmntls Of Water Quality	Introduction to chemical processes affecting the behavior of major and minor chemical species in the aquatic environment. Physical, equilibrium, inorganic/organic, and analytical principles as applied to natural waters. Graduate-requirements include writing a review paper and oral presentation, differential problem sets for homework and exams.
ENVS	518	ENVS 518	Lecture	3	Intr Human Hlth Rsk Asmt	The purpose of this course is to enhance students knowledge and skills related to environmental risk assessment, including hazard assessment, exposure assessment, toxicity assessment, and risk characterization. Graduate-level requirements include conducting a case study that will require them to collect secondary data in the field.

ENVS	520	ENVS 520	Lecture	3	Environmental Physics	Environmental Physics covers how solar energy input, the atmosphere, the oceans, the terrestrial environment and the biosphere interact with each other at global and regional scales. Earth's systems are not static and the course will deal with their evolution over geological times and cover recent and projected future changes to the climate and ozone layer, among other topics that are important for society and its decision makers. This course emphasizes conceptual understanding of mechanisms, data sets and modeling techniques and uses elementary math and physics principles to guide student to a comprehensive, but practical, understanding of the physical aspects of the environment of planet Earth. Graduate students should have completed introductory courses in Calculus and Physics.
LAR	520	LAR 520	Lecture	4	Plant Materials	Laboratories focus on identification and description of native and select exotic landscape plants frequently used in landscape design and revegetation in the Southwest. Lectures emphasize terminology, plant care and maintenance, and influence of site conditions and requirements on plant selection.
PSIO	520	PSIO 520	Lecture	3	Exercise+Envir Physiol	Regulation and adjustment of physiological systems during acute exercise and adaptations with chronic exercise in various populations and environments; emphasizes physiological mechanisms. Graduate-level requirements include a research-review paper on an approved topic.
ENGR / MNE	522	ENGR 522 / MNE 522	Lecture	3	Engr Sustainable Dev	This course is for students who wish to learn and engage in modern sustainable development practices with respect to engineering projects that have three areas of impact: economic, environmental and societal. The course will provide background for an understanding of the complexities and inter-relations of sustainable development issues. The focus will be on the minerals development industry, and the impacts in industrialized and developing nations, communities and the environment. Graduate-level requirements include project management duties, where graduate students are expected to manage groups of undergraduates in the design of the final term project. Additional graduate projects and assignments will have requirements for type and quantity of work.
LAR / RED	522	LAR 522 / RED 522	Lecture		Landscape Analysis	Integrated field and classroom instruction introduces the student to inventory and analysis of biological, physical, social/behavioral, and cultural elements of the landscape. Projects will incorporate principles of landscape ecology and regional landscape planning. Output of the course will deal with implications of the above-named elements on design. In addition, design programming and data manipulation will be introduced and a conceptual design for a given site will be developed.
ENVS / IMB	525	ENVS 525 / IMB 525	Lecture	3	Envir Microbiology	Current concepts in water quality, aerobiology and microbial biogeochemistry. Graduate-level requirements include extra journal readings and more comprehensive exams.
BE / CE / WSM	526	BE 526 / CE 526 / WSM 526	Lecture	3	Watershed Engineering	Design of waterways, erosion control structures and small dams. Methods for frequency analysis and synthetic time distribution of rainfall. Methods for estimating infiltration and runoff from small watersheds, flow routing and storm water management. Estimating erosion using the Revised Universal Soil Loss Equation. Graduate-level requirements include a special project.
ACBS /PLP	527R	ACBS 527R / PLP 527R	Lecture	3	General Mycology	An exploration of the diversity of fungi and fungus like organisms covering general biology and roles as pathogens (of humans and plants), saprobes and symbionts. Fungi as models for eukaryotic molecular research and their uses in industry will be covered. Graduate-level requirements include a term paper 10 pages in length to allow a more in depth exploration of a topic in fungal biology. Also required is a 30 minute oral presentation on a topic of choice for 100 points of grade.

ANTH / HUMS / RELI	528A	ANTH 528A / HUMS 528A / RELI 528A	Lecture	3	Globalization: Env & Religions	This course discusses the impact of globalization on the environment and ecology, with a particular focus on indigenous cultures and religions in the context of environmental instability. Graduate-level requirements include a 25-30 page double-spaced research synthesis and reflective paper that reflects your understanding of Globalization and the Environment and 4 book reviews from books used in class.
CE	529	CE 529	Lecture	3	Spc Tpc Hydr+Wtr Res Eng	Selected advanced topics will be covered in the fields of hydraulics and water resources engineering with emphasis on analysis and design of water systems. Graduate-level requirements include a research paper and/or a comprehensive design project.
RNR	529	RNR 529	Lecture	3	Ecological Climatology	Life evolved on the Earth partly due to favorable climate conditions, but life has also played an important role in shaping the Earth's atmosphere and climate - a perfect example of the complex feedbacks occurring between biological and geophysical systems. This course will explore in-depth interactions occurring between relevant areas of ecology - the study of the interactions of organisms among themselves and with their environment - and climatology - the study of the physical state of the atmosphere - to understand the functioning of terrestrial landscapes in the climate system. A central focus will be on the exchange of energy, water, chemical elements, and trace gases between terrestrial ecosystems and the atmosphere and how this exchange leads to fascinating feedbacks in Earth's climate system. This course combines aspects of physical climatology, hydrology, ecosystem ecology, and biogeography in an interdisciplinary framework to elucidate how the biosphere and atmosphere are inextricably linked. Students that take this course will develop a solid conceptual framework for evaluating how the biosphere responds to climate perturbations and how, in turn, perturbations in the biosphere affect climate. This course will provide students with a critical thinking skill-set that will allow them to evaluate important topical issues regarding climate change. Students will also get an introduction to the vast freely downloadable climate, satellite, and Earth System Model data and an introduction to the technical skills needed to incorporate these data into their own scholarship and research. Graduate student requirements include 1) developing an analysis, writing it up in the format of a scientific paper, and presenting the analysis and paper to the class at the end of the semester, 2) selecting and formally reviewing two scientific papers from the peer-reviewed literature.
ECOL / GENE / WFSC	530	ECOL 530 / GENE 530 / WFSC 530	Lecture	3	Conservation Genetics	Basic methods and theories of genetic/genomic analyses together with the application of these analyses to promote conservation, proper management, and long term survival of free-ranging species, including the exploration of current conservation genetic/genomic literature. Graduate level requirements include a term project and an oral presentation.

ENVS	530R	ENVS 530R	Lecture	3	Env Monitor+Remediation	Designed to provide the graduating students and interested graduates with a combination of lectures, labs and field trips that describe relevant topics in environmental monitoring, characterization and remediation. The topics covered include: basic statistics, data quality, field surveying, near-surface air measurement, automated data acquisition, soil, vadose zone and groundwater sampling and monitoring, soil and water biological properties, including pathogen monitoring and remote sensing. This course focuses on hands-on, laboratory and field experiences design to help the student better understand the principles of and the tools necessary for environmental monitoring. Basic principles and reviewed during lecture as necessary to assist the student in connecting theory with hands-on experiences in the lab and the field. Students are required to complete several problems, review publications, and write weekly or bi-weekly reports that summarize each of the nine topics covered, their laboratory/field trip experiences, and provide answers to questions and exercises. Graduate-level requirements include an independent project for an additional 100 points. This project will consist of either a research paper or a special field/data collection/report on topics agreed upon. The exact format and length of this project is to be determined.
GEOS / HWRS	531	GEOS 531 / HWRS 531	Lecture	4	Hydrogeology	Hydrologic and geologic factors controlling the occurrence and dynamics of groundwater on regional and local scales. Graduate-level requirements include a research paper on a topic related to hydrogeology but not covered in lectures.
AIS / ANTH / ENVS / GEOG / RAM / RNR / WFSC / WSM	531A	AIS 531A / ANTH 531A / ENVS 531A / GEOG 531A / RAM 531A / RNR 531A / WFSC 531A / WSM 531A	Lecture	3	Tradition Ecological Knowledge	An introduction to the growing literature on traditional ecological knowledge and its relationships to the ecological and social sciences. Graduate-level requirements include preparing for and leading a class discussion on a specific topic.
ENVS	531R	ENVS 531R	Lecture	3	Soil Genesis,Morph+Class	Theory and practice of describing characteristics of soils; principles of soil classification and classification systems; making soil interpretations for selected land uses. Graduate-level requirements include an in-depth research paper on a single aspect of a current topic.
GEOS	534A	GEOS 534A	Lecture	3	Intro Explor Seismology	Fundamental theory of seismic wave propagation, and techniques of seismic reflection and refraction data acquisition and interpretation applied to exploration of the Earth's lithospheric structure and natural resources. Study of methods to image the crust in 2-D and 3-D. Graduate-level requirements include development of an additional term project. Projects are more heavily weighted in determining the total grade.
RAM	536A	RAM 536A	Lecture	2	Grazing Ecology+Mngmnt	This course examines the underlying ecologic and economic principles of how rangeland herbivores interact with their environment and how understanding these interactions can be applied to the management of grazing animals and the environments they inhabit. Emphasis is placed on the scientific basis for grazing management decisions of wild and domesticated ungulate herbivores that can be planned to accomplish a variety of outcomes. Focus will be on western rangelands in the U.S. but the basic ecologic and economic concepts you will learn have applicability to most arid and semi-arid rangeland ecosystems throughout the world. Graduate students will develop and present one PowerPoint lecture that summarizes a topic concerning "Integrated Rangeland Ecology and Management."

GEOS	536	GEOS 536	Lecture	3	Earthquakes & Volcanic Systems	The course will focus on the processes and properties associated with earthquake sources and volcanic systems and how these properties affect the hazards associated with these events. Lectures will focus on derivations of common equations used to study these systems and discussions on recent publications related to the modeling of earthquake sources and volcanic eruptions. Students will lead discussions on relevant papers and final projects will involve writing summary papers and applying modeling techniques discussed in the class to carry out original analyzes.
GEOS	537	GEOS 537	Lecture	4	Earth-System Modeling	This course will introduce the basic concepts of numerical modeling of the climate system. The course material will cover: basic processes that shape Earth's climate; application of model hierarchies in climate science; how model predictions of both past and future climates are used to inform policy.
ANTH / GEOG / GEOS / WSM	539A	ANTH 539A / GEOG 539A / GEOS 539A / WSM 539A	Lecture	4	Intro Dendrochronology	Survey of dendrochronological theory and methods. Applications to archaeological, geological, and biological dating problems and paleoenvironmental reconstruction. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. Graduate-level requirements include a research paper reviewing critically some aspect of dendrochronology.
RNR	540	RNR 540	Lecture	3	Climate Change Adaptation	Much of modern society's experience of managing resources and protecting people and infrastructure has occurred during a period of relatively stable climate. In the most recent decades in the Southwest, we have observed a cascade of impacts associated with temperature increases, including changes in snow hydrology, in phenology, and in the severity of drought impacts. Projected future climate changes and impacts may lie outside the range of climate variation that we have observed and may have more serious consequences for society and the environment. Anticipating projected changes will allow society to identify response options across a range of vulnerabilities and manage the risks associated with projected climate changes. In the best possible cases, these actions or adaptations, may provide economic and other benefits to society. In this 3 credit course, we will examine actions to reduce vulnerabilities or increase resilience to the potential impacts of climate change. While the general focus will be on impacts and responses in the arid Southwest (water, fire, species, ecosystems), we will also investigate the philosophies and frameworks for advancing action and incorporation of adaptation planning at the regional, national and international scale. Graduate-level requirements include completing a more in-depth project or research paper based on the course internship. The writing assignment will be identified by agency partners and approved by the instructors, and will address a subject of direct relevance to the organization's program.
MNE	541	MNE 541	Lecture	3	Env Mngmt+Mine Reclamatn	Principles and practices of mine environmental management and reclamation; pre-mining assessment. Design of water management systems (contaminant removal; settling ponds, groundwater protection); recontouring and revegetation; air quality management; noise and seismic mitigation. Maintaining permits; closure and bond release and ultimate land use. Best management practices. Graduate-level requirements include additional assignments and a research paper or presentation on a specific environmental management topic.
ECOL / ENVS / WFSC	542	ECOL 542 / ENVS 542 / WFSC 542	Lecture	4	Limnology	Study of lakes and streams; biological characteristics, as related to physical, chemical, geological, and historical processes operating on fresh waters. Graduate-level requirements include a report that synthesizes literature on a research issue of current concern, an in-class presentation and several discussion meetings.

HWRS	543A	HWRS 543A	Lecture	3	Risk Asmnt for Environment Sys	A multidisciplinary course based on evaluating risk as the loss expected from environmental catastrophes or from the failure of systems designed for environmental protection. Examples will be drawn from hydrology, atmospheric science, and geology. The emphasis is on adapting the tools of probabilistic risk assessment to environmental analyses. Graduate-level requirements include a written review of a seminal paper and its presentation in class.
ECOL / EIS	544	ECOL 544 / EIS 544	Lecture	3	Insect Ecology	The study of how variation in the environment, interactions with other species and the special features of insect "design," have determined the evolution of diverse insect life histories, the dynamics of insect population and the roles of insects in communities.
WFSC	544	WFSC 544	Lecture	4	Wildlife Ecology	Wildlife Ecology, Conservation, and Management introduces advanced students to the ways in which human society influences the distribution and abundance of animals and communities viewed as ecologically, economically or intrinsically valuable and presents the analytical and technical tools available to wildlife professionals whose purpose is to understand population dynamics and manipulate the human-wildlife interface towards specific goals. The course is centered primarily on vertebrate (fish, birds, mammals, reptiles, amphibians) populations but also considers community and ecosystem perspectives. Students will explore sociopolitical perspectives, biological and ecological concepts, and mathematical underpinnings to population regulation and human-wildlife interactions.
CE	546	CE 546	Lecture	3	Geotech Earthquake Engr	Review of plate tectonics and seismology, analysis of earthquake ground motions, travel path and distance effects, and site response effects. Soil liquefaction susceptibility, identification, and mitigation. Introduction to seismic slope stability. Graduate level requirements include a research paper and/or a comprehensive design project.
CSC	547	CSC 547	Lecture	3	Green Computing	This course covers fundamental principles of energy management faced by designers of hardware, operating systems, and data centers. We will explore basic energy management option in individual components such as CPUs, network interfaces, hard drives, memory. We will further present the energy management policies at the operating system level that consider performance vs. energy saving tradeoffs. Finally we will consider large scale data centers where energy management is done at multiple layers from individual components in the system to shutting down entries subset of machines. We will also discuss energy generation and delivery and well as cooling issues in large data centers. In addition to the assignments listed for undergraduates, Graduate-level requirements include a detailed review of the three recent conference publications dealing with energy efficiency.
ECOL	547	ECOL 547	Lecture	3	Intro Theoretical Ecol	Population growth and density dependence; predation; competition and apparent competition; coexistence mechanisms: niches, spatial and temporal variation; food web concepts and properties; applications. Emphasis on understanding through models and examples. Graduate-level requirements include additional questions of a more advanced nature on exams.
GEN	548	GEN 548	Lecture	3	Geophys Exploration+Engr	Principles of gravity, magnetic, seismic and electrical exploration; acquisition and interpretation of data to define geologic structure and evaluate resources. Graduate-level requirements include a special research project collecting and interpreting geophysical field data.

LAR / RNR	548	LAR 548 / RNR 548	Lecture	3	Conserv Plan & Wildlife Recre	This course will introduce the concepts and techniques used in the growing field of human use management in outdoor recreation settings. The focus is on the sociological dimensions of the recreation experience and an understanding of the principles, practices, and dilemmas of outdoor recreation management in natural areas. Graduate-level requirements include students to be team leaders during the project phase of the class. They will be expected to learn how to be project coordinators and work with undergraduate students.
ECOL / HWRS / RNR / WSM	552	ECOL 552 / HWRS 522 / RNR 522 / WSM 522	Lecture		Dryland Ecohydro&Veg Dynamics	Overview of ecological and hydrological interrelationships, including ecologically meaningful water budgets, and associated vegetation dynamics for water-limited, dryland ecosystems. Graduate-level requirements include different grading criteria and exam components plus completing a group research project in coordination with the instructor.
BE / CE	555	BE 555 / CE 555	Lecture	3	Soil+Water Rsrcs Engr	Introduction to soil and water relationships, irrigation systems, irrigation water supply, and irrigation management; basic designs. Graduate-level requirements include a special project on a current irrigation topic.
RAM	556A	RAM 556A	Lecture	4	Rangeland Invent+Monitor	Techniques of mapping and measuring attributes of vegetation and soils for inventory and monitoring of range lands. Interpretation of data with respect to range condition and trend, watershed protection, value for livestock and wildlife habitat. Graduate-level requirements include completion of additional readings and an independent research project and report.
HWRS / WSM	560A	HWRS 560A / WSM 560A	Lecture	4	Watershed Hydrology	Watershed hydrology looks at how water movement, storage and transformation on the Earth's surface is influenced by landscape characteristics, including human modifications of those characteristics, and weather. As such, watershed hydrology will focus on surface water. However, this course offers a brief introduction to groundwater as it pertains to watershed hydrology. Graduate-level requirement includes required completion of a graduate environmental inquiry through volunteer work. Graduate students will be required to blog about these experiences.
ECOL / PLP / PLS	560	ECOL 560 / PLP 560 / PLS 560	Lecture	4	Advanced Plant Biology	Advanced, graduate-level treatment of current understanding of development, metabolism, response to environmental signals and stress, interactions with other organisms, and plant origins and crop domestication.
ARC	561D	ARC 561D	Lecture	3	Computer Energy Analysis	A comprehensive course that teaches students energy conservation and passive solar architecture and up-to-date computer energy simulation techniques. The course promotes students learning through field investigation of existing buildings and/or new design projects. Graduate-level requirements include writing short essays on development exercises and presenting simple payback and lifecycle cost analysis on projects.
ARC	561K	ARC 561K	Lecture	3	Energy and the Environment	A fully online course that fosters awareness and thorough understanding of the qualitative and quantifiable environmental forces that contribute to energy use in buildings. The course introduces basics for understanding solar energy and light, climate and microclimate, and human thermal comfort as related to the built environment. Graduate-level requirements include completion of an additional 2-page report to be uploaded with each skill development exercise
ENVS	564	ENVS 564	Lecture	3	Environmntl Organic Chem	Physical and chemical processes influencing the behavior of contaminants in the subsurface environment. Includes equilibrium and kinetic theory of solubilization-dissolution, volatilization, sorption, hydrolysis, photolysis, surface catalysis and radioactive decay. Graduate-level requirements include a project involving literature research in environmental chemistry.
ARL / GEOG	565	ARL 565 / GEOG 565	Lecture	3	Phy Aspects Of Arid Land	The climate, landforms, hydrology, soils and vegetation of deserts, with special emphasis on processes and distribution at micro-to-macro scales.

GEOS	566	GEOS 566	Lecture	3	Stbl Isot Geoch+Paleocli	An examination of stable isotopes in paleoenvironmental reconstruction, emphasizing O, C, H and N isotopes in the ocean, rivers, ice, lakes, soils, speleothems, and fossils. The class includes in-class presentations and a lab project. Graduate-level requirements include additional in-class presentations and a more rigorous grading scale.
ATMO / CHEE	569A	ATMO 569A / CHEE 596A	Lecture	3	Air Pollution I:Gases	An introduction to the chemistry and physics of the troposphere and stratosphere. Topics include natural biogeochemical cycles; atmospheric photochemistry; stratospheric ozone; urban ozone and particulate matter; atmospheric visibility; acid deposition; air pollution meteorology; Gaussian plume model; photochemical model; air quality regulations. Graduate-level requirements include additional homework and other exercises.
ARC	571N	ARC 571N	Seminar	3	Arid Reg Urb	Students will investigate and understand the cultural, historical and environmental dimensions of city-building in arid regions, with an emphasis on the Arizona/Sonora border region. Graduate students will write a research paper on a topic of their interest, to be determined in consultation with the instructor.
WFSC	571	WFSC 571	Lecture	3	Stream Ecology	This course will examine the structure and function of stream ecosystems with emphasis on the interaction of physical and biotic elements of streams in arid regions. We will examine the role of natural and anthropogenic stressors in shaping aquatic assemblages in streams. Quantification of impairment of stream structure and function requires a thorough understanding of fundamental ecological concepts of natural streams; this will be a major focus. Also, students will learn to use current methods to assess stream condition and signs of impairment. Graduate-level requirements include additional essay questions on exams and graduate student must meet with the instructors to discuss selected research articles. Presentations will be longer than undergraduates.
GEOS / HWRS	572	GEOS 572 / HWRS 572	Lecture	3	Global Biogeochem Cycles	Study of processes affecting global chemical fluxes. Particular attention to current global concerns, i.e., ozone hole, carbon cycle, climate warming, atmospheric oxidation, hydrologic cycle.
HWRS	573	HWRS 573	Lecture	3	Hydrology for Water Resources	This course will develop the students understanding of the hydrologic cycle, its constituent parts on the hydrologic cycle. It will then expose students to various ways in which human management influences the hydrologic cycle and ways in which the hydrologic cycle controls water resources management.
RNR	573	RNR 573	Lecture	3	Spatial Analysis+Modelng	Explores the use of geographic information systems (GIS) as a tool for natural resource and environmental managers. Topics include spatial autocorrelation, interpolation techniques, and model integration. Examines sources of error and possible ramifications. Graduate-level requirements include the students to show additional, sophisticated proficiency with the material through the completion of a final course project, consisting of an additional analysis of data provided by the students (see syllabus for point breakdown).
ECOL / ENVS / WFSC	574	ECOL 574 / ENVS 574 / WFSC 574	Lecture	4	Aquatic Plants+Enviromnt	The role of riparian areas, estuaries, and constructed wetlands in the environment. Emphasis on plants as wildlife habitat for nutrient cycling and bioremediation. Graduate-level requirements include an additional research project and class presentation.
AREC / ARL / ECON / GEOG / HWRS / RNR	575	AREC 575 / ARL 575 / ECON 575 / GEOG 575 / HWRS 575 / RNR 575	Lecture	3	Econ Eval Wtr+Env Policy	Economic incentives, tradable permits and markets for ecosystem services are pivotal in contemporary water and environmental policy. This class covers theory and application of economic concepts needed to evaluate water and environmental laws and policies; including ecosystem service provision, tradable use permits, benefit cost analysis, externalities, public goods and valuation methodologies. Case studies include federal, state, tribal and international water and environmental policies.

GEOS	577	GEOS 577	Lecture	3	Active Tectonics	Regional and subregional examination of faulting, folding, uplift, subsidence, collapse, volcanism, and mass wasting associated with active contemporary deformations of the Earth's crust. Emphasis includes impact on human society. Graduate-level requirements include leadership role on field trips and a special presentation.
ECOL / GC / GEOG / GEOS / HWRS / RNR	578	ECOL 578 / GC 578 / GEOG 578 / GEOS 578 / HWRS 578 / RNR 578	Lecture	3	Global Change	Analysis of the Earth system through an examination of its component parts (particularly climate and biogeochemistry) and their interactions with human activities, emphasizing information needed to understand modern and future environmental changes. Graduate-level requirements include an in-depth written exercise and additional activities as described in the syllabus.
ENVS	580	ENVS 580	Lecture	3	Environmental Assessment	The goal of this course is to advance students' knowledge of various concepts and methods used in assessing human-impacted resources such as contaminated sites, waste places, and disturbed sites to ensure efficient and effective remediation and restoration programs. Focusing on contaminated sites, the course covers socioeconomic, biophysical, political, and cultural dimensions of the impacted sites as well as the assessment of the sustainability of remedial options. The course is delivered through interactive lectures, discussions, and classroom presentations, and is team taught by faculty with varied expertise.
BE	582	BE 582	Lecture	3	Food-Water-Energy Nexus	Integrated engineered solutions in the Food-Water-Energy Nexus are transformational integrated designs -- drivers of change -- that are necessary to make feeding an increased global population this century possible, environmentally sustainable and cost-effective. Graduate students and undergraduate students will be mixed in teams, and each team designs an integrated engineered solution in the Food-Water-Energy Nexus. Each graduate student will be further required to provide detailed design for a chosen specific component of his/her team's designed integrated engineered food-water-energy system. The grade for each graduate student for the Team Design (which accounts for 30% of the final grade as shown above) will be 50% of the team design grade and 50% of his/her individual component design grade.
BE / PLS	583	BE 583 / PLS 583	Lecture	3	Controlled Environ System	An introduction to the technical aspects of greenhouse design, environmental control, hydroponic crop production, plant nutrient delivery systems, intensive field production systems, and post-harvest handling and storage of crops. Graduate-level requirements include submission of a comprehensive report related to a specific greenhouse design project.
PA	584	PA 584	Lecture	3	Environmental Management	This course is a survey of environmental management and economics to maximize social benefit. Covering pollution control, nonrenewable resource extraction, and natural resource management, we address both theory and policy in practice to determine when markets work, when they fail, and what policy can do to help. We also discuss the taxonomy of value and introduce stated- and revealed-preference valuation techniques. This course aims to empower students with a set of tools to rigorously evaluate a range of real-world issues at the human-environment nexus through the synthesis of science, economics, and policy. Basic math (graphing and algebra) will be used in this course, but all concepts will be reviewed during the first class. Students taking this course for graduate credit will complete all the required homework and exams with the undergraduates. In addition, they will also complete a 15-20 page research paper.

BE	587	BE 587	Lecture	3	Metagenomics	<p>Environmental genomics is revolutionizing our understanding of microbes from the environment to human health, towards a holistic view of ecosystems or "One-Health". At its core are new molecular methods called metagenomics to sequence DNA directly from an environmental sample, thus capturing the whole microbial community and bypassing culture. Modern (Next-Gen) sequencing technologies offer vast new datasets of short sequence reads representing these microbial communities, however many hurdles exist in interpreting data with high species complexity and given specialized software for microbial metagenomic analyses. This course focuses on the science of metagenomics towards understanding (1) questions that metagenomics can address, (2) possible approaches for metagenomic sequencing and analysis, and (3) how genes, pathways, and environmental context are translated into ecosystem-level knowledge. This course alternates between traditional lectures and hands-on experience with programming, bioinformatics tools, and metagenomic analysis. The course concludes with several weeks of seminar-format discussions on current research in metagenomic data analysis and a final project of your choice analyzing real-world experimental data.</p> <p>Environmental genomics is revolutionizing our understanding of microbes from the environment to human health, towards a holistic view of ecosystems or "One-Health". At its core are new molecular methods called metagenomics to sequence DNA directly from an environmental sample, thus capturing the whole microbial community and bypassing culture. Modern (Next-Gen) sequencing technologies offer vast new datasets of short sequence reads representing these microbial communities, however many hurdles exist in interpreting data with high species complexity and given specialized software for microbial metagenomic analyses. This course focuses on the science of metagenomics towards understanding (1) questions that metagenomics can address, (2) possible approaches for metagenomic sequencing and analysis, and (3) how genes, pathways, and environmental context are translated into ecosystem-level knowledge. This course alternates between traditional lectures and hands-on experience with programming, bioinformatics tools, and metagenomic analysis. The course concludes with several weeks of seminar-format discussions on current research in metagenomic data analysis and a final project of your choice analyzing real-world experimental data.</p>
GEOS	587	GEOS 587	Lecture	3	Physical and Dynamical Oceanog	<p>The course will introduce the physical properties of seawater including the three-dimensional structures of ocean temperature, salinity and density, their mean states, seasonal and interannual variability and long-term change. The heat, salt and mass budgets of the world oceans will be discussed, with emphasis on the role of the ocean in the climate system. The course will introduce basic concepts and general principles of ocean dynamics to understand large-scale ocean circulation, including wind-drive and density-driven (thermohaline) circulation. Special topics focus on the formation of the western boundary currents (the Gulf Stream), ocean waves and tides, ENSO dynamics, and coastal ocean processes (sea level rise and storm surge).</p>
ECOL	587R	ECOL 587R	Lecture	3	Animal Behavior	<p>Concepts and principles of the mechanism, development, function and evolution of behavior, with emphasis on its adaptiveness. Graduate-level requirements include term paper involving hands-on research.</p>

ARL / ATMO / ENVS / GEOG / GEOS / HWRS / MNE / REM / RNR	590	ARL 590 / ATMO 590 / ENVS 590 / GEOG 590 / GEOS 590 / HWRS 590 / MNE 590 / REM 590 / RNR 590	Lecture	3	Remote Sens Planet Earth	Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.
RNR	596E	RNR 596E	Seminar	2	Restoration Ecology	The Restoration Ecology Seminar aims to provide students with a broad, balanced understanding of science and practice in the field of restoration ecology. This class is an introduction to the common issues, problems, strengths, and weaknesses of restoration activities across all regions, biomes, and intensities of management. A special emphasis is given to the application of restoration ecology in addressing emerging challenges in natural resource ecology and management. Graduate-level requirements include co-leading at least two class sessions.
GEOG	596I	GEOG 596I	Seminar	3	Comp & Int Water Policy	This course examines major issues in comparative and international water policy, including water markets, privatization, dams and river basin management, environmental flows, social equity, and water governance. The course is interdisciplinary and builds on law, geography, political economy, and institutional economics.
LAW	596I	LAW 596I	Seminar	3	Comp & Int Water Policy	This course examines major issues in comparative and international water policy, including water markets, privatization, dams and river basin management, environmental flows, social equity, and water governance. The course is interdisciplinary and builds on law, geography, political economy, and institutional economics.
ENVS	597F	ENVS 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.

GEOG	597F	GEOG 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.
LAS	597F	LAS 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.
NSC	597F	NSC 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.

PLS	597F	PLS 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.
STCH	597F	STCH 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.
TLS	597F	TLS 597F	Workshop	2	Comm/School Garden Workshop	This workshop-based course is designed to enable UA undergraduates and graduates students to work in Tucson-area schools helping students and teachers to undertake the design, construction, planting, harvesting and preparation of foods from a local school garden. The workshop also involves preparing or assembling curriculum materials to enable teachers and students to teach and learn about food production, food histories and geographies, and food politics. The course includes an intensive workshop sponsored by the Tucson Community Food Bank. In addition to attending that workshop, students are also expected to attend at least one fieldtrip among the two that are organized during the semester as well as attend monthly meetings of the group on the UA campus. Most of the workshop, however, revolves around consistent and engaged involvement with a Tucson school and its teachers and students supporting the development and maintenance of school garden and attendant curriculum. Graduate-level requirements include a 8-10 page research paper that explores some aspect of wider impacts of community/school gardens. Expectations about this final paper will be provided during the first week of the course.

GEOG	597S	GEOG 597S	Workshop	3	Sustain Urban Develop & Design	Examines contemporary competition between environment, resources (water, energy), social equity, and economic viability in the community development and revitalization arena. Public policy, planning initiatives, design strategies and technical solutions that bridge the conflicting agendas are analyzed. Field investigation of contemporary cases. Appropriate for students specializing in planning, architecture and landscape architecture. Graduate-level requirements include a case study paper and formal class presentation. The study should include a literature review, and assessment methodology and critical comment.
PLG	597S	PLG 597S	Workshop	3	Sustain Urban Develop & Design	Examines contemporary competition between environment, resources (water, energy), social equity, and economic viability in the community development and revitalization arena. Public policy, planning initiatives, design strategies and technical solutions that bridge the conflicting agendas are analyzed. Field investigation of contemporary cases. Appropriate for students specializing in planning, architecture and landscape architecture. Graduate-level requirements include a case study paper and formal class presentation. The study should include a literature review, and assessment methodology and critical comment.
RED	597S	RED 597S	Workshop	3	Sustain Urban Develop & Design	Examines contemporary competition between environment, resources (water, energy), social equity, and economic viability in the community development and revitalization arena. Public policy, planning initiatives, design strategies and technical solutions that bridge the conflicting agendas are analyzed. Field investigation of contemporary cases. Appropriate for students specializing in planning, architecture and landscape architecture. Graduate-level requirements include a case study paper and formal class presentation. The study should include a literature review, and assessment methodology and critical comment.
ECOL	600B	ECOL 600B	Lecture	3	Fundament Of Ecology	The fundamentals of modern Ecology, including behavioral ecology, population ecology, species interactions and community/ecosystem ecology.
DVP	602	DVP 602	Lecture	3	Culture in Sustain Development	This course emphasizes the cultural and spatial dimensions to development practice and promotes sensitivity to the unique development practice challenges related to language and culture. Students are exposed to a range of regional contexts and are expected to expand their knowledge and understanding of a specific cultural area. The specific regional themes focus on the impacts of culture on problems related to health and nutrition, natural resource management, governance, and economic decision-making, among other. Faculty from different core competency disciplines will participate in this course.'
ECOL	610A	ECOL 610A	Lecture	1	Rsrch Ecology+Evolution	Introduction to the research currently being pursued by faculty and staff in the department.
CE / HWRS	630	CE 630 / HWRS 630	Lecture	3	Adv Catchment Hydrology	Concepts and methodology required to upscale near-surface hydrologic processes to catchment scales with development of watershed models to quantify hydrologic response in different climates. Special attention given to how landscape geomorphologic structure affects hydrologic behavior.
ARL	641	ARL 641	Lecture	3	Nat-Hum Impact Arid Land	The influence of nature and humans on arid lands sustainability and the role of locally-adaptable technologies. Various aspects of measuring, monitoring and describing natural and human impacts on arid lands. Focuses on occurrences such as El Nino, population growth, and utilization of limited resources in relation to their economic and environmental significance.

LAW	643D	LAW 643D	Lecture	2	Native Am Nat Resources	This course will examine several themes: conflicts over which government has sovereign control over which resources; the role that tribal governments play in natural resource allocation and management; questions relating to ownership of natural resources; the changing federal policies relating to natural resources allocation; the role of federal courts, Congress, and Executive branches in relation to the trust responsibilities to protect tribal lands and resources; environmental protection, including EPA policy in relation to Indian Reservations; and natural resource development and management.
LAW	650C	LAW 650C	Lecture	1	Energy Law	Energy has been an essential element of life ever since it began. Modern society would be unthinkable without the all pervasive supporting energy infrastructure. Energy's intrusion into all aspects of life means that the practitioner is likely to be involved in energy related issues in any specialized field of practice. This course is designed to meet that need by providing a comprehensive overview of the various aspects of energy law. Five drivers of change will be considered in developing an understanding of the current state of energy law and how it is likely to evolve. They are: 1. uncontrollable external events 2. technological advances 3. revisions to economic thinking 4. increased reliance on competition 5. evolving social expectations
LAW	662B	LAW 662B	Lecture	2	Land Use Regulation	This course explores the major American legal tools for public control of land uses. As a background, it begins with compensated land use control (eminent domain) and uncompensated private constraints on land uses (nuisance law). It then turns to the first and most fundamental type of land use regulation, zoning, along with the challenges that landowners can make to zoning in general and especially to changes in pre-existing zoning. Two special problems follow: aesthetic regulation (along with its First Amendment implications), and subdivision regulation, especially as the latter is used to finance urban infrastructure. Finally, it takes up some reforms: the requirement that land regulators plan in advance, and that they meet regional responsibilities. Finally, time permitting, we will take up some of the relationships between land use regulation and environmental controls
CE / CHEE	676	CE 676 / CHEE 676	Lecture	3	Adv Water/Waste Treatmnt	Advanced design for water and wastewater treatment. Emphasis on modern environmental engineering processes for water and wastewater treatment.
PLP	695A	PLP 695A	Colloquium	1	Journal Club	Enrolled students take turns selecting and leading the discussion on articles from the primary literature. Enrollment is open to students with interests in any of the three focus areas of the Dept. of Plant Sciences: Plant Biology, Genetics and Genomics; Horticultural and Crop Sciences; and Plant Pathology and Microbiology. Goals of the course include: fostering interaction among students with diverse interests and backgrounds, keeping abreast of current publications of broad interest, and providing a forum where free discussion is encouraged.
ENVS	696A	ENVS 696A	Seminar	1	Soils, Water + Envir Sci	The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.
RAM	696A	RAM 696A	Seminar	1	Rangeland Management	The development and exchange of scholarly information, in a small group setting, on selected topics in Rangeland science and management. Course registrants exchange results of research through discussions, reports, and/or papers.

RNR	696A	RNR 696A	Seminar	1	Renewable Nat Resources	The development and exchange of scholarly information, in a small group setting, on selected topics in Natural Resources science and management. Course registrants exchange results of research through discussions, reports, and/or papers.
WFSC	696A	WFSC 696A	Seminar	1	Fish + Wildlife Ecology	The development and exchange of scholarly information, in a small group setting, on selected topics in Wildlife and Fisheries science and management. Course registrants exchange results of research through discussions, reports, and/or papers.
WSM	696A	WSM 696A	Seminar	1	Watershed Management	This one unit seminar will examine physical, chemical, and biological categories of water pollution, with an emphasis on understanding their ecological impacts. Students will review and critique recent primary literature relevant to their areas of research and interest. The seminar will also examine recent trends in scientific publishing, e.g. subscription vs. open access literature.
GEOG	696C	GEOG 696C	Seminar	3	Physical Geography	Based on the exchange of scholarly information, usually in a small group setting, this course examines contemporary developments in physical geography. The selected topics rotate according to the interests of the faculty convener and the graduate student enrollees. Generally grounded in theories of biophysical space, typical topics include coupled natural and human systems, ecosystem disturbance and resiliency, energy and mass transfers, measurement and modeling of physical systems. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.
LAW	696I	LAW 696I	Seminar	2	Intl Environmntl Law	The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.
ENVS	696P	ENVS 696P	Seminar	1	Hzd Waste Risk & Remed	Interdisciplinary trainees who participate in a colloquium, professional development activities and research translation/community engagement activities.
GEOG	696R	GEOG 696R	Seminar	3	International Environ. Policy	This seminar examines the challenges of understanding and governing environmental change at the international scale. The goal of the seminar is to provide an overview of the major scholars, theories and debates in the governance of international environmental issues such as climate change, land use, oceans, biodiversity, and trans-boundary resources; to critically assess scholarship and policy; and to understand the origins and impacts of international environmental policy in different countries and geographic regions.
ECON	696W	ECON 696W	Seminar	3	Environmental & Energy Econ	The analysis of important and current empirical topics in environmental and energy economics. It begins with a brief introduction to some of the most important theoretical ideas of environmental economics and then dives into recent empirical analyses of the costs and benefits of environmental and energy issues. Topics will include: economic and health costs of pollution, wholesale and retail electricity markets, household energy behavior, emissions markets, the effects of environmental regulation on firms, fuel economy standards and gasoline taxes, and the relationship between the environment and economic development.
RNR	696W	RNR 696W	Seminar	1	Water, Society, & Policy Semnr	This course is designed to introduce students to the various ways that water science, societal forces, and public policy intersect, and to familiarize students with the various units on campus addressing complex interdisciplinary water management questions
MNE	697F	MNE 697F	Workshop	2	Val Mnrl Assts+Prjt	This course provides detailed background and practical application of valuation and risk analysis approaches for determining transaction values for mineral assets.