Stanford University Sustainability Course Inventory

May 2016

Subject	Description	Catalog Nbr	Level	Sustainability Related	Sustainability Focused	Full Course Description
AA	ADVANCED SPACECRAFT DYN/CTRL	271B	GR	X		Attitude representation and parametrization; unperturbed and perturbed attitude dynamics and stability; attitude sensors and actuators; linear and nonlinear attitude control; optimal attitude maneuvers; dynamics of flexible spacecraft and space tethers; invited lectures from industry. Prerequisites: AA 242A, ENGR 105, AA 279A, and familiarity with MatLab.
AA	SPACECRAFT DESIGN LABORATORY	236B	GR	X		Continuation of 236A. Emphasis is on practical application of systems engineering to the life cycle program of spacecraft design, testing, launching, and operations.
AA	DESIGN COMPOSITE STRUCTURES	257	GR	X		Hands-on design, analysis, and manufacturing in composites. Composite beams, columns, and plates; application of finite element methods to composite structures; failure analysis and damage tolerance design of composite structures; and impact damage, compression after impact, and bolted and bonded composites joints. Class divided into working teams (design, analysis, manufacturing, and tests) to design and build a composite structure to be tested to failure; the structure may enter the national SAMPE composite bridge design contest. Prerequisite: 256 or consent of instructor.
AA	ADVANCED CFD	215A	GR	X		High resolution schemes for capturing shock waves and contact discontinuities; upwinding and artificial diffusion; LED and TVD concepts; alternative flow splittings; numerical shock structure. Discretization of Euler and Navier Stokes equations on unstructured meshes; the relationship between finite volume and finite element methods. Time discretization; explicit and implicit schemes; acceleration of steady state calculations; residual averaging; math grid preconditioning. Automatic design; inverse problems and aerodynamic shape optimization via adjoint methods. Pre- or corequisite: 214B or equivalent.
AA	TECHNIQUES OF FAILURE ANALYSIS	252	GR	X		Introduction to the field of failure analysis, including fire and explosion analysis, large scale catastrophe projects, traffic accident reconstruction, aircraft accident investigation, human factors, biomechanics and accidents, design defect cases, materials failures and metallurgical procedures, and structural failures. Product liability, failure modes and effects analysis, failure prevention, engineering ethics, and the engineer as expert witness.
AA	SMART STRUCTURES	280	GR		X	Mechanics of smart materials and current approaches for engineering smart structures to monitor health, self heal, and adapt to environment. Definition of smart structures; constitutive models for smart materials; piezoelectric ceramics; electro-active polymers; shape memory alloys; bio-inspired materials and structures; self-healing materials; sensors and sensor networks; structural health monitoring; and energy harvesting.
AA	SEQUENTIAL DECISION MAKING	229	GR	X		Survey of recent research advances in intelligent decision making for dynamic environments from a computational perspective. Efficient algorithms for single and multiagent planning in situations where a model of the environment may or may not be known. Partially observable Markov decision processes, approximate dynamic programming, and reinforcement learning. New approaches for overcoming challenges in generalization from experience, exploration of the environment, and model representation so that these methods can scale to real problems in a variety of domains including aerospace, air traffic control, and robotics. Students are expected to produce an original research paper on a relevant topic. Prerequisites: AA 228/ CS 238 or CS 221.
AA	SPACECRAFT DESIGN	236A	GR	X		The design of unmanned spacecraft and spacecraft subsystems emphasizing identification of design drivers and current design methods. Topics: spacecraft configuration design, mechanical design, structure and thermal subsystem design, attitude control, electric power, command and telemetry, and design integration and operations.
AA	SPACECRAFT DESIGN	236C	GR	X		The design of unmanned spacecraft and spacecraft subsystems emphasizing identification of design drivers and current design methods. Topics: spacecraft configuration design, mechanical design, structure and thermal subsystem design, attitude control, electric power, command and telemetry, and design integration and operations.
AA	INTRO TO SPACE ENVIRONMENT	251	GR	X		The environment through which space probes and vehicles travel and orbit. Survey of physical phenomena in the sun, solar wind, magnetospheres, ionospheres, and upper atmospheres of objects in the solar system. Introduction to the physical processes governing space plasmas, solar-terrestrial interactions, and ionized and neutral media surrounding the Earth and other solar system bodies. Prerequisite: AA 244A.
AA	GLOBAL POSITIONING SYSTEMS	272C	GR	X		The principles of satellite navigation using GPS. Positioning techniques using code tracking, single and dual frequency, carrier aiding, and use of differential GPS for improved accuracy and integrity. Use of differential carrier techniques for attitude determination and precision position determination.

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AA	ELECTRIC AUTOMOBILES/AIRCRAFT	116Q	GR		X	Transportation accounts for nearly one-third of American energy use and greenhouse gas emissions and three-quarters of American oil consumption. It has crucial impacts on climate change, air pollution, resource depletion, and national security. Students wishing to address these issues reconsider how we move, finding sustainable transportation solutions. An introduction to the issue, covering the past and present of transportation and its impacts; examining alternative fuel proposals; and digging deeper into the most promising option: battery electric vehicles. Energy requirements of air, ground, and maritime transportation; design of electric motors, power control systems, drive trains, and batteries; and technologies for generating renewable energy. Two opportunities for hands-on experiences with electric cars. Prerequisites: Introduction to calculus and Physics AP or elementary mechanics.
AA	INTRO AERONAUTICS/ASTRONAUTICS	100	UG	X		The principles of fluid flow, flight, and propulsion; the creation of lift and drag, aerodynamic performance including takeoff, climb, range, and landing performance, structural concepts, propulsion systems, trajectories, and orbits. The history of aeronautics and astronautics.
AA	MECHANICS OF COMPOSITES	256	GR	X		Fiber reinforced composites. Stress, strain, and strength of composite laminates and honeycomb structures. Failure modes and failure criteria. Environmental effects. Manufacturing processes. Design of composite structures. Individual design project required of each student, resulting in a usable computer software.
AA	AIRCRAFT & ROCKET PROPULSION	283	GR	X		Introduction to the design and performance of airbreathing and rocket engines. Topics: the physical parameters used to characterize propulsion system performance; gas dynamics of nozzles and inlets; cycle analysis of ramjets, turbojets, turbofans, and turboprops; component matching and the compressor map; introduction to liquid and solid propellant rockets; multistage rockets; hybrid rockets; thermodynamics of reacting gases. Prerequisites: undergraduate background in fluid mechanics and thermodynamics.
AA	ANALYSIS OF STRUCTURES	240A	GR	X		Elements of two-dimensional elasticity theory. Boundary value problems; energy methods; analyses of solid and thin walled section beams, trusses, frames, rings, monocoque and semimonocoque structures.
AA	ANALYSIS OF STRUCTURES II	240B	GR	X		Thin plate analysis. Structural stability. Material behavior: plasticity and fracture. Introduction of finite element analysis; truss, frame, and plate structures.
AA	AIRCRAFT DESIGN/SYNTH/ANALYSIS	241A	GR	X		New aircraft systems emphasizing commercial aircraft. Economic and technological factors that create new aircraft markets. Determining market demands and system mission performance requirements; optimizing configuration to comply with requirements; the interaction of disciplines including aerodynamics, structures, propulsion, guidance, payload, ground support, and parametric studies. Applied aerodynamic and design concepts for use in configuration analysis. Application to a student-selected aeronautical system; applied structural fundamentals emphasizing fatigue and fail-safe considerations; design load determination; weight estimation; propulsion system performance; engine types; environmental problems; performance estimation. Direct/indirect operating costs prediction and interpretation. Aircraft functional systems; avionics; aircraft reliability and maintainability.
AA	AIRCRAFT DESIGN/SYNTH/ANALYSIS	241B	GR	X		New aircraft systems emphasizing commercial aircraft. Economic and technological factors that create new aircraft markets. Determining market demands and system mission performance requirements; optimizing configuration to comply with requirements; the interaction of disciplines including aerodynamics, structures, propulsion, guidance, payload, ground support, and parametric studies. Applied aerodynamic and design concepts for use in configuration analysis. Application to a student-selected aeronautical system; applied structural fundamentals emphasizing fatigue and fail-safe considerations; design load determination; weight estimation; propulsion system performance; engine types; environmental problems; performance estimation. Direct/indirect operating costs prediction and interpretation. Aircraft functional systems; avionics; aircraft reliability and maintainability.
AA	DES/CONSTR/TEST OF AIRCRAFT	241X	GR	X		Students grouped according to their expertise to carry out the multidisciplinary design of a solar-powered autonomous aircraft that must meet a clearly stated set of design requirements. Design and construction of the airframe, integration with existing guidance, navigation, and control systems, and development and operation of the resulting design. Design reviews and reports.
AA	ADVANCED ROCKET PROPULSION	284A	GR	X		The principles of rocket propulsion system design and analysis. Fundamental aspects of the physics and chemistry of rocket propulsion. Focus is on the design and analysis of chemical propulsion systems including liquids, solids, and hybrids. Nonchemical propulsion concepts such as electric and nuclear rockets. Launch vehicle design and optimization issues including trajectory calculations.

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AFRICAAM	ALLYSHIP	157P	GR	X		(Co-taught by Dereca Blackmon and Daniel Murray) Is multiracial solidarity necessary to overcome oppression that disproportionately affects people of color? What is frontline leadership and what role should people play if they are not part of frontline communities? In this course we will critically examine practices of solidarity and allyship in movements for collective liberation. Through analysis of historical and contemporary movements, as well as participation in movement work, we will see how movements have built multiracial solidarity to address issues that are important to the liberation of all. We will also see how racial justice intersects with other identities and issues. This course is for students that want to learn how to practice solidarity, whether to be better allies or to work more effectively with allies. As a community engaged learning course, students will have the option to work with an organization that is explicitly devoted to this kind of multiracial movement-building work around a particular issue. Specific issues are yet to be determined, but may include environmental justice, policing and mass incarceration, and education.
AFRICAAM	19TH-CENTURY AMERICA	50B	GR	X		(Same as HISTORY 150B. History majors and others taking 5 units, register in 150B.) Territorial expansion, social change, and economic transformation. The causes and consequences of the Civil War. Topics include: urbanization and the market revolution; slavery and the Old South; sectional conflict; successes and failures of Reconstruction; and late 19th-century society and culture.
AFRICAAM	AFRICAN POLITICS	146A	GR	X		Africa has lagged the rest of the developing world in terms of economic development, the establishment of social order, and the consolidation of democracy. This course seeks to identify the historical and political sources accounting for this lag, and to provide extensive case study and statistical material to understand what sustains it, and how it might be overcome.
AFRICAAM	SOC CLASS, RACE/ETHN & HEALTH	132	UG	X		Examines health disparities in the U.S., looking at the patterns of those disparities and their root causes. Explores the intersection of lower social class and ethnic minority status in affecting health status and access to health care. Compares social and biological conceptualizations of race and ethnicity.
AFRICAAM	FOREIGN AID DEVELOPMENT AFRICA	111	UG	X		Is foreign aid a solution? or a problem? Should there be more aid, less aid, or none at all? How do foreign aid and local initiatives intersect? A clinic in Uganda that addresses AIDS as a family and community problem. Multiple strategies in Tanzania to increase girls' schooling. These are imaginative and innovative approaches to pressing and contested policy challenges. We will examine several contentious issues in contemporary Africa, exploring their roots and the intense conflicts they engender, with special attention to foreign aid and the aid relationship. As African communities and countries work to shape their future, what are the foreign roles and what are their consequences?
AFRICAAM	BLACK LIFE AND DEATH	189	UG	X		Professor Robin Kelley will teach this course. Of course, this is a history/genealogy of how we got to this place - precarity, mass incarceration, privatization and (re)dispossession of black lives, and the movements that erupted ¿ all since the early 1970s. It is as much an intellectual history as it is a political and cultural one since I will circle back to the roots of "neoliberal thinking¿ in 18th and 19th century liberalism, colonialism, imperialism, social Darwinism in the so-called ¿Gilded Age.¿ Will also touch on the rise of social democracy and its recasting of ¿liberal¿ as the welfare state, the ascendance of military Keynesianism, and Hayek¿s and Milton Freidman¿s Cold War resuscitation and revision of 19th century liberalism. Much of our reading and discussion will examine the global economic crisis of the 1970s, and the subsequent restructuring of the political economy, the state, and culture (not limited to the U.S. but looking at the ¿Third World¿ or Global South¿issues of debt, austerity and structural adjustment policies, environmental destruction, and military intervention. But the main focus is on how neoliberalism assaulted most black lives while enriching a handful of others; how is spawned a level of state violence that sometimes feels unprecedented and against which many movements emerged.
AFRICAAM	LITERATURE AND GLOBAL HEALTH	229	GR	X		This course examines the ways writers in literature and medicine have used the narrative form to explore the ethics of care in what has been called the developing world. We will begin with a call made by the editor-in-chief of The Lancet for a literature of global health, namely fiction modeled on the social reform novels of the nineteenth century, understood to have helped readers develop a conscience for public health as the field emerged as a modern medical specialty. We will then spend the quarter understanding how colonial, postcolonial, and world literatures have answered and complicated this call. Readings will include prose fiction by Albert Camus, Joseph Conrad, Tsitsi Dangaremgba, Amitav Ghosh, Susan Sontag as well as physician memoirs featuring Frantz Fanon, Albert Schweitzer, Abraham Verghese, Paul Farmer. And each literary reading will be paired with medical, philosophical, and policy writings that deeply inform the field of global health.

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AFRICAAM	COMMUNITY ORGANIZING	100	UG	X		This course explores the theory, practice and history of grassroots community organizing as a method for developing community power to promoting social justice. We will develop skills for 1-on-1 relational meetings, media messaging, fundraising strategies, power structure analysis, and strategies organizing across racial/ethnic difference. And we will contextualize these through the theories and practices developed in the racial, gender, queer, environmental, immigrant, housing and economic justice movements to better understand how organizing has been used to engage communities in the process of social change. Through this class, students will gain the hard skills and analytical tools needed to successfully organize campaigns and movements that work to address complex systems of power, privilege, and oppression. As a Community-Engaged Learning course, students will work directly with community organizations on campaigns to address community needs, deepen their knowledge of theory and history through hands-on practice, and develop a critical analysis of inequality at the structural and interpersonal levels. Placements with community organizations are limited. Enrollment will be determined on the first day through a simple application process. Students will have the option to continue the course for a second quarter in the Winter, where they will execute a campaign either on campus or in collaboration with their community partner.
AFRICAAM	SOUTH AFRICAN ENCOUNTERS	115	UG	X		This course is a prerequisite for all those accepted to or on the wait list for the following quarter's BOSP Cape Town term abroad. It will explore issues in contemporary South Africa.
AFRICAAM	19TH-CENTURY AMERICA	150B	GR	X		(Same as HISTORY 50B. History majors and others taking 5 units, register for 150B.) Territorial expansion, social change, and economic transformation. The causes and consequences of the Civil War. Topics include: urbanization and the market revolution; slavery and the Old South; sectional conflict; successes and failures of Reconstruction; and late 19th-century society and culture.
AFRICAST	FOREIGN AID DEVELOPMENT AFRICA	212	GR	X		Is foreign aid a solution? or a problem? Should there be more aid, less aid, or none at all? How do foreign aid and local initiatives intersect? A clinic in Uganda that addresses AIDS as a family and community problem. Multiple strategies in Tanzania to increase girls' schooling. These are imaginative and innovative approaches to pressing and contested policy challenges. We will examine several contentious issues in contemporary Africa, exploring their roots and the intense conflicts they engender, with special attention to foreign aid and the aid relationship. As African communities and countries work to shape their future, what are the foreign roles and what are their consequences?
AFRICAST	PUBLIC POLICY MAKING IN AFRICA	111	UG	X		Policy making in Africa and the intersection of policy processes and their political and economic dimensions. The failure to implement agreements by international institutions, national governments, and nongovernmental organizations to promote education. Case studies of crowded and poorly equipped schools, overburdened and underprepared teachers, and underfunded education systems.
AFRICAST	PUBLIC POLICY MAKING IN AFRICA	211	GR	X		Policy making in Africa and the intersection of policy processes and their political and economic dimensions. The failure to implement agreements by international institutions, national governments, and nongovernmental organizations to promote education. Case studies of crowded and poorly equipped schools, overburdened and underprepared teachers, and underfunded education systems.
AFRICAST	LITERATURE AND GLOBAL HEALTH	229	GR	X		This course examines the ways writers in literature and medicine have used the narrative form to explore the ethics of care in what has been called the developing world. We will begin with a call made by the editor-in-chief of The Lancet for a literature of global health, namely fiction modeled on the social reform novels of the nineteenth century, understood to have helped readers develop a conscience for public health as the field emerged as a modern medical specialty. We will then spend the quarter understanding how colonial, postcolonial, and world literatures have answered and complicated this call. Readings will include prose fiction by Albert Camus, Joseph Conrad, Tsitsi Dangaremgba, Amitav Ghosh, Susan Sontag as well as physician memoirs featuring Frantz Fanon, Albert Schweitzer, Abraham Verghese, Paul Farmer. And each literary reading will be paired with medical, philosophical, and policy writings that deeply inform the field of global health.
AFRICAST	HLTH/SCI/MED 20TH CENT AFRICA	48S	GR	X		This course will examine the impact of colonial policies and post-colonial development on patterns of sickness, wellness and health care in twentieth century sub-Saharan Africa. Some topics will include: the role of colonial science in the formulation of ideas about race, colonial epidemics, labor migration and disease, urban health, encounters between African healers and biomedicine, histories of HIV/AIDS, the impact of debt and Structural Adjustment Programs on public health, and the politics of humanitarian interventions in African health. Priority given to history majors and minors.

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AFRICAST	CHALLENGING THE STAUS QUO	142	UG	X		This seminar is part of a broader program on Social Entrepreneurship at CDDRL in partnership with the Haas Center for Public Service. It will use practice to better inform theory. Working with three visiting social entrepreneurs from developing and developed country contexts students will use case studies of successful and failed social change strategies to explore relationships between social entrepreneurship, gender, democracy, development and justice. It interrogates current definitions of democracy and development and explores how they can become more inclusive of marginalized populations. This is a service learning class in which students will learn by working on projects that support the social entrepreneurs' efforts to promote social change. Students should register for either 3 OR 5 units only. Students enrolled in the full 5 units will have a service-learning component along with the course. Students enrolled for 3 units will not complete the service-learning component. Limited enrollment. Attendance at the first class is mandatory in order to participate in service learning.
AFRICAST	CHALLENGING THE STAUS QUO	242	GR	X		This seminar is part of a broader program on Social Entrepreneurship at CDDRL in partnership with the Haas Center for Public Service. It will use practice to better inform theory. Working with three visiting social entrepreneurs from developing and developed country contexts students will use case studies of successful and failed social change strategies to explore relationships between social entrepreneurship, gender, democracy, development and justice. It interrogates current definitions of democracy and development and explores how they can become more inclusive of marginalized populations. This is a service learning class in which students will learn by working on projects that support the social entrepreneurs' efforts to promote social change. Students should register for either 3 OR 5 units only. Students enrolled in the full 5 units will have a service-learning component along with the course. Students enrolled for 3 units will not complete the service-learning component. Limited enrollment. Attendance at the first class is mandatory in order to participate in service learning.
AFRICAST	FOREIGN AID DEVELOPMENT AFRICA	112	UG	X		Is foreign aid a solution? or a problem? Should there be more aid, less aid, or none at all? How do foreign aid and local initiatives intersect? A clinic in Uganda that addresses AIDS as a family and community problem. Multiple strategies in Tanzania to increase girls' schooling. These are imaginative and innovative approaches to pressing and contested policy challenges. We will examine several contentious issues in contemporary Africa, exploring their roots and the intense conflicts they engender, with special attention to foreign aid and the aid relationship. As African communities and countries work to shape their future, what are the foreign roles and what are their consequences?
AMSTUD	ALLYSHIP	157P	GR	X		(Co-taught by Dereca Blackmon and Daniel Murray) Is multiracial solidarity necessary to overcome oppression that disproportionately affects people of color? What is frontline leadership and what role should people play if they are not part of frontline communities? In this course we will critically examine practices of solidarity and allyship in movements for collective liberation. Through analysis of historical and contemporary movements, as well as participation in movement work, we will see how movements have built multiracial solidarity to address issues that are important to the liberation of all. We will also see how racial justice intersects with other identities and issues. This course is for students that want to learn how to practice solidarity, whether to be better allies or to work more effectively with allies. As a community engaged learning course, students will have the option to work with an organization that is explicitly devoted to this kind of multiracial movement-building work around a particular issue. Specific issues are yet to be determined, but may include environmental justice, policing and mass incarceration, and education.
AMSTUD	POLITICS & PUBLIC POLICY	123X	GR	X		(Formerly PS 2) American political institutions (the Presidency, Congress, and the Court) and political processes (the formation of political attitudes and voting) have for some time now been criticized as inadequate to the task of making modern public policy. Against the backdrop of American culture and political history we examine how public policy has been and is being made. We use theories from Political Science and Economics to assess the state of the American system and the policy making process. We use case studies and lectures to analyze contemporary issues including environmental policy, taxes and spending , gun control , economic growth and inequality and mobility. In some of these issue areas we use comparative data from other countries to see how the U.S. is doing relative to other countries. In addition to class room lecture and discussion, student groups are formed to analyze policy issues of relevance to them. Undergraduate Public Policy students are required to enroll in this class for five units.

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AMSTUD	DYSTOPIAN CALIFORNIA	10Q	GR	X		Dystopian California examines the ways the Golden State has been popularly imagined both historically as the Land of Promise and more recently as the land of apocalypse in science fiction and disaster films. Through this lens, we¿ll be exploring anxieties articulated through images of natural disaster, environmental degradation, urbanization and urban decay, invasion (both viral and ¿alien¿), societal collapse, overpopulation, and nuclear holocaust ¿ as well as the tenacity of the human spirit. We¿ll be discussing conceptions of survival and the ways these films both articulate societal fears and help to neutralize them. More broadly we will discuss how these films metaphorically address, through the loss of innocence, the possibility of establishing a truly Utopian California ¿ the Golden Land of Opportunity promised to us ¿ that had been unattainable or lost in the melee of postmodernity
AMSTUD	THE AMERICAN WEST	124A	GR	X		The American West is characterized by frontier mythology, vast distances, marked aridity, and unique political and economic characteristics. This course integrates several disciplinary perspectives into a comprehensive examination of Western North America: its history, physical geography, climate, literature, art, film, institutions, politics, demography, economy, and continuing policy challenges. Students examine themes fundamental to understanding the region: time, space, water, peoples, and boom and bust cycles.
ANTHRO	SMOKE & MIRRORS GLOBAL HEALTH	182N	GR	X		A few years ago, health experts began calling out tobacco as engendering a global health crisis, categorizing the cigarette as the world's greatest weapon of mass destruction. A "global health crisis"? What merits that title if not tobacco use? A hundred million people were killed by tobacco in the 20th century, and ten times that number ¿ a billion people ¿ are predicted to die prematurely from exposure to cigarette smoke over the next hundred years. How has tobacconcome to be labeled a global health crisis over the last decade and what has been the political response? From whence does activism and ongoing complacency regarding tobacco arise? How are they created in different cultural contexts?nnThis course aims to provide students conceptual tools to tackle two specific thought projects: (1) to understand how institutional actors compete to define a situation in the world today as a problem of global health, and (2) to understand the sociocultural means by which something highly dangerous to health such as the cigarette is made both politically contentious and inert. On both fronts, special attention will be given to the ways global health activism and complacency unfold in the U.S. and China.
ANTHRO	THE BOUNDARIES OF HUMANITY	128A	GR	X		Advances in research and technology are blurring the boundaries between humans, animals, and machines, challenging conventional notions of human nature. Seminar explores the question of what it now means to be human and the personal, social, and ethical implications of our advancing technologies through the lens of various disciplines, including anthropology, cognitive psychology, neuroscience, genetics, evolutionary biology, biotechnology, and artificial intelligence. Includes guest speakers from fields and industries where important questions are being raised.
ANTHRO	THEORY OF ECO & ENVIRO ANTHRO	90C	GR		X	Dynamics of culturally inherited human behavior and its relationship to social and physical environments. Topics include a history of ecological approaches in anthropology, subsistence ecology, sharing, risk management, territoriality, warfare, and resource conservation and management. Case studies from Australia, Melanesia, Africa, and S. America.
ANTHRO	ANTHROPOLOGY AND CONSERVATION	363A	GR		X	Graduate seminar focused on key works by anthropologists on environmental conservation. We will discuss both classics (ie, works by Ostrom, Lansing, Bray) as well recent debates regarding communities, neoliberalism and conservation. Students will present on topics of particular interest or relevance to their research.
ANTHRO	MEGACITIES	42	UG	X		In this course we will examine the meaning, processes, and challenges of urbanization. Through a series of targeted readings across history and geography and through the study of varied means of representation (anthropology, literature, cartography, film, etc), the class will analyze the ways in which urban forms have come into being and created, met, and/or ignored challenges such as disease, water, transport, religious and class conflict, colonialism, labor, and trade. Students will read anthropology in conjunction with other disciplines (literature, urban planning, public health, architecture, and economics) to learn the ways in which ethnographies of immigration, urban poverty, class disparity, economic development and indicators, noise, and transportation substantively augment our understandings of how people live within globalization.

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ANTHRO	LANGUAGE AND THE ENVIRONMENT	125	UG		X	Lecture course on vocabulary and grammar as keys to peoples' understanding and use of the environment. Ethnobotany, ethnobiology, and ethnosemantics in the analysis of the language of place, plants and animals, the earth, the body, and disease. Terminological gaps and gluts and what they imply. Language as a strategic resource in environmental management. Language contact and conflict in the modern global environment, with particular attention to the vocabularies of capitalism and property. Language extinction and its environmental implications.
ANTHRO	HUMAN MOBILIY & ADAPTABILITY	183B	GR	X		Mobility, whether in the form of seasonal or permanent migration, is an ancient practice necessary for many subsistence strategies, including hunting-and-gathering and pastoralism. Many new forms of mobility have emerged and now it is nearly impossible to consider a patch of human society that is not engaged in or directly impacted by habitual, patterned geographic mobility. Today, almost everywhere in the world, people can get farther, faster; urbanization, environmental degradation, and civil unrest are driving groups of people who do not have a cultural tradition of nomadic migration to adopt a mobile lifestyle¿sometimes permanently, sometimes temporarily¿in search of new economic or resource opportunities. In this seminar course, we will explore modern patterns of human mobility and migration as adaptive strategies for predictably and unpredictably changing environments. Using a framework of biological and cultural adaptation, we will discuss the major types of current human mobility (e.g. nomadism, immigration, migrant labor, displacement) and how they influence and are influenced by social systems, resource access, and health.
ANTHRO	ANTHRO HEALTH & LATIN AMERICA	337B	GR	X		The purpose of this course is to examine the anthropological and ethnographic research on emerging health issues and sufferings in Latin America. In particular, the class explores how anthropologists understand and ponder social, economic, political, environmental, spatial processes that shape patterns of health, suffering and death, and the strategies to address them. By analyzing paradigmatic case studies, we will discuss theoretical concepts and social perspectives, as well as ethnographic dilemmas and methods.nnTaking a critical perspective, this class will not only explore the standard topics on Latin American health (hunger, infectious disease, mental health, etc.). We will also focus on emerging sufferings (drug use, epidemics, environmental discomforts and sufferings, etc.). Both standard and emerging topics are examined with respect to the changes in political economy, medical institutions and policy approaches, models of care and caregiving, gender violence, circulation and appropriation of expert knowledge, contamination, migration, spatial segregation, violence, marginalization, abandonment, justice and human rights.nnInterdisciplinary investigation is conducted into most of these health issues, not only in the global health field. They are addressed by the South American Social Medicine and Collective Health approaches. This class will include a description and critical analysis of their theoretical frameworks and core concepts, as well as their relationships to international and local medical anthropological theory and research.
ANTHRO	MULTISPECIES ETHNOGRAPHY	170A	GR	X		This course explores new modes of writing and researching in anthropology. Multispecies ethnography considers nonhuman life as objects of analysis¿animals, plants, fungi, bacteria, and viruses¿as having political lives and import. By studying how these nonhuman entities, including metals, interact with and shape human existence, multispecies ethnographers who study ¿life¿ ¿ from the human down to the microbe, must engage in multiple worlds: from the jungle to the laboratory, from the field to the desk. This course will incorporate readings on ¿zoe¿ and ¿bios¿, the making of species categories, relationships between the human and nonhuman, current debates on breaking with the species concept and ¿the rights of mother earth.¿ We will read the conceptual works in conjunction with current multispecies ethnographies to give grounding to the theory.
ANTHRO	MULTISPECIES ETHNOGRAPHY	270A	GR	X		This course explores new modes of writing and researching in anthropology. Multispecies ethnography considers nonhuman life as objects of analysis¿animals, plants, fungi, bacteria, and viruses¿as having political lives and import. By studying how these nonhuman entities, including metals, interact with and shape human existence, multispecies ethnographers who study ¿life¿ ¿ from the human down to the microbe, must engage in multiple worlds: from the jungle to the laboratory, from the field to the desk. This course will incorporate readings on ¿zoe¿ and ¿bios¿, the making of species categories, relationships between the human and nonhuman, current debates on breaking with the species concept and ¿the rights of mother earth.¿ We will read the conceptual works in conjunction with current multispecies ethnographies to give grounding to the theory.

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ANTHRO	ANTHROPOLOGY OF ENVIRONMENT	116B	GR		X	This seminar interrogates the history of anthropology's approach to the environment, beginning with early functionalist, structuralist, and Marxist accounts of human-environment relationships. It builds towards more recent developments in the field, focusing on nonhuman and relational ontologies as well as current projects on the intersections of nature, capital, politics, and landscape histories. At the end of this class, students will be familiar with the intellectual histories of environmental anthropology and contemporary debates and tensions around questions of ethics, agency, environment, and historical causality.
ANTHRO	ANTHROPOLOGY OF ENVIRONMENT	216B	GR		X	This seminar interrogates the history of anthropology's approach to the environment, beginning with early functionalist, structuralist, and Marxist accounts of human-environment relationships. It builds towards more recent developments in the field, focusing on nonhuman and relational ontologies as well as current projects on the intersections of nature, capital, politics, and landscape histories. At the end of this class, students will be familiar with the intellectual histories of environmental anthropology and contemporary debates and tensions around questions of ethics, agency, environment, and historical causality.
ANTHRO	CULTURE AND EPIGENETICS	113	UG	X		The course examines the impact of new research in epigenetics on our understanding of long-term cultural change. The course examines the various attempts that have been made over recent decades to find a synthesis between cultural and biological evolution. These approaches, often termed neo-Darwinian, include memes, dual inheritance theory, theories of cultural selection and transmission, niche construction theory and macro-evolutionary approaches. Research in all these areas will be examined, with particular reference to explanations for the origins of agriculture, but also including other transformations, and critiqued. New research in epigenetics offers an alternative non-Darwinian evolutionary perspective that avoids many of the problems and pitfalls in the neo-Darwinian approaches. Cultural evolution comes to be viewed as cumulative, directional and Lamarckian, since heritable epigenetic variation can underlie evolutionary change. Epigenetics opens the way for human cultural entanglements to become the drivers for evolutionary change, thus allowing the full range of social processes studied in the social and cultural sciences to take their place in the study and analysis of long-term change.
ANTHRO	INDIGENOUS PEOPLE & ENVIR PROB	162	UG		X	The social and cultural consequences of contemporary environmental problems. The impact of market economies, development efforts, and conservation projects on indigenous peoples, emphasizing Latin America. The role of indigenous grass roots organizations in combating environmental destruction and degradation of homeland areas.
ANTHRO	INDIGENOUS PEOPLE & ENVIR PROB	262	GR		X	The social and cultural consequences of contemporary environmental problems. The impact of market economies, development efforts, and conservation projects on indigenous peoples, emphasizing Latin America. The role of indigenous grass roots organizations in combating environmental destruction and degradation of homeland areas.
ANTHRO	ECOGROUP	364	GR		X	Seminar; restricted to graduate students. Topics vary with instructor. How to ask appropriate questions, how to derive research hypotheses from theory, how to design methodologies for testing hypotheses, and how to present results by reading and critiquing key contemporary papers in the field. Ph.D. students enrolling in this course to fulfill the department review course requirement must enroll in 5 units. Graduate students enrolling in this course to participate in a topical forum may enroll in 2 units. Course may be repeated for 2 units.
ANTHRO	THINGS	373	GR	X		This course examines a variety of approaches that claim to explore the relationships between humans and things. Some of the approaches include Marx and material culture studies; Heidegger; cognitive and phenomenological; Actor Network Theory. But there is a need also to examine behavioral and ecological and Darwinian approaches. Many of these approaches do not adequately deal with the physicality of things as objects and there is a need to seek a way to incorporate such aspects of things into social theory.
ANTHRO	ANTHROPOLOGY BROWN BAG	445	GR	X		Current topics and trends in cultural/social anthropology, archaeology, and environmental and ecological anthropology. Enrollment in this noon-time series is restricted to the Department of Anthropology Master¿s students and First and Second-year PhD students.
APPPHYS	INTRO BIOPHYSICS	205	GR	X		Core course appropriate for advanced undergraduate students and graduate students with prior knowledge of calculus and a college physics course. Introduction to how physical principles offer insights into modern biology, with regard to the structural, dynamical, and functional organization of biological systems. Topics include the roles of free energy, diffusion, electromotive forces, non-equilibrium dynamics, and information in fundamental biological processes.

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APPPHYS	ENERGY OPTIONS 21ST CENTURY	79N	GR		X	Preference to freshmen. Choices for meeting the future energy needs of the U.S. and the world. Basic physics of energy sources, technologies that might be employed, and related public policy issues. Trade-offs and societal impacts of different energy sources. Policy options for making rational choices for a sustainable world energy economy.
ARCHLGY	DESIGN OF CITIES	156	UG	X		Long-term, comparative and archaeological view of urban planning and design. Cities are the fastest changing components of the human landscape and are challenging our relationships with nature. They are the historical loci of innovation and change, are cultural hotspots, and present a tremendous challenge through growth, industrial development, the consumption of goods and materials. We will unpack such topics by tracking the genealogy of qualities of life in the ancient Near Eastern city states and those of Graeco-Roman antiquity, with reference also to prehistoric built environments and cities in the Indus Valley and through the Americas. The class takes an explicitly human-centered view of urban design and one that emphasizes long term processes.
ARCHLGY	MONUMENTS AND LANDSCAPES	117B	GR	X		The landscape is a result of the action and interaction of human and natural factors. Communities have altered their landscapes for a variety of reasons, including the subsistence practices; as a consequence of economic growth; to express a social ideology, and as a consequence of political and religious drivers. Accordingly, landscapes enable physical and provide psychological sustenance to people, and the human need to relate to our surroundings is part of the way in which identities are created and disputed. Within the humanities, landscape is being conceptualized as a process, a practice and as performance, and monuments within a given landscape have an equally important role, not to mention history. They are often the most durable and well-known evidence of the ancient civilizations, and should be observed jointly with the landscape. How did the landscape predefine the monument and how did the monument complement, emphasize or devalue the landscape? What philosophy channeled the construction of the monuments within the landscapes? Whether ephemeral or permanent, the human agency left traces in the landscape; thus, both monuments and landscapes are the key indicators for understanding the ideology of a particular culture. Archaeology, through its interdisciplinary nature, provides a unique perspective, as well as tools, for examining the formation processes of all man-made elements, within both natural and cultural landscapes. nnThe course will address the multifaceted issues of the ways that people have consciously and unconsciously shaped the land around them through time. It will look into diverse, geographically and periodically influenced concepts of a monument and landscape. The course will be divided into two parts, with the first one covering the theory and methodological approaches and the second part the conceptual characteristics, modifications and changeability in various archaeological and historical periods and cultural frameworks.
ARTHIST	VISUAL CULTURE OF THE ARCTIC	273	GR		X	In what ways does contemporary art address the slowly unfolding catastrophes of melting ice and thawing permafrost in the Arctic due to climate change? How might contemporary art and experimental cinema help us come to grips with the emotional disturbance of living amidst the deep-seated changes that are happening in our environment? These are the key questions this course attempts to answer.nThe first part of the class attempts to outline the complex history of Arctic visual and cultural representations through an interdisciplinary lens. The second part focuses on the more recent artistic and cinematic responses to climate change in the arctic. For their final projects, students will be able to combine analytical writing with creative projects that could take the form of photography, installation art, web-based art, fiction, video or poetry.
ARTHIST	THE AMERICAN WEST	152	UG	X		The American West is characterized by frontier mythology, vast distances, marked aridity, and unique political and economic characteristics. This course integrates several disciplinary perspectives into a comprehensive examination of Western North America: its history, physical geography, climate, literature, art, film, institutions, politics, demography, economy, and continuing policy challenges. Students examine themes fundamental to understanding the region: time, space, water, peoples, and boom and bust cycles.
ARTSINST	THE STILLNESS OF THE DUNES	15	UG	X		An advanced writing course in nonfiction craft, drawing, and contemplative practice. a significant portion of each class meeting will focus on the development and sharpening of writing craft, especially of the essay, in a hybrid form both scholarly and personal. We will also explore writing as meditative practice, through examples and through short exercises. We will deepen our cultural understanding of the desert and its impact, through art, literature, philosophy, film, and contemplative practice, and the course will build toward a four-day camping trip to the dunes of Death Valley, six weeks into the quarter.

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ARTSINST	PUBLIC SERVICE INTERNSHIP PREP	40	UG	X		Are you prepared for your internship this summer? This workshop series will help you make the most of your internship experience by setting learning goals in advance; negotiating and communicating clear roles and expectations; preparing for a professional role in a non-profit, government, or community setting; and reflecting with successful interns and community partners on how to prepare sufficiently ahead of time. You will read, discuss, and hear from guest speakers, as well as develop a learning plan specific to your summer or academic year internship placement. This course is primarily designed for students who have already identified an internship for summer or a later quarter. You are welcome to attend any and all workshops, but must attend the entire series and do the assignments for 1 unit of credit.
ARTSTUDI	ECOLOGY OF MATERIALS	253	GR		X	Advanced studio-based sculpture course. Artists concerned with environmental impact and the interconnection of art with other fields. Students will take a critical look at the materials used in sculpture, in relation to environmental concerns, and the impact of material and technique upon form and content; therefore understanding the physical, expressive and environmental possibilities of diverse materials. Conceptual and technical considerations. Group discussions, critiques, readings, video presentations, a field trip to a local artist-in-residence program, and visiting lecturers.
ARTSTUDI	ART, INVENTION, & ACTIVISM	157	UG	X		How can art comment on and influence our understanding of the public spaces that we inhabit on a daily basis? This course will explore the many roles that art can play in social spaces as well as the history of art interventions in the public realm. Art can activate a wide variety of sites from the natural to the urban. Through site-specific sculpture and performance we will interact with the political, ecological and social aspects of public space in order to see these places and each other in a new light.
ARTSTUDI	DESIGN IN PUBLIC SPACES	164	UG	X		How does our design of public spaces and elements of our built environment influence and control people¿s movements and expressions in these spaces? Can re-designing a trashcan or a stairway change how people throw away their trash or use the stairs? What are the principles of democracy, surveillance, or personal expression at stake in our current shared spaces? How have artists and designers used their skills to question or re-direct people¿s behavior in these public spheres, or in other spheres of shared cultural heritage? Strategies include re-designing components of the built environment, but also other strategies of intervention, tactical media and reality hacking.
ARTSTUDI	DESIGN MASTERS PROJECT II	360B	GR	X		This two part graduate level seminar and studio course is required for second year JPD MFA students, and open to second year JPD ME students and all MFA art practice students. In this second quarter of the course, students will refine and expand one of their assignments from Sites/Situations I to create a completed site-specific installation, intervention, or product/object, which provokes discussion or change in our community. Works will be realized at various sites around campus, or in the community at large. Issues such as budget, public safety and code will be addressed. Time will be allotted for documentation, critique, and assessment of these projects.
BIO	FRONTIERS IN MARINE BIOLOGY	3	UG	X		An introduction to contemporary research in marine biology, including ecology, conservation biology, environmental toxicology, behavior, biomechanics, evolution, neurobiology, and molecular biology. Emphasis is on new discoveries and the technologies used to make them. Weekly lectures by faculty from the Hopkins Marine Station.
BIO	BIO-LOGGING AND BIO-TELEMETRY	14	UG	X		Bio-logging is a rapidly growing discipline that includes diverse fields such as consumer electronics, medicine, and marine biology. The use of animal-attached digital tags is a powerful approach to study the movement and ecology of individuals over a wide range of temporal and spatial scales. This course is an introduction to bio-logging methods and analysis. Using whales as a model system, students will learn how use multi-sensor tags to study behavioral biomechanics.
BIO	BIOCHEMISTRY I	188	UG	X		Chemistry of major families of biomolecules including proteins, nucleic acids, carbohydrates, lipids, and cofactors. Structural and mechanistic analysis of properties of proteins including molecular recognition, catalysis, signal transduction, membrane transport, and harvesting of energy from light. Molecular evolution.
BIO	ECOLOGY FOR EVERYONE	30	UG	X		Everything is connected, but how? Ecology is the science of interactions and the changes they generate. This project-based course links individual behavior, population growth, species interactions, and ecosystem function. Introduction to measurement, observation, experimental design and hypothesis testing in field projects, mostly done in groups. The goal is to learn to think analytically about everyday ecological processes involving bacteria, fungi, plants, animals and humans. The course uses basic statistics to analyze data; there are no math prerequisites except arithmetic. Open to everyone, including those who may be headed for more advanced courses in ecology and environmental science.

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BIO	DIVERSITY OF FUNGI	115	UG	X		Fungi are critical, yet often hidden, components of the biosphere. They regulate decomposition, are primary partners in plant symbiosis and strongly impact agriculture and economics. Students will explore the fascinating world of fungal biology, ecology and evolution via lecture, lab, field exercises and Saturday field trips that will provide traditional and molecular experiences in the collection, analysis and industrial use of diverse fungi. Students will chose an environmental niche, collect and identify resident fungi, and hypothesize about their community relationship. Prerequisite: Bio 43 recommended.
BIO	DIVERSITY OF FUNGI	239	GR	X		Fungi are critical, yet often hidden, components of the biosphere. They regulate decomposition, are primary partners in plant symbiosis and strongly impact agriculture and economics. Students will explore the fascinating world of fungal biology, ecology and evolution via lecture, lab, field exercises and Saturday field trips that will provide traditional and molecular experiences in the collection, analysis and industrial use of diverse fungi. Students will chose an environmental niche, collect and identify resident fungi, and hypothesize about their community relationship. Prerequisite: Bio 43 recommended.
BIO	CONSERVATION STORYTELLING	16	UG	X		Limited to students admitted to the BOSP South Africa overseas seminar. Through 4 workshop meetings, students will develop and pitch story ideas, form teams in which a writer and a photographer agree to collaborate on a story, and conduct background research prior to departing for South Africa.
BIO	CONSERV SCIENCE AND PRACTICE	33N	GR		X	Preference to freshmen. This course will explore the potential for harmonizing people and nature, for achieving improved outcomes in the well-being of both as a result of conservation investments and interventions. We will consider biophysical, economic, social, and psychological perspectives, examining an array of conservation goals, from protecting endangered species to securing ecosystem services (such as flood control and climate stability) to alleviating poverty and improving mental well-being. We will also study the design and implementation of real conservation and human development efforts worldwide, among the many farmers, ranchers, fishing people, and others managing Earth's lands and waters. Highlights include a field trip to Jasper Ridge Biological Preserve, Stanford¿s very own nature reserve, and guest visits of some impressive conservation leaders internationally.
BIO	CONSERVATION BIOLOGY: LATIN AM	234	GR		X	Principles and application of the science of preserving biological diversity. Conceptually, this course is designed to explore 4 major components relevant to the conservation of biodiversity, as exemplified by the Latin American region. The conceptual frameworks and principles, however, should be generally applicable, and provide insights for all regions of the world, including those of lesser biodiversity. Satisfies Central Menu Area 4 for Bio majors. Prerequisite: BIO 101, orBIO 43 or HUMBIO 2A with consent of instructor. Graduate level students will be expected to conduct a literature research exercise leading to a written paper, addressing a topic of their choosing, derived from any of the themes discussed in class.
BIO	BIOLOGY AND GLOBAL CHANGE	117	UG		X	The biological causes and consequences of anthropogenic and natural changes in the atmosphere, oceans, and terrestrial and freshwater ecosystems. Topics: glacial cycles and marine circulation, greenhouse gases and climate change, tropical deforestation and species extinctions, and human population growth and resource use. Prerequisite: Biology or Human Biology core or graduate standing.
BIO	HUNGER	34N	GR	X		The biology of hunger and satiety, disease states that disrupt normal responses to hunger and satiety, starvation responses and adaptations to starvation in a variety of organisms, food production and distribution mechanisms, historic famines and their causes, the challenges of providing adequate food and energy for the Earth's growing population, local and global efforts to alleviate hunger, and hunger in fiction.
BIO	ECOLOGY BEYOND THE AMAZON	356	GR		X	The course addresses the biodiversity, ecosystem services and impacts of land use change in the sole mountain chain found in Brazil, the Espinhaço Mountains. Although representing only 3% of the Brazilian savanna, these mountains support 50% of its biodiversity. The biodiversity, and particularly the concentration of endemic organisms these mountains hold, and the degree of threat by human activities, make this system a real global biodiversity hotspot. Course will address its ecology and conservation and major threats such as mining, biological invasions, and other anthropogenic drivers of change. Prerequisites: Biocore or equivalent.
BIO	ECOLOGY	101	UG	X		The principles of ecology. Topics: interactions of organisms with their environment, dynamics of populations, species interactions, structure and dynamics of ecological communities, biodiversity. Half-day field trip required.

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BIO	LITERATURE & SCIENCE	3N	GR		X	The state of a changing world ocean, particularly in the eastern Pacific, will be examined through historical and contemporary fiction, non-fiction and scientific publications. Issues will include harvest and mariculture fisheries, land-sea interactions and oceanic climate change in both surface and deep waters.
BIO	ECOLOGY OF THE CERRADO	355	GR		X	This course addresses the origin, evolution and ecology of the second major biome of South America, the Brazilian Cerrado. Strong environmental filters have shaped the most diverse savanna in the world. The Cerrado is under strong pressure due to the expansion of agriculture, cattle ranching, and now afforestation programs. Land use change is the major driver of its destruction and fragmentation, which leads to the erosion of biodiversity and ecosystem services, and loss of cultural heritage. Prerequisite: BioCore or equivalent.
BIO	GLOBAL CHANGE AND DISEASE	2N	GR		X	This seminar will explore the ways in which anthropogenic change, climate change, habitat destruction, land use change, and species invasions effects the ecology and evolution of infectious diseases. Topics will include infectious diseases of humans, wildlife, livestock, and crops, effects of disease on threatened species, disease spillover, emerging diseases, and the role of disease in natural systems. Course will be taught through a combination of popular and scientific readings, discussion, and lecture. .
BIO	PLANT BIO, EVOLUTION, ECOLOGY	43	UG	X		Principles of evolution: macro- and microevolution and population genetics. Ecology: the principles underlying the exchanges of mass and energy between organisms and their environments; population, community, and ecosystem ecology; populations, evolution, and global change. Equivalent to BIOHOPK 43.
BIO	CONSERVATION BIOLOGY: LATIN AM	144	UG		X	Principles and application of the science of preserving biological diversity. Conceptually, this course is designed to explore 4 major components relevant to the conservation of biodiversity, as exemplified by the Latin American region. The conceptual frameworks and principles, however, should be generally applicable, and provide insights for all regions of the world, including those of lesser biodiversity. Satisfies Central Menu Area 4 for Bio majors. Prerequisite: BIO 101, orBIO 43 or HUMBIO 2A with consent of instructor. Graduate level students will be expected to conduct a literature research exercise leading to a written paper, addressing a topic of their choosing, derived from any of the themes discussed in class.
BIO	BEHAVIORAL ECOLOGY	145	UG	X		Ecological and evolutionary perspectives on animal behavior, with an emphasis on social and collective behavior. This is a project-based course in a lecture/seminar format. Seminars will be based on discussion of journal articles. Independent research projects on the behavior of animals on campus.
BIO	FOUND OF COMMUNITY ECOLOGY	227	GR	X		Discussion of classic papers in community ecology (Forbes, Clements, Gleason, Grinnell, Lindeman, Preston, Elton, Hutchinson, May, MacArthur, Odum, Connell, Paine, Tilman, etc.) and contemporary papers on related topics, to develop historical perspectives to understand current issues and identify future directions.
BIO	TOPICS IN POP BIO	302	GR	X		Required of first-year PhD students in population biology, and ecology and evolution. Major conceptual issues and developing topics. This course isnnopen only to Biology PhD students and is not open to auditors."
BIO	TOPICS IN ECOLOGY & EVOLUTION	303	GR	X		Required of first-year PhD students in population biology, and ecology and evolution. Major conceptual issues and developing topics. This course isnnopen only to Biology PhD students and is not open to auditors."
BIO	POPULATION BIO	304	GR	X		Required of first-year PhD students in population biology, and ecology and evolution. Major conceptual issues and developing topics. This course isnnopen only to Biology PhD students and is not open to auditors.
BIO	ETHICAL ISSUES IN ECO/EVO	312	GR	X		Focus is on ethical issues addressed in Donald Kennedy's Academic Duty and others of importance to academics and scientists in the fields of ecology, behavior, and evolutionary biology. Discussions led by faculty and outside guests. Satisfies ethics course requirement for ecology and evolutionary biology.
BIO	INTRO TO CONSERVATION PHOTO	7N	GR		X	Introduction to the field of conservation photography and the strategic use of visual communication in addressing issues concerning the environment and conservation. Students will be introduced to basic digital photography, digital image processing, and the theory and application of photographic techniques. Case studies of conservation issues will be examined through photographs and multimedia platforms including images, video, and audio. Lectures, tutorials, demonstrations, and optional field trips will culminate in the production of individual and group projects.

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BIO	CORE PLANT BIO & ECO EVO LAB	44Y	GR	X		The goal of this course is to develop an understanding of how to conduct biological research, using a topic in Ecology, Evolutionary Biology, and Plant Biology as a practical example. This includes the complete scientific process: assessing background literature, generating testable hypotheses, learning techniques for field- and lab-based data collection, analyzing data using appropriate statistical methods, and finally writing and sharing results. To build these skills, this course will focus on the ecology of oak regeneration at Stanford's nearby Jasper Ridge Biological Preserve. Students, working in teams, will develop novel research hypotheses and execute the necessary experiments and measurements to test these hypotheses. The capstone of the course will be an oral defense of students' findings, as well as a research paper in the style of a peer-reviewed journal article. Labs will be completed both on campus and at Jasper Ridge. Lab fee. Information about this class is available at http://bio44.stanford.edu. Satisfies WIM in Biology.
BIO	ECOL & NAT HIST JASPER RIDGE	105A	GR	X		Formerly 96A - Jasper Ridge Docent Training. First of two-quarter sequence training program to join the Jasper Ridge education/docent program. The scientific basis of ecological research in the context of a field station, hands-on field research, field ecology and the natural history of plants and animals, species interactions, archaeology, geology, hydrology, land management, multidisciplinary environmental education; and research projects, as well as management challenges of the preserve presented by faculty, local experts, and staff. Participants lead research-focused educational tours, assist with classes and research, and attend continuing education classes available to members of the JRBP community after the course.
BIO	ECOL & NAT HIST JASPER RIDGE	105B	GR	X		Formerly 96B - Jasper Ridge Docent Training. First of two-quarter sequence training program to join the Jasper Ridge education/docent program. The scientific basis of ecological research in the context of a field station, hands-on field research, field ecology and the natural history of plants and animals, species interactions, archaeology, geology, hydrology, land management, multidisciplinary environmental education; and research projects, as well as management challenges of the preserve presented by faculty, local experts, and staff. Participants lead research-focused educational tours, assist with classes and research, and attend continuing education classes available to members of the JRBP community after the course.
BIOC	FRONTIERS INTERDSCP BIOSCNCS	459	GR	X		Students register through their affiliated department; otherwise register for CHEMENG 459. For specialists and non-specialists. Sponsored by the Stanford BioX Program. Three seminars per quarter address scientific and technical themes related to interdisciplinary approaches in bioengineering, medicine, and the chemical, physical, and biological sciences. Leading investigators from Stanford and the world present breakthroughs and endeavors that cut across core disciplines. Pre-seminars introduce basic concepts and background for non-experts. Registered students attend all pre-seminars; others welcome. See http://biox.stanford.edu/courses/459.html.
BIOE	ETHICS IN BIOENGINEERING	131	UG	X		Bioengineering focuses on the development and application of new technologies in the biology and medicine. These technologies often have powerful effects on living systems at the microscopic and macroscopic level. They can provide great benefit to society, but they also can be used in dangerous or damaging ways. These effects may be positive or negative, and so it is critical that bioengineers understand the basic principles of ethics when thinking about how the technologies they develop can and should be applied. On a personal level, every bioengineer should understand the basic principles of ethical behavior in the professional setting. This course will involve substantial writing, and will use case-study methodology to introduce both societal and personal ethical principles, with a focus on practical applications.

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BIOE	BIODESIGN FOR MOBILE HEALTH	273	GR	X		Examines the emerging Mobile Health industry. Mobile health (mHealth, or, wireless health) is the provision of health services and information via mobile technologies such as mobile phones and wearable sensors. Innovations in this area promise solutions to the need for universal access to affordable and effective health care by enabling consumers to take charge of their health, creating affordable ways to manage aging and chronic conditions, moving care from the hospital into the home, improving treatment options by providing transparency of measurable clinical outcomes, and shifting the focus from sick care to health improvement and prevention. Topics include the driving needs, applications, challenges and incentives that characterize the emerging mobile health landscape, and include an overview of some of the devices and companies that are already transforming the way health care is accesed today. Faculty and guest speakers discuss the status of the industry and research in Mobile Health, as well as opportunities in and challenges to medical technology innovation unique to this area. Issues related to Key Markets/Applications, Consumer/Enterprise Innovation, Policy/Regulatory, Financing, Business Models, Global Initiatives and Entrepreneurship are covered.
BIOE	ADVANCES IN BIOTECHNOLOGY	450	GR	X		Guest academic and industrial speakers. Latest developments in fields such as bioenergy, green process technology, production of industrial chemicals from renewable resources, protein pharmaceutical production, industrial enzyme production, stem cell applications, medical diagnostics, and medical imaging. Biotechnology ethics, business and patenting issues, and entrepreneurship in biotechnology.
BIOE	BIOSECURITY/BIOTERRISM RESPONS	122	UG	X		Overview of the most pressing biosecurity issues facing the world today. Guest lecturers have included former Secretary of State Condoleezza Rice, former Special Assistant on BioSecurity to Presidents Clinton and Bush Jr. Dr. Ken Bernard, Chief Medical Officer of the Homeland Security Department Dr. Alex Garza, eminent scientists, innovators and physicians in the field, and leaders of relevant technology companies. How well the US and global healthcare systems are prepared to withstand a pandemic or a bioterrorism attack, how the medical/healthcare field, government, and the technology sectors are involved in biosecurity and pandemic or bioterrorism response and how they interface, the rise of synthetic biology with its promises and threats, global bio-surveillance, making the medical diagnosis, isolation, containment, hospital surge capacity, stockpiling and distribution of countermeasures, food and agriculture biosecurity, new promising technologies for detection of bio-threats and countermeasures. Open to medical, graduate, and undergraduate students. No prior background in biology necessary. 4 units for twice weekly attendance (Mon. and Wed.); additional 1 unit for writing a research paper for 5 units total maximum. PLEASE NOTE: This class will meet for the first time on Wednesday, March 30.
BIOE	GLOBAL BIODESIGN	371	GR	X		(Same as OIT 587) This course examines the challenges and opportunities of developing and implementing innovative medical technologies to help patients around the world. Faculty and guest speakers discuss the status of the global medtech industry, as well as trends and issues affecting medical technology innovation in seven primary geographic regions: Africa, China, Europe, India, Japan, Latin America, and the United States. Students explore key differences between the covered geographies, which range from emerging markets with vast bottom-of-the-pyramid and growing middle class populations, to well-established markets with sophisticated demands and shifting demographics. Utilizes real-world case studies and class projects to promote engagement and provide a hands-on learning experience. Students work in multidisciplinary teams with real-world companies to develop a plan for bringing an existing product to a new global market.
BIOE	INTRO TO BIOE RESEARCH	390	GR	X		Preference to medical and bioengineering graduate students with first preference given to Bioengineering Scholarly Concentration medical students. Bioengineering is an interdisciplinary field that leverages the disciplines of biology, medicine, and engineering to understand living systems, and engineer biological systems and improve engineering designs and human and environmental health. Students and faculty make presentations during the course. Students expected to make presentations, complete a short paper, read selected articles, and take quizzes on the material.
BIOE	BIOENGINR DEPT RESEARCH	393	GR	X		Bioengineering department labs at Stanford present recent research projects and results. Guest lecturers. Topics include applications of engineering to biology, medicine, biotechnology, and medical technology, including biodesign and devices, molecular and cellular engineering, regenerative medicine and tissue engineering, biomedical imaging, and biomedical computation. Aut, Win, Spr (Lin, Riedel-Kruse, Barron)

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BIOE	FRONTIERS INTERDSCP BIOSCNCS	459	GR	X		Students register through their affiliated department; otherwise register for CHEMENG 459. For specialists and non-specialists. Sponsored by the Stanford BioX Program. Three seminars per quarter address scientific and technical themes related to interdisciplinary approaches in bioengineering, medicine, and the chemical, physical, and biological sciences. Leading investigators from Stanford and the world present breakthroughs and endeavors that cut across core disciplines. Pre-seminars introduce basic concepts and background for non-experts. Registered students attend all pre-seminars; others welcome. See http://biox.stanford.edu/courses/459.html.
BIOE	SENIOR CAPSTONE DESIGN I	141A	GR	X		Lecture/Lab. First course of two-quarter capstone sequence. Team based project introduces students to the process of designing new biological technologies to address societal needs. Topics include methods for validating societal needs, brainstorming, concept selection, and the engineering design process. First quarter deliverable is a design for the top concept. Second quarter involves implementation and testing. Guest lectures and practical demonstrations are incorporated.
BIOE	SENIOR CAPSTONE DESIGN II	141B	GR	X		Lecture/Lab. Second course of two-quarter capstone sequence. Team based project introduces students to the process of designing new biological technologies to address societal needs. Emphasis is on implementing and testing the design from the first quarter with the at least one round of prototype iteration. Guest lectures and practical demonstrations are incorporated. Prerequisites: BIOE123 and BIOE44. This course is open only to seniors in the undergraduate Bioengineering program.nIMPORTANT NOTE: class meets in Shriram 112.
BIOHOPK	ECOLOGICAL MECHANICS	150H	GR	X		(Graduate students register for 250H.) The principles of life's physical interactions. We will explore basic physics. fluid mechanics, thermal dynamics, and materials science to see how the principles of these fields can be used to investigate ecology at levels from the individual to the community. Topics include: diffusion, boundary layers, fluid-dynamic forces, locomotion, heat-budget models, fracture mechanics, adhesion, beam theory, the statistics of extremes, and the theory of self-organization. Open to students from all backgrounds. Some familiarity with basic physics and calculus advantageous but not necessary.
BIOHOPK	ECOLOGICAL MECHANICS	250H	GR	X		(Graduate students register for 250H.) The principles of life's physical interactions. We will explore basic physics. fluid mechanics, thermal dynamics, and materials science to see how the principles of these fields can be used to investigate ecology at levels from the individual to the community. Topics include: diffusion, boundary layers, fluid-dynamic forces, locomotion, heat-budget models, fracture mechanics, adhesion, beam theory, the statistics of extremes, and the theory of self-organization. Open to students from all backgrounds. Some familiarity with basic physics and calculus advantageous but not necessary.
BIOHOPK	INVERTEBRATE ZOOLOGY	161H	GR	X		(Graduate students register for 261H.) Survey of invertebrate diversity emphasizing form and function in a phylogenetic framework. Morphological diversity, life histories, physiology, and ecology of the major invertebrate groups, concentrating on local marine forms as examples. Current views on the phylogenetic relationships and evolution of the invertebrates. Lectures, lab, plus field trips. Satisfies Central Menu Area 3 for Bio majors. Prerequisite: Biology core or consent of instructor.
BIOHOPK	DISEASE ECOLOGY	168H	GR	X		(Graduate students register for 268H.) Course will lead participants on a journey through the dynamics of infectious diseases that will start at the smallest level from within-host parasite dynamics and will progressively scale up to parasite evolution, disease ecology, public health policies, disease driven poverty traps and the socio-economic impact of infectious diseases on nations. The course will be organized around case studies, including among the others, schistosomiasis, malaria, cholera and sleeping sickness. Participants will have the opportunity to develop a capstone project.
BIOHOPK	MARINE ECOLOGY	272H	GR	X		(Graduate students register for 272H.) This course incorporates the approaches of experimental ecology, biomechanics (ecomechanics), and physiology to develop an integrated perspective on the factors that govern the structures of marine ecosystems and how environment change, including anthropogenic influences, affects ecosystems' species composition and health. Focus is on rocky intertidal, kelp forest, estuarine, and midwater ecosystems of Monterey Bay. Experimental projects done in the field offer experience in a variety of ecological techniques and in analysis of ecological data. Students will engage in presentation and debates of current topics in marine ecology and conservation. Satisfies Central Menu Area 4 for Bio majors. Prerequisite: Biology core or consent of instructor. Fulfills WIM in Biology.

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BIOHOPK	MARINE CONSERVATION BIOLOGY	273H	GR		X	(Graduate students register for 273H.). Introduction to the key concepts of ecology and policy relevant to marine conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/rehabilitation). Also includes emerging approaches such as ecosystem based management, ocean planning, and coupled social-ecological systems. The course will include lectures, readings and discussions of primary literature, and attendance at seminars with visiting scholars. Prerequisite: introductory biology; suggested: a policy and/or introductory ecology course.
BIOHOPK	EXPERIM DESIGN & PROBABILITY	174H	GR	X		(Graduate students register for 274H.) Variability is an integral part of biology. Introduction to probability and its use in designing experiments to address biological problems. Focus is on analysis of variance, when and how to use it, why it works, and how to interpret the results. Design of complex, but practical, asymmetrical experiments and environmental impact studies, and regression and analysis of covariance. Computer-based data analysis. Prerequisite: Biology core or consent of instructor.
BIOHOPK	SENSORY ECOLOGY	287H	GR	X		(Graduate students register for 287H.) Topics: the ways animals receive, filter, and process information gleaned from the environment, sensory receptor mechanisms, neural processing, specialization to life underwater, communication within and between species, importance of behavior to ecosystem structure and dynamics, impact of acoustic and light pollution on marine animals. Emphasis is on the current scientific literature. The laboratory portion of the class explores sensory mechanisms using neurobiological methods and methods of experimental animal behavior.
BIOHOPK	MARINE ECOLOGY	172H	GR	X		Course provides key concepts in ecology , familiarizes students with local marine ecosystems, the methods used in ecological studies of these ecosystems, and the analysis and interpretation of ecological data. Students will engage in presentation and debates of current topics in marine ecology and conservation.
BIOHOPK	OCEANIC BIOLOGY	163H	GR	X		How the physics and chemistry of the oceanic environment affect marine plants and animals. Topics: seawater and ocean circulation, separation of light and nutrients in the two-layered ocean, oceanic food webs and trophic interactions, oceanic environments, biogeography, and global change. Lectures, discussion, and field trips.
BIOHOPK	OCEANIC BIOLOGY	263H	GR		X	How the physics and chemistry of the oceanic environment affect marine plants and animals. Topics: seawater and ocean circulation, separation of light and nutrients in the two-layered ocean, oceanic food webs and trophic interactions, oceanic environments, biogeography, and global change. Lectures, discussion, and field trips.
BIOHOPK	PHYSICAL BIOLOGY	320H	GR	X		Physics, mathematics, and biology are often studies as separate subjects. In this two-week intensive course we will attempt to bring them together in a dynamic combination of lectures and hands on projects. We will draw on the diverse flora and fauna of Monterey Bay for our experimental organisms, and will take advantage of the facilities at Hopkins Marine Station to explore questions at levels ranging from molecules to ecological communities
BIOHOPK	PLANT BIO, EVOLUTION & ECOLOGY	43	UG		X	Introduction to biology in a marine context. Principles of plant biology: physiology, structure, diversity. Principles of evolution: macro and microevolution, population genetics. Ecology: the principles governing the distribution and abundance of organisms; population, community, and ecosystem ecology. Equivalent to BIO 43.
BIOHOPK	CORE LABORATORY	44Y	GR		X	Laboratory and field projects provide working familiarity with the concepts, organisms, and techniques of plant and evolutionary biology, and ecology. Emphasis is on hands-on experimentation in the marine environment, analysis of data, and written and oral presentation of the experiments. Equivalent to BIO 44Y.
BIOHOPK	MARINE CONSERVATION BIOLOGY	173H	GR		X	(Graduate students register for 273H.). Introduction to the key concepts of ecology and policy relevant to marine conservation issues at the population to ecosystems level. Focus on the origin and maintenance of biodiversity and conservation applications from both the biology and policy perspectives (for example, endangered species, captive breeding, reserve design, habitat fragmentation, ecosystem restoration/rehabilitation). Also includes emerging approaches such as ecosystem based management, ocean planning, and coupled social-ecological systems. The course will include lectures, readings and discussions of primary literature, and attendance at seminars with visiting scholars.
BIOHOPK	MARINE POPULATIONS	177H	GR	X		(Graduate students register for 277H.) Course examines the ecological factors and processes that control natural and harvested marine populations. Course emphasizes mathematical models as tools to assess the dynamics of populations and to derive projections of their demographic fate under different management scenarios. Course objectives will be met by a combination of theoretical lectures, assigned readings and class discussions, case study analysis and interactive computer sessions.

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BIOHOPK	SENSORY ECOLOGY	187H	GR	X		(Graduate students register for 287H.) Topics: the ways animals receive, filter, and process information gleaned from the environment, sensory receptor mechanisms, neural processing, specialization to life underwater, communication within and between species, importance of behavior to ecosystem structure and dynamics, impact of acoustic and light pollution on marine animals. Emphasis is on the current scientific literature. The laboratory portion of the class explores sensory mechanisms using neurobiological methods and methods of experimental animal behavior.
BIOHOPK	MARINE POPULATIONS	277H	GR		X	(Graduate students register for 277H.) Course examines the ecological factors and processes that control natural and harvested marine populations. Course emphasizes mathematical models as tools to assess the dynamics of populations and to derive projections of their demographic fate under different management scenarios. Course objectives will be met by a combination of theoretical lectures, assigned readings and class discussions, case study analysis and interactive computer sessions.
CEE	WATER CHEMISTRY LABORATORY	273A	GR	X		(Graduate students register for 273A.) Laboratory application of techniques for the analysis of natural and contaminated waters, emphasizing instrumental techniques
CEE	GLOBAL URBAN DEVELOPMENT	224X	GR		X	A year-long Project-Based Learning course on sustainable urban systems, in collaboration with Sechuan University, Chengdu, China. Students will form multidisciplinary teams of 8-10 and be assigned to study one of two cities: Chengdu, CN and San Jose, CA. Teams will work closely with city partners including municipal officials, industry leaders, community groups, and local academics. First phase conducing research using geospatial data analysis of key performance indicators, second and third phases to address target goals identified in phase one. Teams will propose innovative plans, policies and/or programs for urban development to meet goals. Three quarter commitment preferred, two quarter commitment required. Enrollment limited to ten Stanford students by application. Preference to CEE graduate students within CEE (SDC) and from other departments, upperclass undergraduate applications accepted.
CEE	PHYSICS OF WIND ENERGY	261	GR	X		An introduction to the analysis and modeling of wind energy resources and their extraction. Topics include the physical origins of atmospheric winds; vertical profiles of wind speed and turbulence over land and sea; the wind energy spectrum and its modification by natural topography and built environments; theoretical limits on wind energy extraction by wind turbines and wind farms; modeling of wind turbine aerodynamics and wind farm performance. Final project will focus on development of a new wind energy technology concept. Prerequisites: CEE 262A or ME 351A
CEE	TURB MODEL FOR ENV FLUID MECH	361	GR	X		An introduction to turbulence and its modeling, including Reynolds-average and large-eddy simulation models. Derivation of closure approximations and models. Impact of numerical code truncation error on turbulence model value and accuracy. Discussion of typical models and their applications to turbulent flows in rivers, estuaries, the coastal ocean and the atmospheric boundary layer (e.g., wind turbines and weather models). Prerequisites: knowledge of hydrodynamics or atmosphere dynamics and the basics of transport and mixing in the environment; consent of instructor.
CEE	CHAOS AND TURBULENCE	363B	GR	X		An overview of the statistical analysis of unsteady flows, with a focus on chaos and turbulence. Topics will include random variables and statistical analysis; self-similarity, scaling, and symmetries; the turbulent energy cascade and the Kolmogorov similarity hypotheses; intermittency, refined similarity, and multifractal analysis; mixing and transport in chaotic and turbulent flows; and an overview of the effects of additional conservation laws on flow statistics. Prerequisites: CEE 262A or ME 351A, or permission of instructor.
CEE	ENERGY EFFICIENT BUILDINGS	176A	GR		X	Analysis and design. Thermal analysis of building envelope, heating and cooling requirements, HVAC, and building integrated PV systems. Emphasis is on residential passive solar design and solar water heating. Lab.
CEE	INTEG MGMT OF FAB AND CONSTR	241P	GR	X		Application of the fundamental fabrication and construction management concepts covered in CEE 241T to an actual project; integrated software environments; integration of scope, schedule, and cost information for scheduling, estimating, and progress control; scope management with BIM; off-site fabrication vs. on-site construction and supply chain coordination; group project; project permitting, potential for a joint project with CEE 242P. Prerequisites: CEE 210,CEE 241T.

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CEE	INDUSTRY APPLICATIONS OF VIRTU	212A	GR	X		Building upon the concept of the VDC Scorecard, CEE 112A/212A investigates in the management of Virtual Design and Construction (VDC) programs and projects in the building industry. Interacting with experts and professionals in real estate, architecture, engineering , construction and technology providers, students will learn from the industry applications of Building Information Modeling and its relationship with Integrated Project Delivery, Sustainable Design and Construction, and Virtual Design and Construction. Students will conduct case studies to evaluate the maturity of VDC planning, adoption, technology and performance in practice. Students taking 3 or 4 units will be paired up with independent research or case study projects on the industry applications of VDC. No prerequisite. See CEE 112B/212B in the Winter Quarter and CEE 112C/212C in the Spring Quarter.
CEE	INDUSTRY APPLICATIONS OF VIRTU	112A	GR	X		Building upon the concept of VDC Scorecard, CEE 112A/212A investigates in the management of Virtual Design and Construction (VDC) programs and projects in the building industry. Interacting with experts and professionals in real estate, architecture, engineering, construction and technology providers, students will learn from the industry applications of Building Information Modeling and its relationship with Integrated Project Delivery, Sustainable Design and Construction. Students will conduct case studies to evaluate the maturity of VDC planning, adoption, technology and performance in practice. Students taking 3 or 4 units will be paired up with independent research or case study projects on the industry applications of VDC. No prerequisite. See CEE112B/212B in the Winter Quarter and CEE 112C/212C in the Spring Quarter.
CEE	INDUSTRY APPLICATIONS OF VIRTU	112B	GR	X		CEE 112B/212B is a practicum on the Industry Applications on Virtual Design and Construction (VDC). Students will gain insights and develop skills that are essential for academic research, internships or industry practice in VDC and Building Information Modeling (BIM). Students can choose between one of the two project topics: [1] Industrialized Construction with Virtual Parts (No Prerequisite) or [2] Industry Benchmarking & Applications of the VDC Management Scorecard (Suggested Prerequisite: CEE 112A/212A).
CEE	AQUATIC CHEMISTRY	273	GR	X		Chemical principles and their application to the analysis and solution of problems in aqueous geochemistry (temperatures near 25° C and atmospheric pressure). Emphasis is on natural water systems and the solution of specific chemical problems in water purification technology and water pollution control.
CEE	PRACTICE OF ENVIRO CONSULTING	275K	GR	X		Class consists of eight interactive two-hour seminars with discussions, and will cover the evolution of the environmental consulting business, strategic choices and alternative business models for private and public firms, a review of the key operational issues in managing firm, organizational strategies, knowledge management and innovation, and ethical issues in providing professional services. Case studies will be used to illustrate key concepts. Selected reading materials drawn from the technical and business literature on the consulting business. Student groups will prepare and present an abbreviated business plan for an environmental based business. Enrollment limited to CEE MS and PHD students.
CEE	COASTAL CONTAMINANTS	272	GR		X	Coastal pollution and its effects on ecosystems and human health. The sources, fate, and transport of human pathogens and nutrients. Background on coastal ecosystems and coastal transport phenomena including tides, waves, and cross shelf transport. Introduction to time series analysis with MATLAB.
CEE	CHINA URBANIZATION SEMINAR	126	UG		X	Comparative approach to sustainable cities, with focus on international practices and applicability to China. Tradeoffs regarding land use, infrastructure, energy and water, and the need to balance economic vitality, environmental quality, cultural heritage, and social equity. Student teams collaborate with Chinese faculty and students partners to support urban sustainability projects. Limited enrollment via application; see internationalurbanization.org for details. Prerequisites: consent of the instructor(s).
CEE	COMPUTATIONS IN CEE	101D	GR	X		Computational and visualization methods in the design and analysis of civil and environmental engineering systems. Focus is on applications of MATLAB. How to develop a more lucid and better organized programming style.
CEE	COMPUTATIONS IN CEE	201D	GR	X		Computational and visualization methods in the design and analysis of civil and environmental engineering systems. Focus is on applications of MATLAB. How to develop a more lucid and better organized programming style.

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CEE	CONSTRUCTION ENG FUNDAMENTALS	252Q	GR	X		Construction engineering is a series of technical activities to meet project objectives related to cost and schedule, safety, quality, and sustainability. These activities include: 1) designing temporary works and construction work processes; 2) providing the required temporary and permanent resources; and 3) integrating activities to consider construction during all project phases and between projects. The objectives of CEE 252Q are to learn about the technical fundamentals, resources, and field operations required to complete construction engineering activities and to develop a foundation for continued related learning. The course requires reviewing recorded presentations and other online resources, completing queries, participating in class sessions with guest speakers and in field trips, and completing group exercises and projects. The exercises, completed by all of the student groups, include construction engineering activities for earthwork, concrete construction, and steel erection. Each group will also complete a project to analyze one of the following types of systems or facilities: building electrical systems, lighting systems, HVAC systems, control systems, solar photovoltaic power plant, and wind turbine power plant.
CEE	WEATHER AND STORMS	63	UG	X		Daily and severe weather and global climate. Topics: structure and composition of the atmosphere, fog and cloud formation, rainfall, local winds, wind energy, global circulation, jet streams, high and low pressure systems, inversions, el Niño, la Niña, atmosphere/ocean interactions, fronts, cyclones, thunderstorms, lightning, tornadoes, hurricanes, pollutant transport, global climate and atmospheric optics.
CEE	WEATHER AND STORMS	263C	GR	X		Daily and severe weather and global climate. Topics: structure and composition of the atmosphere, fog and cloud formation, rainfall, local winds, wind energy, global circulation, jet streams, high and low pressure systems, inversions, el Niño, la Niña, atmosphere/ocean interactions, fronts, cyclones, thunderstorms, lightning, tornadoes, hurricanes, pollutant transport, global climate and atmospheric optics.
CEE	INDOOR AIR QUALITY	278C	GR		X	Factors affecting the levels of air pollutants in the built indoor environment. The influence of ventilation, office equipment, floor coverings, furnishings, cleaning practices, and human activities on air quality including carbon dioxide, VOCs, resuspended dust, and airborne molds and fungi. Limited enrollment, preference to CEE students. Prerequisites:Math 42 or 21 and CEE 70, or equivalents.
CEE	INTRO TO ENVIRON SYSTEMS ENGRG	1	UG	X		Field trips visiting environmental systems installations in Northern California, including coastal, freshwater, and urban infrastructure. Requirements: Several campus meetings, and field trips. Enrollment limited; priority given to undergraduates who have declared Environmental Systems Engineering major. Contact hildemann@stanford.edu to request enrollment/permission code.
CEE	BUILDING SYSTEMS	156	UG		X	HVAC, lighting, and envelope systems for commercial and institutional buildings, with a focus on energy efficient design. Knowledge and skills required in the development of low-energy buildings that provide high quality environment for occupants.
CEE	BUILDING SYSTEMS	256	GR	X		HVAC, lighting, and envelope systems for commercial and institutional buildings, with a focus on energy efficient design. Knowledge and skills required in the development of low-energy buildings that provide high quality environment for occupants.
CEE	DEFINING SMART CITIES	125	UG		X	In a rapidly urbanizing world, "the city" paves the way toward sustainability and social well-being. But what does it mean for a city to be smart? Does that also make it sustainable or resilient or livable? This seminar delves into current debates about urbanism through weekly talks by experts on topics such as big data, human-centered design, new urbanism, and natural capital. How urban spaces are shaped, for better or worse, by the complex interaction of cutting-edge technology, human societies, and the natural environment. The goal is to provoke vigorous discussion and to foster an understanding of cities that is at once technological, humanistic, and ecologically sound.
CEE	DEFINING SMART CITIES	225	GR		X	In a rapidly urbanizing world, "the city" paves the way toward sustainability and social well-being. But what does it mean for a city to be smart? Does that also make it sustainable or resilient or livable? This seminar delves into current debates about urbanism through weekly talks by experts on topics such as big data, human-centered design, new urbanism, and natural capital. How urban spaces are shaped, for better or worse, by the complex interaction of cutting-edge technology, human societies, and the natural environment. The goal is to provoke vigorous discussion and to foster an understanding of cities that is at once technological, humanistic, and ecologically sound.

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CEE	INFRASTRUCTURE DELIVERY	241B	GR	X		Infrastructure is critical to the economy, global competitiveness and quality of life. Topics include energy, transportation, water, public facilities ,and communications sectors. Analysis of how projects are designed, constructed, operated, and maintained. Focus is on public works projects in the U.S. Alternative project delivery approaches and organizational strategies. Case studies of real infrastructure projects. Industry guest speakers. Student teams prepare finance/design/build/operate/maintain project proposals.
CEE	INFRASTRUCTURE DEVELOPMENT	241A	GR	X		Infrastructure is critical to the economy, global competitiveness and quality of life. Topics include energy, transportation, water, public facilities, and communications sectors. Analysis of the condition of the nation's infrastructure and how projects are planned and financed. Focus is on public works in the U.S. The role of public and private sectors through a step-by-step study of the project development process. Case studies of real infrastructure projects. Industry guest speakers. Student teams prepare project environmental impact statements.
CEE	THE ENERGY SEMINAR	301	GR		X	Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
CEE	INTERNATIONAL CLIMATE NEGOTIAT	163E	GR		X	Interested in what's going on with international climate negotiations, why it has proven so difficult to reach a meaningful agreement? Wondering whether or not another UN agreement is even a meaningful part of climate policy in 2015? This course traces the history of climate negotiations from the very first awareness of the problem of climate change, through the Kyoto Protocol and Copenhagen Accord, to the current state of international negotiations in the lead-up to the 21st Conference of the Parties meeting in Paris in December 2015. The course covers fundamental concepts in climate change science and policy, international law and multilateral environmental agreements, as well as key issues of climate finance, climate justice, equity, adaptation, communication, and social movements that together comprise the subjects of debate in the negotiations. We will discuss all the key facets of what's being negotiated in Paris and prepare students to follow the outcome of the negotiation in detail. Students also participate in a three-day mock conference of the parties. By application only.
CEE	INTERNATIONAL CLIMATE NEGOTIAT	263E	GR		X	Interested in what's going on with international climate negotiations, why it has proven so difficult to reach a meaningful agreement? Wondering whether or not another UN agreement is even a meaningful part of climate policy in 2015? This course traces the history of climate negotiations from the very first awareness of the problem of climate change, through the Kyoto Protocol and Copenhagen Accord, to the current state of international negotiations in the lead-up to the 21st Conference of the Parties meeting in Paris in December 2015. The course covers fundamental concepts in climate change science and policy, international law and multilateral environmental agreements, as well as key issues of climate finance, climate justice, equity, adaptation, communication, and social movements that together comprise the subjects of debate in the negotiations. We will discuss all the key facets of what's being negotiated in Paris and prepare students to follow the outcome of the negotiation in detail. Students also participate in a three-day mock conference of the parties. By application only.
CEE	INTRO TO SENSING TECHNOLOGIES	255	GR	X		Introduce the design and implementation of sensor networks for monitoring the built and natural environment. Emphasis on the integration of modern sensor and communication technologies, signal processing and statistical models for network data analysis and interpretation to create practical deployments to enable sustainable systems, in areas such as energy, weather, transportation and buildings. Students will be involved in a practical project that may involve deploying a small sensor system, data models and analysis and signal processing. Limited enrollment.
CEE	MICROBIAL BIOENERGY SYSTEMS	274B	GR	X		Introduction to microbial metabolic pathways and to the pathway logic with a special focus on microbial bioenergy systems. The first part of the course emphasizes the metabolic and biochemical principles of pathways, whereas the second part is more specifically directed toward using this knowledge to understand existing systems and to design innovative microbial bioenergy systems for biofuel, biorefinery, and environmental applications. There also is an emphasis on the implications of rerouting of energy and reducing equivalents for the fitness and ecology of the organism.
CEE	RIVERS, STREAMS, AND CANALS	161A	GR	X		Introduction to the movement of water through natural and engineered channels, streams, and rivers. Basic equations and theory (mass, momentum, and energy equations) for steady and unsteady descriptions of the flow. Application of theory to the design of flood- control and canal systems. Flow controls such as weirs and sluice gates; gradually varied flow; Saint-Venant equations and flood waves; and method of characteristics. Open channel flow laboratory experiments: controls such as weirs and gates, gradually varied flow, and waves.

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CEE	WATERSHEDS & WETLANDS	266A	GR	X		Introduction to the occurrence and movement of water in the natural environment and its role in creating and maintaining terrestrial, wetland, and aquatic habitat. Hydrologic processes, including precipitation, evaporation, transpiration, snowmelt, infiltration, subsurface flow, runoff, and streamflow. Rivers and lakes, springs and swamps. Emphasis is on observation and measurement, data analysis, modeling, and prediction. Prerequisite: 101B or equivalent. (Freyberg)
CEE	SOLID MECHANICS	291	GR	X		Introduction to vectors and tensors; kinematics, deformation, forces, and stress concept of continua and structures; balance principles; aspects of objectivity; hyperelastic materials; thermodynamics of materials; variational principles; applications to structural engineering.
CEE	WATER CHEMISTRY LABORATORY	179A	GR	X		Laboratory application of techniques for the analysis of natural and contaminated waters, emphasizing instrumental techniques.
CEE	WATER, PUB HLTH, AND ENGRNG	70N	GR		X	Preference to frosh. Linkages between water, wastewater and public health, with an emphasis on engineering interventions. Topics include the history of water and wastewater infrastructure development in the U.S. and Europe; evolution of epidemiological approaches for water-related health challenges; biological and chemical contaminants in water and wastewater and their management; and current trends and challenges in access to water and sanitation around the world. Identifying ways in which freshwater contributes to human health; exposure routes for water- and sanitation-illness. Classifying illnesses by pathogen type and their geographic distribution. Identifying the health and economic consequences of water- and sanitation-related illnesses; costs and benefits of curative and preventative interventions. Interpreting data related to epidemiological and environmental concepts. No previous experience in engineering is required.
CEE	INFRASTRUCTURE FINANCE & GOV	323A	GR	X		Presentation and discussion of early stage or more mature research on a variety of topics related to financing, governance and sustainability of civil infrastructure projects by researchers associated with the Global Projects Center and visiting speakers. To obtain one unit of credit, students must attend and participate in all seminars, with up to two excused absences. Seminar meets weekly during Autumn, Winter and Spring Quarters.
CEE	INFRASTRUCTURE FINANCE & GOV	323B	GR	X		Presentation and discussion of early stage or more mature research on a variety of topics related to financing, governance and sustainability of civil infrastructure projects by researchers associated with the Global Projects Center and visiting speakers. To obtain one unit of credit, students must attend and participate in all seminars, with up to two excused absences. Seminar meets weekly during Autumn, Winter, and Spring quarters.
CEE	INFRASTRUCTURE FINANCE & GOV	323C	GR	X		Presentation and discussion of early stage or more mature research on a variety of topics related to financing, governance and sustainability of civil infrastructure projects by researchers associated with the Global Projects Center and visiting speakers. To obtain one unit of credit, students must attend and participate in all seminars, with up to two excused absences. Seminar meets weekly during Autumn, Winter and Spring Quarters.
CEE	GLOBAL PROJECT FINANCE	227	GR	X		Public and private sources of finance for large, complex, capital-intensive projects in developed and developing countries. Benefits and disadvantages, major participants, risk sharing, and challenges of project finance in emerging markets. Financial, economic, political, cultural, and technological elements that affect project structures, processes, and outcomes. Case studies.
CEE	AIR QUALITY MANAGEMENT	172	UG		X	Quantitative introduction to the engineering methods used to study and seek solutions to current air quality problems. Topics: global atmospheric changes, urban sources of air pollution, indoor air quality problems, design and efficiencies of pollution control devices, and engineering strategies for managing air quality.
CEE	GLOBAL INFRASTRUCTURE PROJECTS	241C	GR	X		Real infrastructure projects presented by industry guest speakers. Energy, transportation, water, public facilities and communications projects are featured. Course provides comparisons of project development and delivery approaches for mega-projects around the world. Alternative project delivery methods, the role of public and private sector, different project management strategies, and lessons learned. Field trips to local projects.
CEE	AD LECTURE SERIES COURSE	32V	GR	X		Seminar will be a companion to the Spring Architecture and Landscape Architecture Lecture Series. Students will converse with lecturers before the lectures, attend thte lecture, and prepare short documents (written, graphic, exploratory) for two of the lectures. The course meeting dates will correspond with the lecture dates listed below.nApril 6: Nic Rader of Snohetta (http://snohetta.com)nApril 20: Mark Jensen (http://jensen-architects.com)nMay 4: Kevin Conger of CMG Landscape Architecture (http://www.cmgsite.com)nMay 18: Odile Decq (http://www.odiledecq.com)nJune 2: Gregg Pasquarelli of SHoP Architects. (http://www.shoparc.com) Gregg will be the Fourth Annual AD Program Graduation Speaker

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CEE	FLOODS & DROUGHTS, DAMS & AQUE	266B	GR	X		Sociotechnical systems associated with human use of water as a resource and the hazards posed by too much or too little water. Potable and non-potable water use and conservation. Irrigation, hydroelectric power generation, rural and urban water supply systems, storm water management, flood damage mitigation, and water law and institutions. Emphasis is on engineering design. Prerequisite: 166A or equivalent. (Freyberg)
CEE	ENVIRONMENTAL BIOTECHNOLOGY	271B	GR	X		Stoichiometry, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants. Design of dispersed growth and biofilm-based processes. Applications include treatment of municipal and industrial waste waters, detoxification of hazardous chemicals, and groundwater remediation.
CEE	CEMENT-BASED MATL'S,PROPERTIES	223A	GR	X		Students will develop an understanding of the chemical and physical processes of cement and concrete hydration, strength development, mechanical performance and durability. Students will learn how the properties of materials and admixture combine to create a wide range of cement-based materials used in the built environment. The course will address sustainable construction, including the use of alternative cements, admixtures, and aggregates. Students will apply the principles in this course to various aspects of civil and structural engineering, including innovative mix design specification and review, structural investigations and failure analysis, and cementitious materials research.
CEE	AIR POLLUTION	64	UG		X	Survey of Survey of air pollution and global warming and their renewable energy solutions. Topics: evolution of the Earth's atmosphere, history of discovery of chemicals in the air, bases and particles in urban smog, visibility, indoor air pollution, acid rain, stratospheric and Antarctic ozone loss, the historic climate record, causes and effects of global warming, impacts of energy systems on pollution and climate, renewable energy solutions to air pollution and global warming. UG Reqs: GER: DBNatSci
CEE	AIR POLLUTION	263D	GR		X	Survey of Survey of air pollution and global warming and their renewable energy solutions. Topics: evolution of the Earth's atmosphere, history of discovery of chemicals in the air, bases and particles in urban smog, visibility, indoor air pollution, acid rain, stratospheric and Antarctic ozone loss, the historic climate record, causes and effects of global warming, impacts of energy systems on pollution and climate, renewable energy solutions to air pollution and global warming. UG Reqs: GER: DBNatSci
CEE	GLOBAL URBAN DEVELOPMENT	224Y	GR		X	Sustainable Urban Systems Project: San Jose is a selective opportunity to engage in a unique, real-world learning experience being piloted for a new Sustainable Urban Systems initiative within the Department of Civil and Environmental Engineering. it combines a project-based learning model with real-world problem-solving in an urban setting. Building off student work conducted in Fall and Winter quarters, Spring quarter students will work with planners in the City of San Jose to develop strategic solutions for high-priority challenges like affordable housing, stormwater management, and transit-oriented mixed-use development immersive trips to San Jose are a core part of the Spring quarter learning experience and students will engage in a variety of community activities throughout the quarter.
CEE	SUSTAINABLE URBAN SYS PROJ SJ	224Z	GR		X	Sustainable Urban Systems Project: San Jose is a selective opportunity to engage in a unique, real-world learning experience being piloted for a new Sustainable Urban Systems initiative within the Department of Civil and Environmental Engineering. it combines a project-based learning model with real-world problem-solving in an urban setting. Building off student work conducted in Fall and Winter quarters, Spring quarter students will work with planners in the City of San Jose to develop strategic solutions for high-priority challenges like affordable housing, stormwater management, and transit-oriented mixed-use development immersive trips to San Jose are a core part of the Spring quarter learning experience and students will engage in a variety of community activities throughout the quarter.
CEE	SUSTAINABLE URBAN SYS SEMINAR	279X	GR		X	SYSTEM OF SYSTEMS: Cities are based on several different systems; infrastructures, networks and environments. The effectiveness and efficiency of these systems determine how cities work and how successful a city is at delivering critical services. These systems are not discrete and must be considered holistically as well as individually. These core systems are interconnected and must be treated as such. Understanding one system and making it work better means that cities must comprehend the larger context and how the various systems are interconnected. This seminar series will explore various aspects of these critical systems and how we can make them more resilient and robust, to meet future challenges. Guest speakers, discussion and critical readings.

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CEE	DESIGN FOR A SUSTAINABLE WORLD	177S	GR		X	Technology-based problems faced by developing communities worldwide. Student groups partner with organizations abroad to work on concept, feasibility, design, implementation, and evaluation phases of various projects. Past projects include a water and health initiative, a green school design, seismic safety, and medical device. Admission based on written application and interview.
CEE	DESIGN FOR A SUSTAINABLE WORLD	277S	GR		X	Technology-based problems faced by developing communities worldwide. Student groups partner with organizations abroad to work on concept, feasibility, design, implementation, and evaluation phases of various projects. Past projects include a water and health initiative, a green school design, seismic safety, and medical device. Admission based on written application and interview. See http://esw.stanford.edu for application. (Staff)
CEE	INDUSTRIALIZED CONSTRUCTION	324	GR	X		The course will present driving forces, comprehensive concepts, technologies, and managerial aspects of Industrialized Construction. Further a series of case studies of successful and failed industry implementations in Sweden, North America and Japan will be presented, showcasing process and technology platforms; use of renewable resources and other sustainable design and construction practices. The contrast between industrialized construction practices in Sweden, the U.S. and other countries is highlighted. Project-orientated vs. product-oriented approaches are essential, along with business models and strategies for industrialized construction companies and their opportunities for innovations. The course includes lectures, case studies, and course group-project assignments with leading companies in the industry.nnVisiting lecturer Dr Jerker Lessing, one of Sweden¿s leading experts on industrialized construction with more than 15 years of experience in this field, is giving this course. This is a unique opportunity to learn about this comprehensive, emerging construction concept. Dr Lessing¿s research at Lund University has pioneered the area of industrialized construction and established models and strategic perspectives that are widely adopted throughout academia and industry. Dr Lessing has published articles and books and he frequently lectures on the topic in Sweden and internationally. He is the Director and General manager of Research and Development at BoKlok, an industrialized house-building company which is a joint venture of the construction company SKANSKA and furniture giant IKEA. n- Notes:nAttendance Mandatory. No Exam. Case and Problem Discussion. CR/NC and Auditing Not Allowed.nEligible for SDC Building & Infrastructure Development concentration area requirement.nNumber of students limited to 20; prerequisites: CEE100 or equivalent. To apply, please email resume to jlessing@stanford.edu and complete the following form: http://goo.gl/forms/guo17lfTcb
CEE	BUILDING INFO MODELING WORKSHO	120A	GR	X		The foundational Building Information Modeling course introduces techniques for creating, managing, and applying of building information models in the building design and construction process. The course covers processes and tools for creating, organizing, and working with 2D and 3D computer representations of building components and geometries to produce models used in architectural design, construction planning and documentation, rendering and visualization, simulation and analysis.
CEE	BUILDING INFO MODELING WORKSHO	220A	GR	X		The foundational Building Information Modeling course introduces techniques for creating, managing, and applying of building information models in the building design and construction process. The course covers processes and tools for creating, organizing, and working with 2D and 3D computer representations of building components and geometries to produce models used in architectural design, construction planning and documentation, rendering and visualization, simulation and analysis.
CEE	DESIGN & INNOVATION CIRC ECON	144	UG	X		The last 150 years of our industrial evolution have been material and energy intensive. The linear model of production and consumption manufactures goods from raw materials, wells and uses them, and then discards the products as waste. Circular economy provides a framework for systems-level redesign. It builds on schools of thought including regenerative design, performance economy industrial ecology, blue economy, biomimicry, and cradle to cradle. This course introduces the concepts of the circular economy and applies them to case studies of consumer products, household goods, and fixed assets.n nStudents will conduct independent projects on circular economy. Students may work alone or in small teams under the guidance of the teaching team and various collaborators worldwide. Class is limited to 14 students. All disciplines are welcome. This class fulfills the Writing & Rhetoric 2 requirement. Prerequisite: PWR 1.

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CEE	SITUATED WORKPLACE PUBLIC LIFE	32S	GR	X		The modern workplace has undergone fundamental change and continues to evolve. The context of work in many industries is today being shaped substantially by changing workforce demographics, the pervasiveness of mobile and embedded information technologies, hyper-connected work models on a global scale, evolving notions of health and well being, etc. nnOur public realm is changing too. People are moving to cities in greater numbers than ever before posing both challenges and opportunities related to new levels of density, sustainable resource management, resilient infrastructures, as well as new forms of civic engagement at neighborhood levels, to name but a few. These changes at an urban scale impact how and where public life happens and how it interacts with new modalities at work.nnThis course will combine research, conceptual explorations, studio design work, seminars and guest lectures to explore the impact of the changing workplace on the morphology of the city by examining these bi-coastal seats of innovation. As the creative workplace continues to evolve, how will it engage the public realm within both well-established urban frameworks such as San Francisco and Boston, and emerging suburban contexts, such as Silicon Valley?nnThe course will join graduate students from the Northeastern University School of Architecture with students from the Stanford University Architectural Design program. Students will reside primarily at their prospective universities and will travel selectively for site research, team charettes and project reviews. Project sites on both coasts will be utilized for research and studio work. This is an opportunity for students from two top universities, both situated in the epicenters of workplace change, to explore and conduct valuable research on an issue that is changing their urban environments.
CEE	AIR POLLUTION FUNDAMENTALS	278A	GR		X	The sources and health effects of gaseous and particulate air pollutants. The influence of meteorology on pollution: temperature profiles, stability classes, inversion layers, turbulence. Atmospheric diffusion equations, downwind dispersion of emissions from point and line sources. Removal of air pollutants via settling, diffusion, coagulation, precipitation, Mechanisms for ozone formation, in the troposphere versus in the stratosphere. Effects of airborne particle size and composition on light scattering/absorption, and on visual range.
CEE	WASTEWATER TREATMENT	174B	GR	X		This course builds upon CEE 174A, covering basic hydraulics and the fundamental processes used to treat wastewater. In addition to understanding the details behind the fundamental processes, students will learn to feel comfortable developing initial design criteria (30% designs) for fundamental processes. Students should also develop a feel for the typical values of water treatment parameters and the equipment involved. After covering conventional processes, the class addresses newer processes used to meet emerging treatment objectives, including nutrient removal, composting of biosolids and recycling of wastewater for beneficial uses, including potable reuse. Pre-requisites: CEE 174A.
CEE	PROVIDING SAFE WATER	174A	GR		X	This course will cover basic hydraulics and the fundamental processes used to provide and control water, and will introduce the basics of engineering design. In addition to understanding the details behind the fundamental processes, students will learn to feel comfortable developing initial design criteria (30% designs) for fundamental processes. Students should also develop a feel for the typical values of water treatment parameters and the equipment involved. The course should enable students to work competently in environmental engineering firms or on non-profit projects in the developing world such as Engineers without Borders. Pre-requisite: Chem31B/X.
CEE	GROUNDWORK FOR COP21	163F	GR		X	This course will prepare undergraduate and coterm students to observe the climate change negotiations (COP 21) in Paris in November/December 2015. Students will develop individual projects to be carried out before and during the negotiation session and be paired with mentors. Please note: Along with EARTHSYS 163E/ CEE 163E, this course is part of the required two-course-set in which undergraduate and co-terminal masters degree students must enroll to receive accreditation to the climate negotiations.
CEE	GROUNDWORK FOR COP21	263F	GR		X	This course will prepare undergraduate and coterm students to observe the climate change negotiations (COP 21) in Paris in November/December 2015. Students will develop individual projects to be carried out before and during the negotiation session and be paired with mentors. Please note: Along with EARTHSYS 163E/ CEE 163E, this course is part of the required two-course-set in which undergraduate and co-terminal masters degree students must enroll to receive accreditation to the climate negotiations.

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CEE	HOW BUILDINGS ARE MADE	131C	GR	X		This course will provide an introduction to the materials and methods used in building construction. A combination of in-class lectures, reading assignments, and building site visits will provide students with an awareness of construction materials and their use within building systems. All relevant building types and construction materials will be explored, including wood, steel, concrete and masonry. Building foundations and basic structural systems will be explained. Building envelope elements will be considered, with an analysis of various glass and glazing materials, cladding types, and roofing systems. Interior Floor, wall and ceiling finishes will be discussed. New and emerging building trends will also be examined, wuch as prefabricated and modular construction. Guest presenters, drawn from Bay Area consulting firms, will cover several topics of interest. Students will have an opportunity to experience real world material applications at local construction sites, and gain a thorough understanding of the construction process.
CEE	ENERGY STORAGE INTEGRATION	176C	GR		X	This course will provide in-depth introduction to existing energy storage solutions being used on the electric grid and in vehicles with a primary focus on batteries and electrochemical storage. We will discuss the operating characteristics, cost and efficiency of these technologies and how tradeoff decisions can be made. Special attention will be given to system-level integration of new storage technologies, including chargers, inverters, battery management systems and controls, into the existing vehicle and grid infrastructure. Further investigations include issues relating to integration of electric vehicle charging with demand-side management, scheduled renewable energy absorption and local grid balancing. Class format involves regular guest lectures, required lab participation, and field trips to relevant sites. Enrollment is limited; if you are interested in taking the course, please fill out a brief questionnaire at http://goo.gl/forms/i3YH91Qx05 n Please contact jtaggart@stanford.edu with any questions regarding the application or course information.
CEE	ENERGY STORAGE INTEGRATION	276C	GR		X	This course will provide in-depth introduction to existing energy storage solutions being used on the electric grid and in vehicles with a primary focus on batteries and electrochemical storage. We will discuss the operating characteristics, cost and efficiency of these technologies and how tradeoff decisions can be made. Special attention will be given to system-level integration of new storage technologies, including chargers, inverters, battery management systems and controls, into the existing vehicle and grid infrastructure. Further investigations include issues relating to integration of electric vehicle charging with demand-side management, scheduled renewable energy absorption and local grid balancing. Class format involves regular guest lectures, required lab participation, and field trips to relevant sites. Enrollment is limited; if you are interested in taking the course, please fill out a brief questionnaire at http://goo.gl/forms/i3YH91Qx05 n Please contact jtaggart@stanford.edu with any questions regarding the application or course information.
CEE	CALIF MODERNISM: WEB OF APPREN	32U	GR	X		This course will study at the development of Modernism in pre and post WWII California. The class will investigate responses to climatic, technological, and cultural changes that were specific to the state but have now become an idealized tread. We will look at architects and landscape architects who apprenticed with significant design leaders and track how their involvement and explore resulted in changes in building technologies, and influenced the next generation of design thinking and experimentation. The investigations will occur through research, drawings and models, as well as site visits.
CEE	ENVIRONMENTAL GOVERNANCE	277C	GR	X		This interdisciplinary course presents an overview of environmental governance through an examination of how and why societies manage the relationships between human beings and the natural world. By comparing regulatory, community-based, and incentive-based environmental management systems, we address why certain environmental problems are managed as they are, and what approaches to environmental management are more (or less) successful. Designed for graduate students and upper-level undergraduates with some exposure to both the natural sciences (ecology/environmental chemistry), and the social sciences (anthropology, economics, political science, or sociology). A pre-course incoming survey is required.
CEE	INTRO TO PHD STUDIES IN CEE	379	GR	X		This seminar course will cover important topics for students considering a PhD in Civil and Environmental Engineering. Sessions will include presentations and discussions on career development, exploring research and adviser options, and the mechanics of PhD studies, including General Qualifying Exam requirements for all CEE PHD Students. In addition, CEE faculty will give presentations on their research. This seminar is required for CEE students considering a PHD or preparing to sit for the General Qualifying Exam in Civil and Environmental Engineering.

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CEE	INTRO TO REAL ESTATE & DEVELOP	248S	GR	X		This seminar will offer students an introduction to Real Estate Development. Senior Principals from Sares Regis, a regional commercial and residential real estate development company, will cover topics on all aspects of the development process. Guest speakers from the fields of architecture and engineering, finance and marketing will participate in some of the classes. They will offer the students a window into the world of how houses, apartments, office buildings and public facilities are conceived of, brought through the design and approval process, financed, marketed and then sold and/or rented. There will be five one-and-a-half-hour lectures (robust class discussion encouraged). Classes commence on April 14th and complete on May 12th. There will be one written project assignment due prior to class on May12th. No prior knowledge of real estate is required.
CEE	ENERGY POLICY IN CALIFORNIA	263G	GR		X	This seminar will provide an in-depth analysis of the role of California state agencies in driving energy policy development, technology innovation, and market structures. The course will cover three areas: 1) roles and responsibilities of key state agencies; 2) current and evolving energy and climate policies; and 3) development of California's 21st century energy systems. Presentations will include experts from the California Energy Commission, the California Public Utilities Commission, the California Air Resources Board, the California Independent System Operator, the California Legislature, and the Governor's office. This class is required for all Stanford Energy Internships in California (SEIC) fellowship awardees and is open to other interested undergraduate and graduate students. Class dates are: April 2nd (10am-2pm), April 30th (10am-1pm), and May 21st (10am-1pm). Lunch will be provided. May be repeat for credit. If interested you can fill out this webform: http://web.stanford.edu/~sburbank/Energy.fb
CEE	INTERMEDIATE ARCH STUDIO	134B	GR	X		This studio offers students experience in working with a real site and a real client program to develop a community facility. Students will develop site analysis, review a program for development and ultimately design their own solutions that meet client and community goals. Sustainability, historic preservation, community needs and materials will all play a part in the development of students final project. Students will also gain an understanding of graphic conventions, verbal and presentation techniques
CEE	INTERMEDIATE ARCH STUDIO	234B	GR	X		This studio offers students experience in working with a real site and a real client program to develop a community facility. Students will develop site analysis, review a program for development and ultimately design their own solutions that meet client and community goals. Sustainability, historic preservation, community needs and materials will all play a part in the development of students final project. Students will also gain an understanding of graphic conventions, verbal and presentation techniques. Course may be repeated for credit.
CEE	ENVIRONMENTAL ORGANIC REACTION	270B	GR	X		With over 70,000 chemicals now in production worldwide, predicting their fate in the environment is a difficult task. The course focuses on developing two key skillls. First, students should develop the ability to derive mass balance equations used to quantify the fate of chemicals in the environment. With so many chemicals having been introduced in the past ~60 years, many of the key parameters needed for mass balance models have not been measured experimentally. The class builds on CEE 270, which developed methods of predicting equilibrium partitioning coefficients. For many situations involving reactions of target contaminants, equilibrium is not attained. The course develops methods of predicting the reactivity of chemicals based upon their chemical structures both qualitatively and quantitatively. natural reaction processes covered include acid-base speciation, nucleophilic substitution, oxidation/reduction reactions, and photochemical reactions. Key treatment ractions (ozone, UV treatment and advanced oxidation) are also covered. Prerequisites: CEE 270, Chem 31B/X.
CEE	ENVIRO SCI & TECHNOLOGY	70	UG		X	Introduction to environmental quality and the technical background necessary for understanding environmental issues, controlling environmental degradation, and preserving air and water quality. Material balance concepts for tracking substances in the environmental and engineering systems.
CEE	MANAGING SUSTAIN BLDG PROJECTS	100	UG		X	Managing the life cycle of buildings from the owner, designer, and contractor perspectives emphasizing sustainability goals; methods to define, communicate, coordinate, and manage multidisciplinary project objectives including scope, quality, life cycle cost and value, schedule, safety, energy, and social concerns; roles, responsibilities, and risks for project participants; virtual design and construction methods for product, organization, and process modeling; lifecycle assessment methods; individual writing assignment related to a real world project.

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CEE	LEGAL ASPECTS ENGR+CONSTRUCT	102	UG	X		Introduction to the key legal principles affecting design, construction and the delivery of infrastructure projects. The course begins with an introduction to the structure of law, including principles of contract, negligence, professional responsibility, intellectual property, land use and environmental law, then draws on these concepts to examine current and developing means of project delivery.
CEE	INTRO TO SENSING TECHNOLOGIES	155	UG	X		Introduce the design and implementation of sensor networks for monitoring the built and natural environment. Emphasis on the integration of modern sensor and communication technologies, signal processing and statistical models for network data analysis and interpretation to create practical deployments to enable sustainable systems, in areas such as energy, weather, transportation and buildings. Students will be involved in a practical project that may involve deploying a small sensor system, data models and analysis and signal processing. Limited enrollment.
CEE	ENVIRNMTL PLANNING METHODS	171	UG		X	Intended primarily for juniors and seniors; first year graduate students welcome. Course introduces key environmental policy design and implementation concepts and provides opportunities to work with a range of environmental planning methods. Environmental laws and regulations (e.g., US Clean Water Act and the US National Environmental Policy Act) are examined. Course demonstrates how firms have gone beyond regulatory compliance and introduced environmental sustainability issues into core business strategies. Course uses a simulated negotiation of a financial penalty between a student team representing the US EPA (and other government agencies) and a team representing a firm that is out of compliance with Clean Water Act regulations. Professionals with experience in such negotiations provide coaching for student teams.
CEE	AQUATIC CHEM & BIOLOGY	177	UG	X		Introduction to chemical and biological processes in the aqueous environment. Basic aqueous equilibria; the structure, behavior, and fate of major classes of chemicals that dissolve in water; redox reactions; the biochemistry of aquatic microbial life; and biogeochemical processes that govern the fate of nutrients and metals in the environment and in engineered systems.
CEE	HUMAN EXPOSURE ANALYSIS	178	UG	X		(Graduate students register for 276.) Scientific and engineering issues involved in quantifying human exposure to toxic chemicals in the environment. Pollutant behavior, inhalation exposure, dermal exposure, and assessment tools. Overview of the complexities, uncertainties, and physical, chemical, and biological issues relevant to risk assessment. Lab projects.
CEE	INTEGRATED CE DESIGN PROJECT	183	UG	X		Studio format. Design concepts for civil engineering facilities from schematic design through construction, taking into account sustainable engineering issues. Design exercises culminating in the design of a civil engineering facility, emphasizing structural systems and materials and integration with architectural, construction and other project requirements.
CEE	DECISION ANALYSIS FOR CEE ENG	206	GR		X	Current challenges in selecting an appropriate site, alternate design, or retrofit strategy based on environmental, economic, and social factors can be best addressed through applications of decision science. Basics of decision theory, including development of decision trees with discrete and continuous random variables, expected value decision making, utility theory value of information, and elementary multi-attribute decision making will be covered in the class. Examples will cover many areas of civil and environmental engineering problems.
CEE	LIFE CYCLE ASSESSMENT	226	GR		X	Life cycle modeling of products, industrial processes, and infrastructure/building systems; material and energy balances for large interdependent systems; environmental accounting; and life cycle costing. These methods, based on ISO 14000 standards, are used to examine emerging technologies, such as biobased products, building materials, building integrated photovoltaics, and alternative design strategies, such as remanufacturing, dematerialization, LEED, and Design for Environment: DfE. Student teams complete a life cycle assessment of a product or system chosen from industry.
CEE	CONSTRUCTION ENGIN MANAGEMENT	258	GR	X		Presentations from construction industry leaders. Discussions with speakers from various segments of industry regarding career options. Student groups interact with industry representatives after class.
CEE	GROUNDWATER FLOW	268	GR	X		Flow and mass transport in porous media. Applications of potential flow theory and numerical modeling methods to practical groundwater problems: flow to and from wells, rivers, lakes, drainage ditches; flow through and under dams; streamline tracing; capture zones of wells; and mixing schemes for in-situ remediation. Prerequisites: calculus and introductory fluid mechanics.

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CEE	ORGANIC CONTAMINANTS IN WATER	270	GR		X	Transport of chemical constituents in surface and groundwater including advection, dispersion, sorption, interphase mass transfer, and transformation; impacts on water quality. Emphasis is on physicochemical processes and the behavior of hazardous waste contaminants.
CEE	HUMAN EXPOSURE ANALYSIS	276	GR	X		(Graduate students register for 276.) Scientific and engineering issues involved in quantifying human exposure to toxic chemicals in the environment. Pollutant behavior, inhalation exposure, dermal exposure, and assessment tools. Overview of the complexities, uncertainties, and physical, chemical, and biological issues relevant to risk assessment. Lab projects.
CEE	ENVIRONMENTAL ENGR SEMINAR	279	GR		X	Current research, practice, and thinking in environmental engineering and science. Attendance at seminars is self-directed, the 20 hours of required seminar attendance may be accrued throughout the school year. Must prepare a publication synopsis, and maintain log of seminar attendance. See Aut Qtr CEE 279 syllabus for details on course requirements. Contact hildemann@stanford.edu to be added to Coursework website.
CEE	SUSTAINABLE BUILT ENVIR RSRCH	316	GR		X	Intended for early stage Ph.D. students in Sustainable Design and Construction (SDC). Covers dominant methodological approaches at the intersection of engineering, social management science and computer science. Overviews an array of methods available for research, focusing on methods commonly used in SDC. Publications using various methods will be analyzed, and journal review processes will be discussed. Major deliverable is research proposal using one or more of the methods discussed. Students will gain familiarity with the array of methods available for SDC research, know how to apply the methods in their own research area, and receive guidance on publishing their research in scientific journals.
CEE	MECHANICS OF FLUID	101B	GR	X		Physical properties of fluids and their effect on flow behavior; equations of motion for incompressible ideal flow, including the special case of hydrostatics; continuity, energy, and momentum principles; control volume analysis; laminar and turbulent flows; internal and external flows in specific engineering applications including pipes, open channels, estuaries, and wind turbines.
CEE	GEOTECHNICAL ENGINEERING	101C	GR	X		Introduction to the principles of soil mechanics. Soil classification, shear strength and stress-strain behavior of soils, consolidation theory, analysis and design of earth retaining structures, introduction to shallow and deep foundation design, slope stability. Lab projects.
CEE	UNDERSTANDING ENERGY	107A	GR		X	Energy is one of the world's main drivers of opportunity and development for human beings. At the same time, our energy system has significant consequences for our society, political system, economy, and environment. For example, energy production and use is the #1 source of greenhouse gas emissions. This course surveys key aspects of each energy resource, including significance and potential conversion processes and technologies, drivers and barriers, policy and regulatory environment, and social, economic, and environmental impacts. Both depletable and renewable energy resources are covered, including oil, natural gas, coal, nuclear, biomass, hydroelectric, wind, solar, photovoltaics, geothermal, and ocean energy, with cross-cutting topics including electricity, storage, climate change, sustainability, green buildings, energy efficiency, transportation, and the developing world. Understanding Energy is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource - from fossil fuels to renewable energy. The other two classes are CEE107W/207W Understanding Energy - Workshop, and CEE 107F/207F Understanding Energy -- Field Trips. Note that this course was formerly called Energy Resources (CEE 173A/207A &Earthsys 103). Prerequisites: Algebra. May not be taken for credit by students who have completed CEE 107S.
CEE	UNDERSTANDING ENERGY FIELD TRI	107F	GR		X	Understanding Energy - Field Trips takes students on trips to major energy resource sites located within a few hours of Stanford University. Students visit at least two of the many field trips offered, including to a nuclear power plant, a wind farm, a geothermal facility, a solar photovoltaic (PV) farm, a hydroelectric power plant, an oil field, and a natural gas-fired power plant, among others (field trips offered may vary by quarter). Students meet 7-8 times during the quarter to debrief previous field trips and prepare for future ones. Open to all majors and backgrounds. Understanding Energy - Field Trips is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource -- from fossil fuels to renewable energy. The other two courses are CEE 107A/207A & EARTHSYS 103 Understanding Energy, and CEE 107W/207W & EARTHSYS 103W Understanding Energy - Workshop. Priority is given to students who have taken or are concurrently enrolled in CEE 173A, CEE 107A, CEE 207A, EARTHSYS 103, or CEE 107S/207S.

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CEE	UNDERSTANDING ENERGY WORKSHOP	107W	GR		X	Interactive workshop that goes in depth into cross-cutting energy topics touched on by CEE 107A/207A & EARTHSYS 103 - Understanding Energy. Topics covered include energy and sustainability, energy information analysis, energy and climate change policy, electricity storage, exergy and energy quality, energy-water nexus, energy and land use, energy and air quality, and transportation policy. Students are graded on attendance, participation, and a short final paper. Sessions will involve discussions, group activities, and fun debates. Open to all majors and backgrounds. This workshop is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource -- from fossil fuels to renewable energy. The other two classes are CEE 107A/207A & EARTHSYS 103 Understanding Energy, and CEE 107F/207F & EARTHSYS 103F Understanding Energy Field Trips. Prerequisites: Must have taken or take concurrently CEE 173A, CEE 107A, CEE 207A, EARTHSYS 103, or CEE 107S/207S.
CEE	INFRASTRUCTURE DEVELOPMENT	141A	GR	X		Infrastructure is critical to the economy, global competitiveness and quality of life. Topics include energy, transportation, water, public facilities, and communications sectors. Analysis of the condition of the nation's infrastructure and how projects are planned and financed. Focus is on public works in the U.S. The role of public and private sectors through a step-by-step study of the project development process. Case studies of real infrastructure projects. Industry guest speakers. Student teams prepare project environmental impact statements.
CEE	INFRASTRUCTURE DELIVERY	141B	GR	X		Infrastructure is critical to the economy, global competitiveness and quality of life. Topics include energy, transportation, water, public facilities ,and communications sectors. Analysis of how projects are designed, constructed, operated, and maintained. Focus is on public works projects in the U.S. Alternative project delivery approaches and organizational strategies. Case studies of real infrastructure projects. Industry guest speakers. Student teams prepare finance/design/build/operate/maintain project proposals.
CEE	GLOBAL INFRASTRUCTURE PROJECTS	141C	GR	X		Real infrastructure projects presented by industry guest speakers. Energy, transportation, water, public facilities and communications projects are featured. Course provides comparisons of project development and delivery approaches for mega-projects around the world. Alternative project delivery methods, the role of public and private sector, different project management strategies, and lessons learned. Field trips to local projects.
CEE	WATERSHEDS & WETLANDS	166A	GR		X	Introduction to the occurrence and movement of water in the natural environment and its role in creating and maintaining terrestrial, wetland, and aquatic habitat. Hydrologic processes, including precipitation, evaporation, transpiration, snowmelt, infiltration, subsurface flow, runoff, and streamflow. Rivers and lakes, springs and swamps. Emphasis is on observation and measurement, data analysis, modeling, and prediction.
CEE	FLOODS & DROUGHTS, DAMS & AQUE	166B	GR		X	Sociotechnical systems associated with human use of water as a resource and the hazards posed by too much or too little water. Potable and non-potable water use and conservation. Irrigation, hydroelectric power generation, rural and urban water supply systems, storm water management, flood damage mitigation, and water law and institutions. Emphasis is on engineering design.
CEE	INDOOR AIR QUALITY	172A	GR		X	Factors affecting the levels of air pollutants in the built indoor environment. The influence of ventilation, office equipment, floor coverings, furnishings, cleaning practices, and human activities on air quality including carbon dioxide, VOCs, resuspended dust, and airborne molds and fungi. Limited enrollment, preference to CEE students.

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CEE	CA COAST-SCIENCE POLICY LAW	175A	GR		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
CEE	ELECTR PWR: RNWBLS & EFICIENCY	176B	GR		X	This course introduces analysis, sizing and performance estimations (electrical and financial) of renewable energy systems on both sides of the electric meter with an emphasis on photovoltaics and wind-power systems. Basic electric power generation, transmission and distribution, as well as distributed generation will be introduced. Optional Laboratory section for a 4th unit of credit.
CEE	SUSTAINABLE ENG SEMINAR	177X	GR		X	This course is the first half of a two quarter, project-based design course that addresses the cultural, political, organizational, technical, and business issues at the heart of implementing sustainable engineering projects in the developing world. Students will be placed into one of three project teams and tackle a real-world design challenge in partnership with social entrepreneurs and NGOs. In CEE 177X/277X, students will gain the background skills and context necessary to effectively design engineering projects in developing nations. Instructor consent required.
CEE	ENVIRONMNTL ENGINEERING DESIGN	179C	GR		X	Application of engineering fundamentals including environmental engineering, hydrology, and engineering economy to a design problem. Enrollment limited; preference to seniors in Civil and Environmental Engineering.
CEE	UNDERSTANDING ENERGY	207A	GR		X	Energy is one of the world's main drivers of opportunity and development for human beings. At the same time, our energy system has significant consequences for our society, political system, economy, and environment. For example, energy production and use is the #1 source of greenhouse gas emissions. This course surveys key aspects of each energy resource, including significance and potential conversion processes and technologies, drivers and barriers, policy and regulatory environment, and social, economic, and environmental impacts. Both depletable and renewable energy resources are covered, including oil, natural gas, coal, nuclear, biomass, hydroelectric, wind, solar, photovoltaics, geothermal, and ocean energy, with cross-cutting topics including electricity, storage, climate change, sustainability, green buildings, energy efficiency, transportation, and the developing world. Understanding Energy is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource - from fossil fuels to renewable energy. The other two classes are CEE107W/207W Understanding Energy - Workshop, and CEE 107F/207F Understanding Energy -- Field Trips. Note that this course was formerly called Energy Resources (CEE 173A/207A &Earthsys 103).

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CEE	UNDERSTANDING ENERGY FIELD TRI	207F	GR		X	Understanding Energy - Field Trips takes students on trips to major energy resource sites located within a few hours of Stanford University. Students visit at least two of the many field trips offered, including to a nuclear power plant, a wind farm, a geothermal facility, a solar photovoltaic (PV) farm, a hydroelectric power plant, an oil field, and a natural gas-fired power plant, among others (field trips offered may vary by quarter). Students meet 7-8 times during the quarter to debrief previous field trips and prepare for future ones. Open to all majors and backgrounds. Understanding Energy - Field Trips is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource -- from fossil fuels to renewable energy. The other two courses are CEE 107A/207A & EARTHSYS 103 Understanding Energy, and CEE 107W/207W & EARTHSYS 103W Understanding Energy - Workshop. Priority is given to students who have taken or are concurrently enrolled in CEE 173A, CEE 107A, CEE 207A, EARTHSYS 103, or CEE 107S/207S.
CEE	UNDERSTANDING ENERGY WORKSHOP	207W	GR		X	Interactive workshop that goes in depth into cross-cutting energy topics touched on by CEE 107A/207A & EARTHSYS 103 - Understanding Energy. Topics covered include energy and sustainability, energy information analysis, energy and climate change policy, electricity storage, exergy and energy quality, energy-water nexus, energy and land use, energy and air quality, and transportation policy. Students are graded on attendance, participation, and a short final paper. Sessions will involve discussions, group activities, and fun debates. Open to all majors and backgrounds. This workshop is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource -- from fossil fuels to renewable energy. The other two classes are CEE 107A/207A & EARTHSYS 103 Understanding Energy, and CEE 107F/207F & EARTHSYS 103F Understanding Energy Field Trips.
CEE	COMP INTEG AEC GLOBAL TEAMWORK	222B	GR	X		Global AEC student teams continue their project activity focusing on the most challenging concept developed in 222A and chosen jointly with their client. Comprehensive team project focusing on design and construction, including: project development and documentation; detailing, 3D and 4D modeling, simulation, sustainable concepts, cost benefit analysis, and life-cycle cost analysis; and final project presentation of product and process.
CEE	ADVANCED BLDG ENERGY DESIGN	226E	GR		X	Innovative methods and systems for the integrated design and evaluation of energy efficient buildings. Guest practitioners and researchers in energy efficient buildings. Student initiated final project. Prerequisites: CEE 156 or CEE 256. All students are expected to participate in the group project assignments. Students taking the course for two units will not be required to complete in-class assignments or individual homework assignments.
CEE	SUSTAINABLE BANKING SEMINAR	244A	GR		X	This seminar explores ideas for redesigning banks and the banking sector to achieve three goals: (1) keep the bank and its depositors safe, (2) keep the borrowers, communities, and societies affected by the bank's lending decisions safe, and (3) use bank transactions to improve the sustainability of natural ecosystems. Weekly speakers include bankers, bank regulators, and financial technology (fintech) innovators focused on sustainable banking.
CEE	REAL ESTATE DEV AND FINANCE	246B	GR	X		Introduction to the Real Estate Development Process from conception, feasibility analysis, due diligence, entitlements, planning, financing, market analysis, contract negotiation, construction, marketing, asset management and disposition. Pro-forma and Financial modeling in Real Estate. Financing options for different types of Real Estate projects and products. Redevelopment projects. Affordable Housing. The class will combine lectures, case studies, field work (Group Project) and guest speakers. Recommended knowledge of spreadsheets. Enrollment limited to 40; no auditors. Instructor consent is required. Only Seniors or Grad students. Students must please kindly email the instructor a short paragraph indicating if they are an undergrad or grad student, their current year (Frosh/Soph/Junior or Senior), their Department and Program, and their reason for taking the class.
CEE	PHYSICAL HYDROGEOLOGY	260A	GR	X		(Formerly GES 230.) Theory of underground water occurrence and flow, analysis of field data and aquifer tests, geologic groundwater environments, solution of field problems, and groundwater modeling. Introduction to groundwater contaminant transport and unsaturated flow. Lab.
CEE	CONTAMINANT HYDROGEOLOGY	260C	GR		X	For earth scientists and engineers. Environmental, geologic, and water resource problems involving migration of contaminated groundwater through porous media and associated biogeochemical and fluid-rock reactions. Conceptual and quantitative treatment of advective-dispersive transport with reacting solutes. Predictive models of contaminant behavior controlled by local equilibrium and kinetics. Modern methods of contaminant transport simulation and reactive transport modeling using geochemical transport software. Some Matlab programming / program modification required. Prerequisite: Physical Hydrogeology ESS 220 / CEE 260A (Gorelick) or equivalent. Recommended: course work in environmental chemistry or geochemistry (e.g., one or more of the following: ESS 155, ESS 156/256 GS 90, GS 170/279, GS 171, CEE 177 or CEE 270).

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CEE	TRNSPRT/MXNG IN SRFC WTR FLOWS	262B	GR	X		Application of fluid mechanics to problems of pollutant transport and mixing in the water environment. Mathematical models of advection, diffusion, and dispersion. Application of theory to problems of transport and mixing in rivers, estuaries, and lakes and reservoirs. Recommended: 262A and CME 102 (formerly ENGR 155A), or equivalents.
CEE	AIR POLLUTION MODELING	263A	GR		X	The numerical modeling of urban, regional, and global air pollution focusing on gas chemistry and radiative transfer. Stratospheric, free-tropospheric, and urban chemistry. Methods for solving stiff systems of chemical ordinary differential, including the multistep implicit-explicit method, Gear's method with sparse-matrix techniques, and the family method. Numerical methods of solving radiative transfer, coagulation, condensation, and chemical equilibrium problems. Project involves developing a basic chemical ordinary differential equation solver.
CEE	ATMOSPHERE/ENERGY SEMINAR	263S	GR		X	Interdisciplinary seminar with talks by researchers and practitioners in the fields of atmospheric science and renewable energy engineering. Addresses the causes of climate, air pollution, and weather problems and methods of addressing these problems through renewable and efficient energy systems. May be repeated for credit.
CEE	SUSTNBL WTR RESOURCES DEV	265A	GR		X	Alternative criteria for judging the sustainability of projects. Application of criteria to evaluate sustainability of water resources projects in several countries. Case studies illustrate the role of political, social, economic, and environmental factors in decision making. Influence of international aid agencies and NGOs on water projects. Evaluation of benefit-cost analysis and environmental impact assessment as techniques for enhancing the sustainability of future projects. Limited enrollment.
CEE	EFMH SEMINAR	269A	GR	X		Problems in all branches of water resources. Talks by visitors, faculty, and students. May be repeated two times for credit.
CEE	EFMH SEMINAR	269B	GR	X		Problems in all branches of water resources. Talks by visitors, faculty, and students. May be repeated two times for credit.
CEE	EFMH SEMINAR	269C	GR	X		Problems in all branches of water resources. Talks by visitors, faculty, and students. May be repeated two times for credit.
CEE	MODERN POWER SYSTEMS	272R	GR	X		Focus is on Power Engineering from a systems point of view. Topics covered may include modeling of generation, transmission and distribution systems, load flow analysis, transient and steady-state stability analysis. Special emphasis given to modern market operations and dispatch, modeling intermittent controllable power sources, storage technologies, mechanisms for demand response, sensing the grid and the role of market mechanisms for deep integration. Course content may vary year to year.
CEE	SMARTGRIDS AND ADVANCED POWER	272T	GR		X	A series of seminar and lectures focused on power engineering. Renowned researchers from universities and national labs will deliver bi-weekly seminars on the state of the art of power system engineering. Seminar topics may include: power system analysis and simulation, control and stability, new market mechanisms, computation challenges and solutions, detection and estimation, and the role of communications in the grid. The instructors will cover relevant background materials in the in-between weeks. The seminars are planned to continue throughout the next academic year, so the course may be repeated for credit.
CEE	ENVIRONMENTAL MICROBIOLOGY I	274A	GR	X		Basics of microbiology and biochemistry. The biochemical and biophysical principles of biochemical reactions, energetics, and mechanisms of energy conservation. Diversity of microbial catabolism, flow of organic matter in nature: the carbon cycle, and biogeochemical cycles. Bacterial physiology, phylogeny, and the ecology of microbes in soil and marine sediments, bacterial adhesion, and biofilm formation. Microbes in the degradation of pollutants.

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CEE	CA COAST-SCIENCE POLICY LAW	275A	GR		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
CEE	SUSTAINABLE ENG SEMINAR	277X	GR		X	This course is the first half of a two quarter, project-based design course that addresses the cultural, political, organizational, technical, and business issues at the heart of implementing sustainable engineering projects in the developing world. Students will be placed into one of three project teams and tackle a real-world design challenge in partnership with social entrepreneurs and NGOs. In CEE 177X/277X, students will gain the background skills and context necessary to effectively design engineering projects in developing nations. Instructor consent required.
CEE	MANAGING CRITICAL INFRASTRUCT	297M	GR		X	Safe and effective performance of infrastructure systems is critical to our economy, quality of life and safety. This course will present topics associated with risk analysis and management of critical civil infrastructure systems, tolerable risk and community resilience. Methods of risk analysis including systems analysis, reliability analysis, expert elicitation and systems analysis for spatially distributed infrastructure systems will be presented. Aspects of seismic and flood risk analysis will also be discussed. Case histories and lessons learned from Hurricane Katrina, Tohoku earthquake, among others will be presented. The evolution of change in the risk management of civil infrastructure systems; how they are analyzed, designed and operated is discussed. Guest speakers. Student presentations.
CEE	ADV TOPICS COASTAL POLLUTION	374T	GR		X	May be repeated for credit. Prerequisite: consent of instructor.
CEE	ADV TOPICS H2O, HEALTH & DEV	374W	GR	X		Advanced topics in water, health and development. Emphasis on low-and-middle-income countries. Class content varies according to interests of students. Instructor consent required.
CHEM	VENTURES ENGRNG SCIENCE-BASED	296	GR	X		Open to seniors and graduate students interested in the creation of new ventures and entrepreneurship in engineering and science intensive industries such as chemical, energy, materials, bioengineering, environmental, clean-tech, pharmaceuticals, medical, and biotechnology. Exploration of the dynamics, complexity, and challenges that define creating new ventures, particularly in industries that require long development times, large investments, integration across a wide range of technical and non-technical disciplines, and the creation and protection of intellectual property. Covers business basics, opportunity viability, creating start-ups, entrepreneurial leadership, and entrepreneurship as a career. Teaching methods include lectures, case studies, guest speakers, and individual and team projects.
CHEM	SCIENCE IN THE NEWS	25N	GR	X		Preference to freshmen. Possible topics include: diseases such as avian flu, HIV, and malaria; environmental issues such as climate change, atmospheric pollution, and human population; energy sources in the future; evolution; stem cell research; nanotechnology; and drug development. Focus is on the scientific basis for these topics as a basis for intelligent discussion of societal and political implications. Sources include the popular media and scientific media for the nonspecialist, especially those available on the web.

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CHEM	SCIENCE INNOVATION	28N	GR	X		Preference to freshmen. The course will explore evolutionary and revolutionary scientific advances; their consequences to society, biotechnology, and the economy; and mechanisms for communicating science to the public. The course will engage academic and industrial thought leaders and provide an opportunity for students to participate in communicating science to the public.
CHEM	EXPLORING THE SCIENCES	10	UG	X		Development and practice of critical problem solving and study skills using wide variety of scientific examples that illustrate the broad yet integrated nature of current research. Student teams will have the opportunity to explore and present on topics revolving around five central issues: energy, climate change, water resources, medicine, and food & nutrition from a chemical perspective. Course offered in August prior to start of fall quarter.
CHEM	EXPLORING CHEMICAL RESEARCH	111	UG	X		Preference to freshmen and sophomores. Department faculty describe their cutting-edge research and its applications.
CHEM	PHYSICAL BIOCHEMISTRY	135	UG	X		Introduction to the physical principles that underlie biological function for students in the life sciences. Chemical thermodynamics: first, second and third laws, heat & work, entropy, free energy, chemical equilibrium, physical equilibrium, osmotic pressure, other colligative properties. Chemical kinetics: rate laws, integration of rate laws, reaction mechanisms, enzyme kinetics. Applications to proteins, lipids, nucleic acids, carbohydrates, small molecules, and macromolecular assemblies.
CHEMENG	BIOTECHNOLOGY	25B	GR	X		Biology and chemistry fundamentals, genetic engineering, cell culture, protein production, pharmaceuticals, genomics, viruses, gene therapy, evolution, immunology, antibodies, vaccines, transgenic animals, cloning, stem cells, intellectual property, governmental regulations, and ethics. Prerequisites: CHEM 31 and MATH 41 or equivalent courage.
CHEMENG	ENERGY AND MASS TRANSPORT	120B	GR	X		General diffusive transport, heat transport by conduction, Fourier's law, conduction in composites with analogies to electrical circuits, advection-diffusion equations, forced convection, boundary layer heat transport via forced convection in laminar flow, forced convection correlations, free convection, free convection boundary layers, free convection correlations and application to geophysical flows, melting and heat transfer at interfaces, radiation, diffusive transport of mass for dilute and non-dilute transfer, mass and heat transport analogies, mass transport with bulk chemical reaction, mass transport with interfacial chemical reaction, evaporation.
CHEMENG	INTRO TO CHEMICAL ENGINEERING	20	UG	X		Overview of chemical engineering through discussion and engineering analysis of physical and chemical processes. Topics: overall staged separations, material and energy balances, concepts of rate processes, energy and mass transport, and kinetics of chemical reactions. Applications of these concepts to areas of current technological importance: biotechnology, energy, production of chemicals, materials processing, and purification. Prerequisite: CHEM 31.
CHEMENG	COLLOQUIUM	699	GR	X		Weekly lectures by experts from academia and industry in the field of chemical engineering.
CHEMENG	COLLOQUIUM	699	GR	X		Weekly lectures by experts from academia and industry in the field of chemical engineering.
CHEMENG	COLLOQUIUM	699	GR	X		Weekly lectures by experts from academia and industry in the field of chemical engineering.
CHEMENG	CHEMICAL ENGINEERNG PROFESSION	10	UG	X		Open to all undergraduates. Overview of and careers in chemical engineering; opportunities to develop networks with working professionals. Panel discussions on career paths and post-graduation opportunities available. Areas include biotechnology, electronics, energy, environment, management consulting, nanotechnology, and graduate school in business, law, medicine, and engineering.
CHEMENG	HETEROGEN CATALYSIS ENERGY TRS	142	UG	X		(Formerly 124/224) Introduction to heterogeneous catalysis, including models of surface reactivity, surface equilibria, kinetics of surface reactions, electronic and geometrical effects in heterogeneous catalysis, trends in reactivity, catalyst structure and composition, electro-catalysis and photo-catalysis. Selected applications and challenges in energy transformations will be discussed.
CHEMENG	POLYMERS CLEAN ENERGY & WATER	162	UG		X	The first five weeks of this course will be devoted to the fundamental aspects of polymers necessary to understand the applications in energy and the environment. These include: polymer chain configuration, morphology of semi-crystalline and amorphous solids, thermal transition behavior, thermodynamics of polymer blends and block copolymers, and the time/temperature dependence of linear viscoelasticity. The remaining five weeks of class will be devoted to applications, with special emphasis on membrane transport, including ion transport in fuel cell exchange membranes, gas transport in hydrogen enrichment membranes, and water transport in desalination membranes. In addition, completely degradable biocomposites will be discussed.

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CHEMENG	CHEMICAL ENGRNG PLANT DESIGN	180	UG	X		Open to seniors in chemical engineering or by consent of instructor. Application of chemical engineering principles to the design of practical plants for the manufacture of chemicals and related materials. Topics: flow-sheet development from a conceptual design, equipment design for distillation, chemical reactions, heat transfer, pumping, and compression; estimation of capital expenditures and production costs; plant construction.
CHEMENG	VENTURES ENGRNG SCIENCE-BASED	196	UG	X		Open to seniors and graduate students interested in the creation of new ventures and entrepreneurship in engineering and science intensive industries such as chemical, energy, materials, bioengineering, environmental, clean-tech, pharmaceuticals, medical, and biotechnology. Exploration of the dynamics, complexity, and challenges that define creating new ventures, particularly in industries that require long development times, large investments, integration across a wide range of technical and non-technical disciplines, and the creation and protection of intellectual property. Covers business basics, opportunity viability, creating start-ups, entrepreneurial leadership, and entrepreneurship as a career. Teaching methods include lectures, case studies, guest speakers, and individual and team projects.
CHEMENG	POLYMERS CLEAN ENERGY & WATER	262	GR		X	The first five weeks of this course will be devoted to the fundamental aspects of polymers necessary to understand the applications in energy and the environment. These include: polymer chain configuration, morphology of semi-crystalline and amorphous solids, thermal transition behavior, thermodynamics of polymer blends and block copolymers, and the time/temperature dependence of linear viscoelasticity. The remaining five weeks of class will be devoted to applications, with special emphasis on membrane transport, including ion transport in fuel cell exchange membranes, gas transport in hydrogen enrichment membranes, and water transport in desalination membranes. In addition, completely degradable biocomposites will be discussed.
CHEMENG	VENTURES ENGRNG SCIENCE-BASED	296	GR	X		Open to seniors and graduate students interested in the creation of new ventures and entrepreneurship in engineering and science intensive industries such as chemical, energy, materials, bioengineering, environmental, clean-tech, pharmaceuticals, medical, and biotechnology. Exploration of the dynamics, complexity, and challenges that define creating new ventures, particularly in industries that require long development times, large investments, integration across a wide range of technical and non-technical disciplines, and the creation and protection of intellectual property. Covers business basics, opportunity viability, creating start-ups, entrepreneurial leadership, and entrepreneurship as a career. Teaching methods include lectures, case studies, guest speakers, and individual and team projects.
CHEMENG	TOPICS IN ENERGY & CATALYSIS	516	GR	X		Recent developments and current research. May be repeated for credit.
CHEMENG	ENERGY: CHEM TRANSFORMATIONS	25E	GR	X		An introduction and overview to the challenges and opportunities of energy supply and consumption. Emphasis on energy technologies where chemistry and engineering play key roles. Review of energy fundamentals along with historical energy perspectives and current energy production technologies. In depth analysises of solar thermal systems, biofuels, photovoltaics and electrochemical devices (batteries and fuel cells).
CHEMENG	SCI ENGRNG ENVIR REG & POLICY	60Q	GR		X	Preference to sophomores. How environmental policy is formulated in the U.S. How and what type of scientific research is incorporated into decisions. How to determine acceptable risk, the public's right to know of chemical hazards, waste disposal and clean manufacturing, brownfield redevelopment, and new source review regulations. The proper use of science and engineering including media presentation and misrepresentation, public scientific and technical literacy, and emotional reactions. Alternative models to formulation of environmental policy. Political and economic forces, and stakeholder discussions.
CHEMENG	UNDERGRADUATE HONORS SEMINAR	191H	GR	X		For Chemical Engineering majors approved for B.S. with Honors research program. Honors research proposal must be submitted and unofficial transcript document BSH status prior to required concurrent registration in 190H and 191H. May be repeated for credit. Corequisite: 190H
CHEMENG	UNDERGRADUATE HONORS SEMINAR	191H	GR	X		For Chemical Engineering majors approved for B.S. with Honors research program. Honors research proposal must be submitted and unofficial transcript document BSH status prior to required concurrent registration in 190H and 191H. May be repeated for credit. Corequisite: 190H
CHPR	HLTHY SUSTAINABLE FOOD SYSTEMS	213	GR		X	(HumBio students must enroll in HumBio 113S) Discussion-based seminar. Focus on problems with and systems-based solutions to food system issues. Four particular settings are addressed: University, worksite, hospital, and school food. Traditional vs. disruptive food system models compared and contrasted. The goal is to determine how best to m

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CHPR	DISEASE CONTROL SYSTEMS	254	GR	X		(HumBio students must enroll in HumBio 154A.)This course teaches operations research and modeling techniques to improve public health programs and disease control systems. Students will engage in in-depth interdisciplinary study of disease detection and control strategies from a "systems science" perspective, which involves the use of common mathematical modeling and operations research techniques such as optimization, queuing theory, Markov and Kermack-McKendrick models, and microsimulation. Lectures and problem sets will focus on applying these techniques to classical public health dilemmas such as how to optimize screening programs, reduce waiting times for healthcare services, solve resource allocation problems, and compare macro-scale disease control strategies that cannot be easily evaluated through randomized trials. Readings will complement the lectures and problem sets by offering critical perspectives from the public health history, sociology, and epidemiology. In-depth case studies from non-governmental organizations, departments of public health, and international agencies will drive the course. Open to upper-division undergraduate students.
CHPR	THEORETICAL FOUNDATIONS	228	GR	X		Focuses on the knowledge and skills, respect and thoughtful practice of designing health promotion interventions that are relevant, theoretically-informed, have broad impacts, and can endure. Provides an in-depth review of intervention approaches for health promotion and disease prevention and covers the leading theories of behavior change. Follows an integrative model to demonstrate similarities and differences between the theoretical approaches, seeking what is useful and worthwhile in each theoretical model rather than looking primarily for what is most easily criticized. Practical in nature with emphasis on the specifics of needs assessments and intervention development and delivery and how these may vary across community settings, with diverse populations, addressing different behaviors, and leveraging traditional and emerging delivery channels. Explores intervention creation, delivery, effectiveness, and sustainability to identify and better understand the resources and other practical considerations necessary to produce, deliver, monitor, and disseminate an intervention with demonstrated effectiveness. Examples drawn from across the behavioral spectrum and include tobacco control, physical activity, healthy diet, stress and distress, as well as consideration of the complexities of extending interventions to target multiple risk behaviors. Students develop a foundational understanding of behavior change theory, rigorous research methods, and creative design strategies to advance the health of individuals and communities.
CHPR	META-RESEARCH	206	GR	X		Open to graduate, medical, and undergraduate students. Appraisal of the quality and credibility of research findings; evaluation of sources of bias. Meta-analysis as a quantitative (statistical) method for combining results of independent studies. Examples from medicine, epidemiology, genomics, ecology, social/behavioral sciences, education. Collaborative analyses. Project involving generation of a meta-research project or reworking and evaluation of an existing published meta-analysis. Prerequisite: knowledge of basic statistics.
CLASSICS	ARCH OF ANC MEDIT ENVIRONMENTS	358	GR	X		This seminar examines the interplay between classical archaeologists¿ conceptions and analyses of ancient Mediterranean environments. These themes loom large now - during what might be called the ¿environmental turn¿ of the Anthropocene in the humanities and social sciences - and their increasing resonance provides the basis for critical reflection of the discipline¿s past and future trends. Topics will include: environmental determinism, ¿non-human¿ agency, the role of science in archaeological/historical practice, and the compartmentalization of environment/climate as analytic focus.
CME	APPLIED MATH CHEMICAL, BIOSCI	330	GR	X		Mathematical solution methods via applied problems including chemical reaction sequences, mass and heat transfer in chemical reactors, quantum mechanics, fluid mechanics of reacting systems, and chromatography. Topics include generalized vector space theory, linear operator theory with eigenvalue methods, phase plane methods, perturbation theory (regular and singular), solution of parabolic and elliptic partial differential equations, and transform methods (Laplace and Fourier). Prerequisites: CME 102/ ENGR 155A and CME 104/ ENGR 155B, or equivalents.

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COMM	SWAR ENVIRONMENTAL JOURNALISM	177C	GR		X	(Graduate students register for COMM / EARTHSYS 277C.) A practical, writing-intensive course for science and journalism students that begins with the assumption that you already know how to research and relay the essential facts of almost any environmental story. You will go beyond the basics, both as reporters and storytellers. Learn how to write stories that stand on fact but move like fiction, that have protagonists and antagonists, that create suspense, that reveal character through dialogue and action, and that pay off with resonant finales. Limited enrollment: preference to journalism students and students in the natural and environmental sciences. Prerequisite: COMM 104, EARTHSYS 200 or consent of instructor. Admission by application only, available from thayden@stanford.edu. Applications due Nov. 30, 2015.
COMM	SWAR ENVIRONMENTAL JOURNALISM	277C	GR		X	(Graduate students register for COMM / EARTHSYS 277C.) A practical, writing-intensive course for science and journalism students that begins with the assumption that you already know how to research and relay the essential facts of almost any environmental story. You will go beyond the basics, both as reporters and storytellers. Learn how to write stories that stand on fact but move like fiction, that have protagonists and antagonists, that create suspense, that reveal character through dialogue and action, and that pay off with resonant finales. Limited enrollment: preference to journalism students and students in the natural and environmental sciences. Prerequisite: COMM 104, EARTHSYS 200 or consent of instructor. Admission by application only, available from thayden@stanford.edu. Applications due Nov. 30, 2015.
COMPLIT	THE CONTEMPORARY	331	GR	X		Drawing on philosophy, theory, literature, and the arts, this graduate students seminar examines the concept of the contemporary and asks what it means to belong to our historical age: how do thinkers, writers, and artists make sense of the man-made catastrophes of the modern era; how by employing innovative thinking and aesthetics they allow us to consider the human condition as well as politics and ethics in our time. Philosophical readings include Arendt, Rorty, Agamben, Bauman, Taylor; literary readings include Marilynne Robinson, J. M. Coetzee, Phillip Roth, Sebald, Kluge, Celan among others.
COMPLIT	IMAGINING THE OCEANS	168	UG	X		How has Western culture constructed the world's oceans since the beginning of global ocean exploration? How have imaginative visions of the ocean been shaped by marine science, technology, exploration, commerce and leisure? Authors read might include Cook, Equiano, and Steinbeck; Defoe, Verne, Stevenson, Conrad, Woolf and Hemingway; Coleridge, Baudelaire, Moore, Bishop and Walcott. Films by Painlevé and Bigelow. Seminar co-ordinated with a spring 2015 Cantor Arts Center public exhibition. Visits to Cantor; other possible field trips include Hopkins Marine Station and SF Maritime Historical Park.
COMPLIT	IMAGINING THE OCEANS	368A	GR	X		How has Western culture constructed the world's oceans since the beginning of global ocean exploration? How have imaginative visions of the ocean been shaped by marine science, technology, exploration, commerce and leisure? Primary authors read might include Cook, Banks, Equiano, Ricketts, and Steinbeck; Defoe, Cooper, Verne, Conrad, Woolf and Hemingway; Coleridge, Baudelaire, Moore, Bishop and Walcott. Critical readings include Schmitt, Rediker and Linebaugh, Baucom, Best, Corbin, Auden, Sontag and Heller-Roazen. Films by Sekula, Painlevé and Bigelow. Seminar coordinated with a 2015 Cantor Arts Center public exhibition. Visits to the Cantor; other possible field trips include Hopkins Marine Station and SF Maritime Historical Park. Open to graduate students only.
COMPLIT	LITERATURE AND GLOBAL HEALTH	229	GR	X		This course examines the ways writers in literature and medicine have used the narrative form to explore the ethics of care in what has been called the developing world. We will begin with a call made by the editor-in-chief of The Lancet for a literature of global health, namely fiction modeled on the social reform novels of the nineteenth century, understood to have helped readers develop a conscience for public health as the field emerged as a modern medical specialty. We will then spend the quarter understanding how colonial, postcolonial, and world literatures have answered and complicated this call. Readings will include prose fiction by Albert Camus, Joseph Conrad, Tsitsi Dangaremgba, Amitav Ghosh, Susan Sontag as well as physician memoirs featuring Frantz Fanon, Albert Schweitzer, Abraham Verghese, Paul Farmer. And each literary reading will be paired with medical, philosophical, and policy writings that deeply inform the field of global health.
COMPMED	TRAINING IN RESEARCH	202	GR	X		Emphasis is on providing introductory training and practical, hands-on workshops for students interested in learning more about research biomethodology and animal models of human and animal disease. Topics include basic care and principals guiding the use of research animals, animal health and welfare, and research animal enrichment, basic mouse handling, rodent breeding, and the principals of rodent surgery and anesthesia. Content delivered online and in-person.

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CS	TOPICS IN COMP SUSTAINABILITY	325	GR		X	Computational Sustainability focuses on developing computational models, methods and tools for sustainable development. In this course, we will study recent computational approaches that have contributed to addressing sustainability topics related to biodiversity, climate, environment, urban design, transportation, buildings and others. Computational themes include machine learning, optimization, statistical modeling, and data mining.
CS	COMPUTATIONAL THINKING & SYS	44N	GR	X		Computing in the real-world is too often viewed as working away concocting some computer incantations hidden inside some high technology company. However, computing and computer communication has infiltrated and in many cases revolutionized several ¿systems¿ in the real world, including financial systems, inventory management, advertising systems, supply chain management, transportation systems, defense systems and so on. Moreover, the discipline of thinking that has developed to build these systems, computational thinking, has powerful applicability to real-world problems and situations outside of computer programming. This course provides an introduction and exposure to some of these dramatic trends, opportunities and risks. Also included is an introduction to some basic ideas in ¿computational thinking¿. The course will include guest speakers. No programming competence is assumed but exposure to programming would be useful. Interest in the real world and interest is not being run-over by this trend is essential.
CS	SOLUTIONS TO GLOBAL CHALLENGES	377E	GR	X		In this course we creatively apply information technologies to collectively attack Global Grand Challenges (e.g., global warming, rising healthcare costs and declining access, and ensuring quality education for all). This quarter we will focus on assisting refugees. Interdisciplinary student teams will carry out need-finding within a target domain, followed by brainstorming to propose a quarter long project. Teams will spend the rest of the quarter applying user-centered design methods to rapidly iterate through design, prototyping, and testing of their solutions. This course will interweave a weekly lecture with a weekly studio session where students apply the techniques hands-on in a small-scale, supportive environment.
CS	CS + SOCIAL GOOD	90SI	GR	X		Learn web technologies by working on real world projects focused on creating positive social impact. The class will cover basic topics related to web development and provide resources for more advanced learning. Students will work on small teams to implement high-impact projects for partner organizations. The aim of the class is to empower students to leverage technology for social good by inspiring action, facilitating collaboration, and forging pathways toward change. No web application experience required. Prerequisite: 106B. Application required; apply online at http://bit.ly/90siApp. Applications accepted until midnight on September 14th.
CS	SOCIAL ECONOMIC IMPACT OF AI	22A	GR	X		Recent advances in computing may place us at the threshold of a unique turning point in human history. Soon we are likely to entrust management of our environment, economy, security, infrastructure, food production, healthcare, and to a large degree even our personal activities, to artificially intelligent computer systems. The prospect of "turning over the keys" to increasingly autonomous systems raises many complex and troubling questions. How will society respond as versatile robots and machine-learning systems displace an ever-expanding spectrum of blue- and white-collar workers? Will the benefits of this technological revolution be broadly distributed or accrue to a lucky few? How can we ensure that these systems respect our ethical principles when they make decisions at speeds and for rationales that exceed our ability to comprehend? What, if any, legal rights and responsibilities should we grant them? And should we regard them merely as sophisticated tools or as a newly emerging form of life? The goal of CS22 is to equip students with the intellectual tools, ethical foundation, and psychological framework to successfully navigate the coming age of intelligent machines.
CS	COMP VISION: FOUNDATION & APP	131	UG	X		Robots that can navigate space and perform duties, search engines that can index billions of images and videos, algorithms that can diagnose medical images for diseases, or smart cars that can see and drive safely: Lying in the heart of these modern AI applications are computer vision technologies that can perceive, understand and reconstruct the complex visual world. This course is designed for students who are interested in learning about the fundamental principles and important applications of computer vision. Course will introduce a number of fundamental concepts in computer vision and expose students to a number of real-world applications, plus guide students through a series of well designed projects such that they will get to implement cutting-edge computer vision algorithms. Prerequisites: Students should be familiar with Matlab (i.e. have programmed in Matlab before) and Linux; plus Calculus & Linear Algebra.

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CSRE	SPIRITUALTY/NONVIOLENT SOCIAL	162A	GR	X		A life of engagement in social transformation is often built on a foundation of spiritual and religious commitments. Case studies of nonviolent social change agents including Rosa Parks in the civil rights movement, César Chávez in the labor movement, and WIlliam Sloane Coffin in the peace movement; the religious and spiritual underpinnings of their commitments. Theory and principles of nonviolence. Films and readings. Service learning component includes placements in organizations engaged in social transformation. Service Learning Course (certified by Haas Center).
CSRE	APPROACHING RESCH AND COMMTY	146A	GR	X		Comparative perspective on research with communities and basic overview of research methodologies, with an emphasis on the principles and practices of doing community-based research as a collaborative enterprise between academic researchers and community members. How academic scholarship can be made useful to communities. How service experiences and interests can be used to develop research questions in collaboration with communities and serve as a starting point for developing senior theses or other independent research projects. Through the coursework, students are encouraged to develop a draft proposal for an actual community-based research project. The course is highly recommended for students planning to apply for community-based summer research fellowships through the Haas Center for Public Service (Community-based Research Fellowship Program) or CRSE (Community Research Summer Internship). Students who complete the course will be given priority for these fellowships.
CSRE	COMMUNITY ORGANIZING PRACTICUM	100B	GR	X		Continuation of projects and community engagement from CSRE 100. Prerequisite: completion of CSRE 100.
CSRE	ETHICS/POLITICS PUBLIC SERVICE	178	UG	X		Ethical and political questions in public service work, including volunteering, service learning, humanitarian assistance, and public service professions such as medicine and teaching. Motives and outcomes in service work. Connections between service work and justice. Is mandatory service an oxymoron? History of public service in the U.S. Issues in crosscultural service work. Integration with the Haas Center for Public Service to connect service activities and public service aspirations with academic experiences at Stanford.
CSRE	COMMUNITY ORGANIZING	100	UG	X		This course explores the theory, practice and history of grassroots community organizing as a method for developing community power to promoting social justice. We will develop skills for 1-on-1 relational meetings, media messaging, fundraising strategies, power structure analysis, and strategies organizing across racial/ethnic difference. And we will contextualize these through the theories and practices developed in the racial, gender, queer, environmental, immigrant, housing and economic justice movements to better understand how organizing has been used to engage communities in the process of social change. Through this class, students will gain the hard skills and analytical tools needed to successfully organize campaigns and movements that work to address complex systems of power, privilege, and oppression. As a Community-Engaged Learning course, students will work directly with community organizations on campaigns to address community needs, deepen their knowledge of theory and history through hands-on practice, and develop a critical analysis of inequality at the structural and interpersonal levels. Placements with community organizations are limited. Enrollment will be determined on the first day through a simple application process. Students will have the option to continue the course for a second quarter in the Winter, where they will execute a campaign either on campus or in collaboration with their community partner.
CSRE	COMMUNITY MATTERS	146	UG	X		(Taught in conjunction with URBANST 123B. Students participating in CRSI must enroll in CSRE 146. All others can enroll in either course.) This course focuses on issues of research design and how to select specific methodological strategies to assure ethical and effective partnership-based research. In this course, students will plan for their own participation in a CB(P)R project. Topical themes will include best practice strategies for (a) defining and selecting community problems or issues to be addressed, (b) generating relevant and useful research questions, (c) choosing specific means and methods for data collection [e.g., surveys, interviews, focus groups, etc.], (d) storing, organizing and analyzing data, (e) reflecting on and critiquing research findings, and (f) carrying out dissemination in ways that can be expected to enhance community power and advance community development. Students will be provided with opportunities to workshop their respective projects-in-development, (e.g., developing and sharing research questions, data collection instruments, strategies for engaging community constituents as co-researchers, etc.). Students will leave the course with a plan for participating in a CBPR project.

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CSRE	PUBLIC SERVICE INTERNSHIP	198	UG	X		Students should consult with CCSRE Director of Community Engaged Learning (ddmurray@stanford.edu) to develop or sign-up for a community service internship. Group meetings may be required. May be repeated for credit. Service Learning Course (certified by Haas Center).
CSRE	INDIAN COUNTRY ECON DEVELOPMNT	109B	GR	X		The history of competing tribal and Western economic models, and the legal, political, social, and cultural implications for tribal economic development. Case studies include mineral resource extraction, gaming, and cultural tourism. 21st-century strategies for sustainable economic development and protection of political and cultural sovereignty.
EARTH	LIVING ON THE EDGE	15	UG		X	A weekend field trip along the Pacific Coast. Tour local beaches, geology, and landforms with expert guides from the Department of Geological and Environmental Sciences. Enjoy a BBQ dinner and stay overnight in cabins along the Santa Cruz coast. Get to know faculty and graduate students in the Earth Sciences. Requirements: Two c
EARTH	OUR NATIONAL PARKS	14	UG		X	Explore the history and natural science of three national parks proximal to Stanford. Under the guidance of instructors, students will work in teams to learn about chosen aspects of these parks, develop dynamic self-guided tours for public consumption, and implement (and publish) these tours using the XibitEd app for iPhones. Students will learn how to present their findings to a general, non-scientific audience, delineate physical locations at which storytelling will take place through the XibitEd system, and create and configure the content for the system. The course will culminate in the publishing of the experiential learning tours, as well as a weekend-long field trip to the Pinnacles National Park
EARTH	OUR NATIONAL PARKS	114A	GR		X	Explore the history and natural science of three national parks proximal to Stanford. Under the guidance of instructors, students will work in teams to learn about chosen aspects of these parks, develop dynamic self-guided tours for public consumption, and implement (and publish) these tours using the XibitEd app for iPhones. Students will learn how to present their findings to a general, non-scientific audience, delineate physical locations at which storytelling will take place through the XibitEd system, and create and configure the content for the system. The course will culminate in the publishing of the experiential learning tours, as well as a weekend-long field trip to the Pinnacles National Park
EARTH	COMMUNICATING SCIENCE	218	GR		X	For undergraduates and graduate students interested in teaching science in local schools. Inquiry-based science teaching methods. How to communicate scientific knowledge and improve presentations. Six weeks of supervised teaching in a local school classroom. Prerequisite: course in introductory biology, geology, chemistry, or marine sciences.
EARTH	RESEARCH PREP FOR UNDERGRADS	100	UG		X	For undergraduates planning to conduct research during the summer with faculty in the School of Earth Sciences. Readings, oral presentations, proposal development. May be repeated for credit.
EARTH	CLIMATE & SOCIETY	2	UG		X	How and why is the climate changing? How might a changing climate affect human society? And what can we do to alter the course of climate change and adapt to any climatic changes that do occur? This course provides an introduction to the natural science and social science of climate change. The focus is on what science tells us about the causes, consequences, and solutions to climate change, as well as on how scientific progress is made on these issues.
EARTH	DIRECTED RESEARCH	400	GR		X	Independent research for graduate student projects.
EARTH	GEOLOGY, ENVIRONMENT, ART	193	UG		X	Multi-day field trip that combines exploration of regional geology, ecology, and environmental history with guided drawing exercises. We¿ll visit several sites of geologic and environmental interest, discuss their formation and significance, and use drawing as tool for close observation. Students will gain an understanding of the natural processes shaping California, acquire new skills and techniques for artistic expression, and gain an appreciation for how scientific and aesthetic perspectives complement and enhance one another in the study of nature. No previous scientific or artistic experience is required.
EARTH	RES IN THE EARTH AND ENV SCI	1	UG		X	Primarily for freshmen and sophomores. An introduction to faculty and research areas in the School of Earth Sciences, including biogeochemistry, oceanography, paleobiology, geophysics, tectonics, geostatistics, soil science, hydrogeology, energy resources, earth surface processes, geochronology, volcanoes and earthquakes, and remote sensing. May be repeated for credit.
EARTH	EARTH SCIENCES SEMINAR	300	GR		X	Required for incoming graduate students except coterms. Research questions, tools, and approaches of faculty members from all departments in the School of Earth Sciences. Goals are: to inform new graduate students about the school's range of scientific interests and expertise; and introduce them to university and school resources. Panel discussions or faculty member presentations at each meeting. May be repeated for credit.

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EARTH	NEGOTIATION	251	GR		X	Students learn to prepare for and conduct negotiations in a variety of arenas including getting a job, managing workplace conflict, negotiating transactions, and managing personal relationships. Interactive class. The internationally travelled instructor who has mediated cases in over 75 countries will require students to negotiate real life case studies and discuss their results in class. Application required before first day of class; students should enroll on Axess and complete the application on Coursework before March 18.
EARTH	GEOKIDS:EARTHSCI EDUCATION	5	UG		X	Service learning through the Geokids program. Eight weeks of supervised teaching to early elementary students about Earth sciences. Hands-on teaching strategies for science standards-based instruction.
EARTH	GS FIELD TRIPS	191	UG	X		Four- to seven-day field trips to locations of geologic and environmental interest. Includes trips offered during Thanksgiving and Spring breaks. May be repeated for credit.
EARTHSYS	BUILDING A SUSTAINABLE SOCIETY	121	UG		X	"Building a Sustainable Society: New approaches for integrating human and environmental priorities" draws on economics, natural resources management, sociology and leadership science to examine theoretical frameworks and diverse case studies that illustrate challenges as well as effective strategies in building a sustainable society where human beings and the natural environment thrive. Themes include collaborative consumption, the sharing economy, worker-owned cooperatives, community-corporate partnerships, cradle to cradle design, social entrepreneurship, impact investing, "beyond GDP", and transformative leadership. Critical perspectives, lectures and student-led discussions guide analysis of innovations within public, private and civic sectors globally. Students explore their personal values and motivations and develop their potential to become transformative leaders.
EARTHSYS	SWAR ENVIRONMENTAL JOURNALISM	177C	GR		X	(Graduate students register for COMM / EARTHSYS 277C.) A practical, writing-intensive course for science and journalism students that begins with the assumption that you already know how to research and relay the essential facts of almost any environmental story. You will go beyond the basics, both as reporters and storytellers. Learn how to write stories that stand on fact but move like fiction, that have protagonists and antagonists, that create suspense, that reveal character through dialogue and action, and that pay off with resonant finales. Limited enrollment: preference to journalism students and students in the natural and environmental sciences. Prerequisite: COMM 104, EARTHSYS 200 or consent of instructor. Admission by application only, available from thayden@stanford.edu. Applications due Nov. 30, 2015.
EARTHSYS	SWAR ENVIRONMENTAL JOURNALISM	277C	GR		X	(Graduate students register for COMM / EARTHSYS 277C.) A practical, writing-intensive course for science and journalism students that begins with the assumption that you already know how to research and relay the essential facts of almost any environmental story. You will go beyond the basics, both as reporters and storytellers. Learn how to write stories that stand on fact but move like fiction, that have protagonists and antagonists, that create suspense, that reveal character through dialogue and action, and that pay off with resonant finales. Limited enrollment: preference to journalism students and students in the natural and environmental sciences. Prerequisite: COMM 104, EARTHSYS 200 or consent of instructor. Admission by application only, available from thayden@stanford.edu. Applications due Nov. 30, 2015.
EARTHSYS	PUBLIC SERVICE INTERNSHIP PREP	9	UG		X	Are you prepared for your internship this summer? This workshop series will help you make the most of your internship experience by setting learning goals in advance; negotiating and communicating clear roles and expectations; preparing for a professional role in a non-profit, government, or community setting; and reflecting with successful interns and community partners on how to prepare sufficiently ahead of time. You will read, discuss, and hear from guest speakers, as well as develop a learning plan specific to your summer or academic year internship placement. This course is primarily designed for students who have already identified an internship for summer or a later quarter. You are welcome to attend any and all workshops, but must attend the entire series and do the assignments for 1 unit of credit.
EARTHSYS	ECOLOGY FOR EVERYONE	30	UG		X	Everything is connected, but how? Ecology is the science of interactions and the changes they generate. This project-based course links individual behavior, population growth, species interactions, and ecosystem function. Introduction to measurement, observation, experimental design and hypothesis testing in field projects, mostly done in groups. The goal is to learn to think analytically about everyday ecological processes involving bacteria, fungi, plants, animals and humans. The course uses basic statistics to analyze data; there are no math prerequisites except arithmetic. Open to everyone, including those who may be headed for more advanced courses in ecology and environmental science.

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EARTHSYS	FARM GARDEN ENVIRNMNT PRACTCM	186	UG		X	Farms and gardens provide excellent settings for place-based environmental education that emphasize human ecological relationships and experiential learning. The O'Donohue Family Stanford Educational Farm is the setting to explore the principles and practices of farm and garden-based education in conjunction with the farm's new field trip program for local youth. The course includes readings and reflections on environmental education and emphasis on learning by doing, engaging students in the practice of team teaching.
EARTHSYS	FARM GARDEN ENVIRNMNT PRACTCM	286	GR		X	Farms and gardens provide excellent settings for place-based environmental education that emphasize human ecological relationships and experiential learning. The O'Donohue Family Stanford Educational Farm is the setting to explore the principles and practices of farm and garden-based education in conjunction with the farm's new field trip program for local youth. The course includes readings and reflections on environmental education and emphasis on learning by doing, engaging students in the practice of team teaching.
EARTHSYS	FD LB: FOOD SYSTEM DESIGN & IN	289A	GR		X	FEED Lab is a 3-4 unit introductory course in design thinking and food system innovation offered through the FEED Collaborative. Targeted at graduate students interested in food and the food system, this course provides a series of diverse, primarily hands-on experiences (design projects with industry-leading thinkers, field work, and collaborative leadership development) in which students both learn and apply the process of human-centered design to projects of real consequence in the food system. The intent of this course is to develop students' creative confidence, collaborative leadership ability, and skills in systems thinking to prepare them to be more effective as innovators and leaders in the food system. This course is mandatory for any student wishing to qualify for the FEED Collaborative's summer Leadership and Innovation Program, in which select students participate in full-time, paid, externship roles with collaborating thought-leaders in the industry. Admission is by application: http://feedcollaborative.org/classes/.
EARTHSYS	FEEDING NINE BILLION	185	UG		X	Feeding a growing and wealthier population is a huge task, and one with implications for many aspects of society and the environment. There are many tough choices to be made- on fertilizers, groundwater pumping, pesticide use, organics, genetic modification, etc. Unfortunately, many people form strong opinions about these issues before understanding some of the basics of how food is grown, such as how most farmers currently manage their fields, and their reasons for doing so. The goal of this class is to present an overview of global agriculture, and the tradeoffs involved with different practices. Students will develop two key knowledge bases: basic principles of crop ecology and agronomy, and familiarity with the scale of the global food system. The last few weeks of the course will be devoted to building on this knowledge base to evaluate different future directions for agriculture.
EARTHSYS	SPANISH IN SCIENCE	207	GR		X	For graduate and undergraduate students interested in the natural sciences and the Spanish language. Students will acquire the ability to communicate in Spanish using scientific language and will enhance their ability to read scientific literature written in Spanish. Emphasis on the development of science in Spanish-speaking countries or regions. Course is conducted in Spanish and intended for students pursuing degrees in the sciences, particularly disciplines such as ecology, environmental science, sustainability, resource management, anthropology, and archeology.
EARTHSYS	ENVIRON COMMUNIC CAPSTONE	294	GR		X	Group-project based course focused on applying the skills and theoretical understanding gained through the Environmental Communication Master of Arts in Earth Systems course progression to a real-world communication challenge. Students design, plan, and implement an integrated communication strategy around a defined environmental topic or research program, such as the implementation of the new student farm; a specific research group¿s laboratory or expedition work; or an topic or concept of interest across research groups, such as climate change adaptation or marine conservation. Restricted to students enrolled in the Environmental Communication Master of Arts in Earth Systems, or by permission of the instructor.
EARTHSYS	ENVIRNMNTL JUSTICE IN BAY AREA	16SI	GR		X	Hands-on, discussion-based class that seeks to expose students to the intersectionality of social justice and environmental well being. Through student-led talks and field trips around the Bay, the course pushes participants to think about connections between issues of privilege, race, health, gender equality, and class in environmental issues. Students from all experiences and fields of study are encouraged to join to gain a sense of place, engage critically with complex challenges, and learn about environmental justice in and out of the classroom.

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EARTHSYS	THE WATER COURSE	104	UG	X		How can we balance all the competing, and growing, demands for freshwater? When you turn on your tap, where does the water come from? Water is essential for life. But, around the world, governments and citizens are challenged to balance the human demands on our freshwater resources, while protecting the integrity of natural ecosystems. At the core of the challenge is our limited understanding, in many parts of the world, of the watershed-scale hydrologic cycle - the course that the water follows from rainfall, to river, to groundwater, to ocean, to atmosphere, and back again. The Water Course takes students along that course, exploring the role that natural systems and human systems play in impacting both the quantity and quality of our freshwater. We will consider the scientific and ethical questions surrounding decisions about water allocation, and discuss new scientific methods that provide support for science-based decision making in the management of freshwater resources. You will connect global-scale issues to your personal experiences with freshwater through a quarter-long project investigating both water quantity and water quality in your hometown and surrounding watershed. You will produce a numerical model, and make approximations, to describe a complex natural system. Using online resources you will explore the pathway that water takes from rainfall to your tap.
EARTHSYS	PODCASTING THE ANTHROPOCENE	135	UG		X	Identification and interview of Stanford researchers to be featured in an audio podcast. Exploration of interviewing techniques, audio storytelling, audio editing, and podcasting as a newly emerging media platform. Individual and group projects. Group workshops focused on preparation, review, and critiques of podcasts.
EARTHSYS	PODCASTING THE ANTHROPOCENE	235	GR		X	Identification and interview of Stanford researchers to be featured in an audio podcast. Exploration of interviewing techniques, audio storytelling, audio editing, and podcasting as a newly emerging media platform. Individual and group projects. Group workshops focused on preparation, review, and critiques of podcasts.
EARTHSYS	INT. WRITING: COMM CLIMATE CHA	154	UG		X	In the next two decades floods, droughts and famine caused by climate change will displace more than 250 million people around the world. In this course students will develop an increased understanding of how different stakeholders including scientists, aid organizations, locals, policy makers, activists, and media professionals communicate the climate change crisis. They will select a site experiencing the devastating effects and research the voices telling the stories of those sites and the audiences who are (or are not) listening. Students might want to investigate drought-ridden areas such as the Central Valley of California or Darfur, Sudan; Alpine glaciers melting in the Alps or in Alaska; the increasingly flooded Pacific islands; the hurricane ravaged Gulf Coast, among many others. Data from various stakeholders will be analyzed and synthesized for a magazine length article designed to bring attention to a region and/or issue that has previously been neglected. Students will write and submit their article for publication.nnFor students who have completed the first two levels of the writing requirement and want further work in developing writing abilities, especially within discipline-specific contexts and nonfiction genres. Individual conferences with instructor and peer workshops. Prerequisite: first two levels of the writing requirement or equivalent transfer credit. For more information, see https://undergrad.stanford.edu/programs/pwr/explore/notation-science-writing.
EARTHSYS	INTERNATIONAL CLIMATE NEGOTIAT	163E	GR		X	Interested in what's going on with international climate negotiations, why it has proven so difficult to reach a meaningful agreement? Wondering whether or not another UN agreement is even a meaningful part of climate policy in 2015? This course traces the history of climate negotiations from the very first awareness of the problem of climate change, through the Kyoto Protocol and Copenhagen Accord, to the current state of international negotiations in the lead-up to the 21st Conference of the Parties meeting in Paris in December 2015. The course covers fundamental concepts in climate change science and policy, international law and multilateral environmental agreements, as well as key issues of climate finance, climate justice, equity, adaptation, communication, and social movements that together comprise the subjects of debate in the negotiations. We will discuss all the key facets of what's being negotiated in Paris and prepare students to follow the outcome of the negotiation in detail. Students also participate in a three-day mock conference of the parties. By application only.

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EARTHSYS	INTERNATIONAL CLIMATE NEGOTIAT	263E	GR		X	Interested in what's going on with international climate negotiations, why it has proven so difficult to reach a meaningful agreement? Wondering whether or not another UN agreement is even a meaningful part of climate policy in 2015? This course traces the history of climate negotiations from the very first awareness of the problem of climate change, through the Kyoto Protocol and Copenhagen Accord, to the current state of international negotiations in the lead-up to the 21st Conference of the Parties meeting in Paris in December 2015. The course covers fundamental concepts in climate change science and policy, international law and multilateral environmental agreements, as well as key issues of climate finance, climate justice, equity, adaptation, communication, and social movements that together comprise the subjects of debate in the negotiations. We will discuss all the key facets of what's being negotiated in Paris and prepare students to follow the outcome of the negotiation in detail. Students also participate in a three-day mock conference of the parties. By application only.
EARTHSYS	PALEOBIOLOGY	122	UG	X		Introduction to the fossil record with emphasis on marine invertebrates. Major debates in paleontological research. The history of animal life in the oceans. Topics include the nature of the fossil record, evolutionary radiations, mass extinctions, and the relationship between biological evolution and environmental change. Fossil taxa through time. Exercises in phylogenetics, paleoecology, biostratigraphy, and statistical methods.
EARTHSYS	INTRO TO ENVIRONMENT COMMUNIC	191	UG		X	Introduction to the history, development, and current state of communication of environmental science and policy to non-specialist audiences. Includes fundamental principles, core competencies, and major challenges of effective environmental communication in the public and policy realms and an overview of the current range and scope of research and practice in environmental communication. Intended for senior undergraduates and above with a background in environmental science and policy. Prerequisite: Earth Systems core (EarthSys 111 and EarthSys 112) or equivalent.
EARTHSYS	INTRO TO ENVIRONMENT COMMUNIC	291	GR		X	Introduction to the history, development, and current state of communication of environmental science and policy to non-specialist audiences. Includes fundamental principles, core competencies, and major challenges of effective environmental communication in the public and policy realms and an overview of the current range and scope of research and practice in environmental communication. Intended for senior undergraduates and above with a background in environmental science and policy. Prerequisite: Earth Systems core (EarthSys 111 and EarthSys 112) or equivalent.
EARTHSYS	ATMOSPHERE, OCEAN, AND CLIMATE	246B	GR		X	Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the large-scale ocean circulation. This course will give an overview of the structure and dynamics of the major ocean current systems that contribute to the meridional overturning circulation, the transport of heat, salt, and biogeochemical tracers, and the regulation of climate. Topics include the tropical ocean circulation, the wind-driven gyres and western boundary currents, the thermohaline circulation, the Antarctic Circumpolar Current, water mass formation, atmosphere-ocean coupling, and climate variability. Prerequisites: EESS 146A or EESS 246A, or CEE 164 or CEE 262D, or consent of instructor.
EARTHSYS	MICROBIAL PHYSIOLOGY	255	GR		X	Introduction to the physiology of microbes including cellular structure, transcription and translation, growth and metabolism, mechanisms for stress resistance and the formation of microbial communities. These topics will be covered in relation to the evolution of early life on Earth, ancient ecosystems, and the interpretation of the rock record. Recommended: introductory biology and chemistry.
EARTHSYS	FEED THE CHANGE	187	UG		X	Introductory course in design thinking and food system analysis offered through the FEED Collaborative. Targeted at upper-class undergraduates, this course provides a series of diverse, primarily hands-on experiences (design projects, field work, and storytelling) in which students both learn and apply the process of human-centered design to projects of real consequence in the food system. Students will also develop knowledge and basic tools for working effectively in teams and for analyzing complex systems. The goal of this course is to develop the creative confidence of students and, in turn, to work collaboratively with thought leaders in the local food system to design innovative solutions to the challenges they face. Admission is by application: http://feedcollaborative.org/classes/.

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EARTHSYS	INV MAJ: MICROB WRLD SUST PLAN	44N	GR		X	Microbes are often viewed through the lens of infectious disease yet they play a much broader and underappreciated role in sustaining our Earth system. From introducing oxygen into the Earth¿s atmosphere over 2 billion years ago to consuming greenhouse gases today, microbial communities have had (and continue to have) a significant impact on our planet. In this seminar, students will learn how microbes transformed the ancient Earth environment into our modern planet, how they currently sustain our Earth¿s ecosystems, and how scientists study them both in the present and in the past. Students will be exposed to the fundamentals of microbiology, biogeochemistry, and Earth history.
EARTHSYS	THE GLOBAL WARMING PARADOX	41N	GR		X	Preference to freshman. Focus is on the complex climate challenges posed by the substantial benefits of energy consumption, including the critical tension between the enormous global demand for increased human well-being and the negative climate consequences of large-scale emissions of carbon dioxide. Topics include: Earth¿s energy balance; detection and attribution of climate change; the climate response to enhanced greenhouse forcing; impacts of climate change on natural and human systems; and proposed methods for curbing further climate change. Sources include peer-reviewed scientific papers, current research results, and portrayal of scientific findings by the mass media and social networks.
EARTHSYS	SUSTAINABLE CITIES	160	UG		X	Service-learning course that exposes students to sustainability concepts and urban planning as a tool for determining sustainable outcomes in the Bay Area. Focus will be on the relationship of land use and transportation planning to housing and employment patterns, mobility, public health, and social equity. Topics will include government initiatives to counteract urban sprawl and promote smart growth and livability, political realities of organizing and building coalitions around sustainability goals, and increasing opportunities for low-income and communities of color to achieve sustainability outcomes. Students will participate in team-based projects in collaboration with local community partners and take part in significant off-site fieldwork. Prerequisites: consent of the instructor.
EARTHSYS	ENV COMM PRACTICUM	293	GR		X	Students complete an internship or similar practical experience in a professional environmental communication setting. Potential placements include environmental publications, NGOs, government agencies, on-campus entities, and science centers and museums. Restricted to students enrolled in the Environmental Communication Master of Arts in Earth Systems.
EARTHSYS	PHYSICAL OCEANOGRAPHY	164	UG		X	The dynamic basis of oceanography. Topics: physical environment; conservation equations for salt, heat, and momentum; geostrophic flows; wind-driven flows; the Gulf Stream; equatorial dynamics and ENSO; thermohaline circulation of the deep oceans; and tides. Prerequisite: PHYSICS 41 (formerly 53).
EARTHSYS	WORLD FOOD ECON	206	GR		X	The economics of food production, consumption, and trade. The micro- and macro- determinants of food supply and demand, including the interrelationship among food, income, population, and public-sector decision making. Emphasis on the role of agriculture in poverty alleviation, economic development, and environmental outcomes. (graduate students enroll in 206)
EARTHSYS	OPEN SPACE MANGMNT PRACTICU	176	UG		X	The unique patchwork of urban-to-rural land uses, property ownership, and ecosystems in our region poses numerous challenges and opportunities for regional conservation and environmental stewardship. Students in this class will address a particular challenge through a faculty-mentored research project engaged with the Peninsula Open Space Trust, Acterra, or the Amah Mutsun Land Trust that focuses on open space management. By focusing on a project driven by the needs of these organizations and carried out through engagement with the community, and with thorough reflection, study, and discussion about the roles of scientific, economic, and policy research in local-scale environmental decision-making, students will explore the underlying challenges and complexities of what it means to actually do community-engaged research for conservation and open space preservation in the real world. As such, this course will provide students with skills and experience in research design in conservation biology and ecology, community and stakeholder engagement, land use policy and planning, and the practical aspects of land and environmental management.

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EARTHSYS	OPEN SPACE MANGMNT PRACTICU	276	GR		X	The unique patchwork of urban-to-rural land uses, property ownership, and ecosystems in our region poses numerous challenges and opportunities for regional conservation and environmental stewardship. Students in this class will address a particular challenge through a faculty-mentored research project engaged with the Peninsula Open Space Trust, Acterra, or the Amah Mutsun Land Trust that focuses on open space management. By focusing on a project driven by the needs of these organizations and carried out through engagement with the community, and with thorough reflection, study, and discussion about the roles of scientific, economic, and policy research in local-scale environmental decision-making, students will explore the underlying challenges and complexities of what it means to actually do community-engaged research for conservation and open space preservation in the real world. As such, this course will provide students with skills and experience in research design in conservation biology and ecology, community and stakeholder engagement, land use policy and planning, and the practical aspects of land and environmental management.
EARTHSYS	TERRESTRIAL ECOSYSTEMS	128	UG		X	The what, when, and how do we know it regarding life on land¿including plants, fungi, invertebrates, and vertebrates (yes, dinosaurs)¿and how all of those components interact with each other and with changing climates, continental drift, atmospheric composition, and environmental perturbations like glaciation and mass extinction.
EARTHSYS	MULTIMEDIA ENVIRONMNTAL COMMUN	292	GR		X	Theory and practice of effective, accurate and engaging use of photography and web video production in environmental communication. Emphasis on group project work and peer critiquing in each modality, including some out-of-class work time. Limited class size, preference to Earth Systems Master's students.
EARTHSYS	CONTROL OF NATURE	107	UG		X	Think controlling the earth¿s climate is science fiction? It is when you watch Snowpiercer or Dune, but scientists are already devising geoengineering schemes to slow climate change. Will we ever resurrect the woolly mammoth or even a T. Rex (think Jurassic Park)? Based on current research, that day will come in your lifetime. Who gets to decide what species to save? And more generally, what scientific and ethical principles should guide our decisions to control nature? In this course, we will examine the science behind ways that people alter and engineer the earth, critically examining the positive and negative consequences. We¿ll explore these issues first through popular movies and books and then, more substantively, in scientific research.
EARTHSYS	BIOGEO CYCL ON EARTH	232	GR		X	This course examines biogeochemical cycles and how they developed through the interaction between the atmosphere, hydrosphere, biosphere, and lithosphere. Emphasis is on the long-term carbon cycle and how it is connected to other biogeochemical cycles on Earth. The course consists of lectures, discussion of research papers, and quantitative modeling of biogeochemical cycles. Students produce a model on some aspect of the cycles discussed in this course. Grades based on class interaction, student presentations, and the modeling project.
EARTHSYS	SOIL AND WATER CHEMISTRY	256	GR		X	This course examines biogeochemical cycles and how they developed through the interaction between the atmosphere, hydrosphere, biosphere, and lithosphere. Emphasis is on the long-term carbon cycle and how it is connected to other biogeochemical cycles on Earth. The course consists of lectures, discussion of research papers, and quantitative modeling of biogeochemical cycles. Students produce a model on some aspect of the cycles discussed in this course. Grades based on class interaction, student presentations, and the modeling project.
EARTHSYS	GROUNDWORK FOR COP21	163F	GR		X	This course will prepare undergraduate and coterm students to observe the climate change negotiations (COP 21) in Paris in November/December 2015. Students will develop individual projects to be carried out before and during the negotiation session and be paired with mentors. Please note: Along with EARTHSYS 163E/ CEE 163E, this course is part of the required two-course-set in which undergraduate and co-terminal masters degree students must enroll to receive accreditation to the climate negotiations.
EARTHSYS	GROUNDWORK FOR COP21	263F	GR		X	This course will prepare undergraduate and coterm students to observe the climate change negotiations (COP 21) in Paris in November/December 2015. Students will develop individual projects to be carried out before and during the negotiation session and be paired with mentors. Please note: Along with EARTHSYS 163E/ CEE 163E, this course is part of the required two-course-set in which undergraduate and co-terminal masters degree students must enroll to receive accreditation to the climate negotiations.

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EARTHSYS	UNDERSTANDING ENERGY FIELD TRI	103F	GR		X	Understanding Energy - Field Trips takes students on trips to major energy resource sites located within a few hours of Stanford University. Students visit at least two of the many field trips offered, including to a nuclear power plant, a wind farm, a geothermal facility, a solar photovoltaic (PV) farm, a hydroelectric power plant, an oil field, and a natural gas-fired power plant, among others (field trips offered may vary by quarter). Students meet 7-8 times during the quarter to debrief previous field trips and prepare for future ones. Open to all majors and backgrounds. Understanding Energy - Field Trips is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource -- from fossil fuels to renewable energy. The other two courses are CEE 107A/207A & EARTHSYS 103 Understanding Energy, and CEE 107W/207W & EARTHSYS 103W Understanding Energy - Workshop. Priority is given to students who have taken or are concurrently enrolled in CEE 173A, CEE 107A, CEE 207A, EARTHSYS 103, or CEE 107S/207S.
EARTHSYS	WILD WRITING	149	UG		X	What is wilderness and why does it matter? In this course we will interrogate answers to this question articulated by influential and diverse American environmental thinkers of the 19th, 20th, and 21st centuries, who through their writing transformed public perceptions of wilderness and inspired such actions as the founding of the National Park System, the passage of the Wilderness Act and the Clean Air and Water Acts, the establishment of the Environmental Protection Agency, and the birth of the environmental and climate justice movements. Students will also develop their own responses to the question of what is wilderness and why it matters through a series of writing exercises that integrate personal narrative, wilderness experience, and environmental scholarship, culminating in a ~3000 word narrative nonfiction essay. This course will provide students with knowledge, tools, experience, and skills that will empower them to become more persuasive environmental storytellers and advocates.
EARTHSYS	WILD WRITING	249	GR		X	What is wilderness and why does it matter? In this course we will interrogate answers to this question articulated by influential and diverse American environmental thinkers of the 19th, 20th, and 21st centuries, who through their writing transformed public perceptions of wilderness and inspired such actions as the founding of the National Park System, the passage of the Wilderness Act and the Clean Air and Water Acts, the establishment of the Environmental Protection Agency, and the birth of the environmental and climate justice movements. Students will also develop their own responses to the question of what is wilderness and why it matters through a series of writing exercises that integrate personal narrative, wilderness experience, and environmental scholarship, culminating in a ~3000 word narrative nonfiction essay. This course will provide students with knowledge, tools, experience, and skills that will empower them to become more persuasive environmental storytellers and advocates.
EARTHSYS	INTRO TO EARTH SYSTEM HISTORY	4	UG		X	Introduction to the history of the Earth, with a focus on processes that maintain or threaten habitability. Principles of stratigraphy, correlation, the geological timescale, the history of biodiversity, and the interpretation of fossils. The use of data from sedimentary geology, geochemistry, and paleontology to test theories for critical events in Earth history such as mass extinctions. One half-day field trip.
EARTHSYS	OCEANS:INTRO MARINE ENVIRON	8	UG		X	The course will provide a basic understanding of how the ocean functions as a suite of interconnected ecosystems, both naturally and under the influence of human activities. Emphasis is on the interactions between the physical and chemical environment and the dominant organisms of each ecosystem. The types of ecosystems discussed include coral reefs, deep-sea hydrothermal vents, coastal upwelling systems, blue-water oceans, estuaries, and near-shore dead zones. Lectures, multimedia presentations, group activities, and tide-pooling day trip.
EARTHSYS	INTRO TO EARTH SYSTEMS	10	UG		X	For non-majors and prospective Earth Systems majors. Multidisciplinary approach using the principles of geology, biology, engineering, and economics to describe how the Earth operates as an interconnected, integrated system. Goal is to understand global change on all time scales. Focus is on sciences, technological principles, and sociopolitical approaches applied to solid earth, oceans, water, energy, and food and population. Case studies: environmental degradation, loss of biodiversity, and resource sustainability.
EARTHSYS	STANFORD BEHAVIOR CHANGE	18	UG		X	Stanford Green Living Council training course. Strategies for designing and implementing effective behavior change programs for environmental sustainability on campus. Includes methods from community-based social marketing, psychology, behavioral economics, education, public health, social movements, and design. Students design a behavior change intervention project targeting a specific environmental sustainability-related behavior. Lectures online and weekly sections/workshops.

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EARTHSYS	ENERGY AND THE ENVIRONMENT	101	UG		X	Energy use in modern society and the consequences of current and future energy use patterns. Case studies illustrate resource estimation, engineering analysis of energy systems, and options for managing carbon emissions. Focus is on energy definitions, use patterns, resource estimation, pollution.
EARTHSYS	RENEWABLE & GREENER ENERGY	102	UG		X	Do you want a much better understanding of renewable power technologies? Did you know that wind and solar are the fastest growing forms of electricity generation? Are you interested in hearing about the most recent, and future, designs for green power? Do you want to understand what limits power extraction from renewable resources and how current designs could be improved? This course dives deep into these and related issues for wind, solar, biomass, geothermal, tidal and wave power technologies. We welcome all student, from non-majors to MBAs and grad students. If you are potentially interested in an energy or environmental related major, this course is particularly useful.
EARTHSYS	UNDERSTANDING ENERGY	103	UG		X	Energy is one of the world's main drivers of opportunity and development for human beings. At the same time, our energy system has significant consequences for our society, political system, economy, and environment. For example, energy production and use is the #1 source of greenhouse gas emissions. This course surveys key aspects of each energy resource, including significance and potential conversion processes and technologies, drivers and barriers, policy and regulatory environment, and social, economic, and environmental impacts. Both depletable and renewable energy resources are covered, including oil, natural gas, coal, nuclear, biomass, hydroelectric, wind, solar, photovoltaics, geothermal, and ocean energy, with cross-cutting topics including electricity, storage, climate change, sustainability, green buildings, energy efficiency, transportation, and the developing world. Understanding Energy is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource - from fossil fuels to renewable energy. The other two classes are CEE107W/207W Understanding Energy - Workshop, and CEE 107F/207F Understanding Energy -- Field Trips. Note that this course was formerly called Energy Resources (CEE 173A/207A &Earthsys 103).
EARTHSYS	UNDERSTANDING ENERGY	103	UG		X	Energy is one of the world's main drivers of opportunity and development for human beings. At the same time, our energy system has significant consequences for our society, political system, economy, and environment. For example, energy production and use is the #1 source of greenhouse gas emissions. This course surveys key aspects of each energy resource, including significance and potential conversion processes and technologies, drivers and barriers, policy and regulatory environment, and social, economic, and environmental impacts. Both depletable and renewable energy resources are covered, including oil, natural gas, coal, nuclear, biomass, hydroelectric, wind, solar, photovoltaics, geothermal, and ocean energy, with cross-cutting topics including electricity, storage, climate change, sustainability, green buildings, energy efficiency, transportation, and the developing world. Understanding Energy is part of a trio of inter-related courses aimed at gaining an in-depth understanding of each energy resource - from fossil fuels to renewable energy. The other two classes are CEE107W/207W Understanding Energy - Workshop, and CEE 107F/207F Understanding Energy -- Field Trips. Note that this course was formerly called Energy Resources (CEE 173A/207A &Earthsys 103).
EARTHSYS	WORLD FOOD ECON	106	UG	X		The economics of food production, consumption, and trade. The micro- and macro- determinants of food supply and demand, including the interrelationship among food, income, population, and public-sector decision making. Emphasis on the role of agriculture in poverty alleviation, economic development, and environmental outcomes. (graduate students enroll in 206)
EARTHSYS	BIOLOGY AND GLOBAL CHANGE	111	UG	X		The biological causes and consequences of anthropogenic and natural changes in the atmosphere, oceans, and terrestrial and freshwater ecosystems. Topics: glacial cycles and marine circulation, greenhouse gases and climate change, tropical deforestation and species extinctions, and human population growth and resource use.
EARTHSYS	HUMAN SOCIETY & ENVIRO CHANGE	112	UG		X	Interdisciplinary approaches to understanding human-environment interactions with a focus on economics, policy, culture, history, and the role of the state.

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EARTHSYS	EARTHQUAKES AND VOLCANOES	113	UG		X	Is the "Big One" overdue in California? What kind of damage would that cause? What can we do to reduce the impact of such hazards in urban environments? Does "fracking" cause earthquakes and are we at risk? Is the United States vulnerable to a giant tsunami? The geologic record contains evidence of volcanic super eruptions throughout Earth's history. What causes these gigantic explosive eruptions, and can they be predicted in the future? This course will address these and related issues. For non-majors and potential Earth scientists. No prerequisites. More information at:https://stanford.box.com/s/tpwwqpl2ryxfty6stq8wo2j78fj06ikg
EARTHSYS	REMOTE SENSING OF THE OCEAN	141	UG	X		How to observe and interpret physical and biological changes in the oceans using satellite technologies. Topics: principles of satellite remote sensing, classes of satellite remote sensors, converting radiometric data into biological and physical quantities, sensor calibration and validation, interpreting large-scale oceanographic features.
EARTHSYS	REMOTE SENSING OF LAND	142	UG	X		The use of satellite remote sensing to monitor land use and land cover, with emphasis on terrestrial changes. Topics include pre-processing data, biophysical properties of vegetation observable by satellite, accuracy assessment of maps derived from remote sensing, and methodologies to detect changes such as urbanization, deforestation, vegetation health, and wildfires.
EARTHSYS	FUNDAMENTALS OF GIS	144	UG		X	Survey of geographic information including maps, satellite imagery, and census data, approaches to spatial data, and tools for integrating and examining spatially-explicit data. Emphasis is on fundamental concepts of geographic information science and associated technologies. Topics include geographic data structure, cartography, remotely sensed data, statistical analysis of geographic data, spatial analysis, map design, and geographic information system software. Computer lab assignments. All students are required to attend a weekly lab on Tuesdays or Thursdays from 6 pm to 9 pm.
EARTHSYS	BIOLOGICAL OCEANOGRAPHY	151	UG	X		Required for Earth Systems students in the oceans track. Interdisciplinary look at how oceanic environments control the form and function of marine life. Topics include distributions of planktonic production and abundance, nutrient cycling, the role of ocean biology in the climate system, expected effects of climate changes on ocean biology. Local weekend field trips. Designed to be taken concurrently with Marine Chemistry (EESS/ EARTHSYS 152/252).
EARTHSYS	MARINE CHEMISTRY	152	UG	X		Introduction to the interdisciplinary knowledge and skills required to critically evaluate problems in marine chemistry and related disciplines. Physical, chemical, and biological processes that determine the chemical composition of seawater. Air-sea gas exchange, carbonate chemistry, and chemical equilibria, nutrient and trace element cycling, particle reactivity, sediment chemistry, and diagenesis. Examination of chemical tracers of mixing and circulation and feedbacks of ocean processes on atmospheric chemistry and climate. Designed to be taken concurrently with Biological Oceanography (EESS/ EARTHSYS 151/251)
EARTHSYS	SCIENCE OF SOILS	155	UG	X		Physical, chemical, and biological processes within soil systems. Emphasis is on factors governing nutrient availability, plant growth and production, land-resource management, and pollution within soils. How to classify soils and assess nutrient cycling and contaminant fate.

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EARTHSYS	CA COAST-SCIENCE POLICY LAW	175	UG		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
EARTHSYS	TRADEOFFS IN CLIMATE DECISIONS	188	UG		X	How can we ensure that measures taken to mitigate global climate change don¿t create larger social and environmental problems? What metrics should be used to compare potential climate solutions beyond cost and technical feasibility, and how should these metrics be weighed against each other? How can modeling efforts and stakeholder engagement be best integrated into climate decision making? What information are we still missing to make fully informed decisions between technologies and policies? Exploration of these questions, alongside other issues related to potential negative externalities of emerging climate solutions. Evaluation of energy, land use, and geoengineering approaches in an integrated context, culminating in a climate stabilization group project.
EARTHSYS	RSRCH/ANALYSIS/WRITING FOR PUB	200	GR		X	Preference to graduate students and senior undergraduates in environmental, natural and social sciences, engineering, journalism. Students help produce and publish SAGE, an eco advice column, by choosing, researching, and answering questions about sustainable living submitted by Stanford alumni and the general public. (Meets Earth Systems WIM requirement).
EARTHSYS	FUNDAMENTALS OF MODELING	211	GR		X	Simulation models are a powerful tool for environmental research, if used properly. The major concepts and techniques for building and evaluating models. Topics include model calibration, model selection, uncertainty and sensitivity analysis, and Monte Carlo and bootstrap methods. Emphasis is on gaining hands-on experience using the R programming language.
EARTHSYS	REMOTE SENSING OF THE OCEAN	241	GR		X	How to observe and interpret physical and biological changes in the oceans using satellite technologies. Topics: principles of satellite remote sensing, classes of satellite remote sensors, converting radiometric data into biological and physical quantities, sensor calibration and validation, interpreting large-scale oceanographic features.
EARTHSYS	REMOTE SENSING OF LAND	242	GR		X	The use of satellite remote sensing to monitor land use and land cover, with emphasis on terrestrial changes. Topics include pre-processing data, biophysical properties of vegetation observable by satellite, accuracy assessment of maps derived from remote sensing, and methodologies to detect changes such as urbanization, deforestation, vegetation health, and wildfires.
EARTHSYS	BIOLOGICAL OCEANOGRAPHY	251	GR		X	Required for Earth Systems students in the oceans track. Interdisciplinary look at how oceanic environments control the form and function of marine life. Topics include distributions of planktonic production and abundance, nutrient cycling, the role of ocean biology in the climate system, expected effects of climate changes on ocean biology. Local weekend field trips. Designed to be taken concurrently with Marine Chemistry (EESS/ EARTHSYS 152/252).

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EARTHSYS	MARINE CHEMISTRY	252	GR		X	Introduction to the interdisciplinary knowledge and skills required to critically evaluate problems in marine chemistry and related disciplines. Physical, chemical, and biological processes that determine the chemical composition of seawater. Air-sea gas exchange, carbonate chemistry, and chemical equilibria, nutrient and trace element cycling, particle reactivity, sediment chemistry, and diagenesis. Examination of chemical tracers of mixing and circulation and feedbacks of ocean processes on atmospheric chemistry and climate. Designed to be taken concurrently with Biological Oceanography (EESS/ EARTHSYS 151/251)
EARTHSYS	CA COAST-SCIENCE POLICY LAW	275	GR		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
EARTHSYS	TRADEOFFS IN CLIMATE DECISIONS	288	GR		X	How can we ensure that measures taken to mitigate global climate change don¿t create larger social and environmental problems? What metrics should be used to compare potential climate solutions beyond cost and technical feasibility, and how should these metrics be weighed against each other? How can modeling efforts and stakeholder engagement be best integrated into climate decision making? What information are we still missing to make fully informed decisions between technologies and policies? Exploration of these questions, alongside other issues related to potential negative externalities of emerging climate solutions. Evaluation of energy, land use, and geoengineering approaches in an integrated context, culminating in a climate stabilization group project.
EARTHSYS	MASTERS SEMINAR	290	GR	X		Required of and open only to Earth Systems master's students. Reflection on the Earth Systems coterm experience and development of skills to clearly articulate interdisciplinary expertise to potential employers, graduate or professional schools, colleagues, business partners, etc. Hands-on projects to take students through a series of guided reflection activities. Individual and small group exercises. Required, self-chosen final project encapsulates each student's MS expertise in a form relevant to his or her future goals (ie. a personal statement, research poster, portfolio, etc.).
EARTHSYS	EARTH SYSTEMS BOOK REVIEW	298	GR	X		For Earth Systems master's students and advanced undergraduates only. Analysis and discussion of selected literary nonfiction books relevant to Earth systems topics. Examples of previous topics include political presentations of environmental change in the popular press, review of the collected works of Aldo Leopold, disaster literature, and global warming.

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EARTHSYS	SUSTAINABILITY & SOCIAL JUSTIC	11Q	GR		X	At its core, sustainability is a conversation about equity. Equity between people today and people tomorrow. Equity between the many diverse people today who are all trying to pursue their hopes and dreams. Equity between human beings and the myriad other living creatures we share this planet with. Movements for environmental sustainability and social justice share a concern for equity, but have largely evolved in parallel. Mounting evidence however shows that environmental and social change are almost always inextricably linked, and the climate crisis is pushing together these two areas of study like never before. That is good news, but tough questions remain. What happens when the environmental costs of personal freedom can no longer be sustained? Should the needs of the many always outweigh the needs of the few? Are we responsible for repairing the injustices of our parents' and grandparents' generations? Where are the win-win solutions? In this interdisciplinary seminar, we will explore the theory and practice of sustainability and social justice, examining case studies where they have intersected, and where they have not. Readings will draw from sustainability science, environmental justice, environmental ethics, religious studies, social psychology, and ecological economics. Through weekly readings, discussions, and journal writing, students will develop a personal sustainability manifesto and analyze a policy, technology, or social movement through the lens of social and environmental sustainability.
EARTHSYS	ECOL & NAT HIST JASPER RIDGE	105A	GR		X	Formerly 96A - Jasper Ridge Docent Training. First of two-quarter sequence training program to join the Jasper Ridge education/docent program. The scientific basis of ecological research in the context of a field station, hands-on field research, field ecology and the natural history of plants and animals, species interactions, archaeology, geology, hydrology, land management, multidisciplinary environmental education; and research projects, as well as management challenges of the preserve presented by faculty, local experts, and staff. Participants lead research-focused educational tours, assist with classes and research, and attend continuing education classes available to members of the JRBP community after the course.
EARTHSYS	ECOL & NAT HIST JASPER RIDGE	105B	GR		X	Formerly 96B - Jasper Ridge Docent Training. First of two-quarter sequence training program to join the Jasper Ridge education/docent program. The scientific basis of ecological research in the context of a field station, hands-on field research, field ecology and the natural history of plants and animals, species interactions, archaeology, geology, hydrology, land management, multidisciplinary environmental education; and research projects, as well as management challenges of the preserve presented by faculty, local experts, and staff. Participants lead research-focused educational tours, assist with classes and research, and attend continuing education classes available to members of the JRBP community after the course.
EARTHSYS	ATMOSPHERE, OCEAN, AND CLIMATE	146A	GR	X		Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the atmospheric circulation. Topics include the global energy balance, the greenhouse effect, the vertical and meridional structure of the atmosphere, dry and moist convection, the equations of motion for the atmosphere and ocean, including the effects of rotation, and the poleward transport of heat by the large-scale atmospheric circulation and storm systems.
EARTHSYS	ATMOSPHERE, OCEAN, AND CLIMATE	146B	GR	X		Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the atmospheric circulation. Topics include the global energy balance, the greenhouse effect, the vertical and meridional structure of the atmosphere, dry and moist convection, the equations of motion for the atmosphere and ocean, including the effects of rotation, and the poleward transport of heat by the large-scale atmospheric circulation and storm systems.
EARTHSYS	LOCAL SUSTAINABLE AGRICULTURE	180B	GR		X	Field-based training in ecologically sound agricultural practices at the Stanford Community Farm. Weekly lessons, field work, and group projects. Field trips to educational farms in the area. Topics include: soils, composting, irrigation techniques, IPM, basic plant anatomy and physiology, weeds, greenhouse management, and marketing.
EARTHSYS	SENIOR CAPSTONE AND REFLECTION	210A	GR	X		The Earth Systems Senior Capstone and Reflection, required of all seniors, provides students with opportunities to synthesize and reflect on their learning in the major. Students participate in guided career development and planning activities and initiate work on an independent or group capstone project related to an Earth Systems problem or question of interest. In addition, students learn and apply principles of effective oral communication through developing and giving a formal presentation on their internship. Students must also take EARTHSYS 210P, Earth Systems Capstone Project, in the quarter following the Senior Capstone and Reflection Course.

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EARTHSYS	SENIOR CAPSTONE AND REFLECTION	210B	GR		X	The Earth Systems Senior Capstone and Reflection, required of all seniors, provides students with opportunities to synthesize and reflect on their learning in the major. Students participate in guided career development and planning activities and initiate work on an independent or group capstone project related to an Earth Systems problem or question of interest. In addition, students learn and apply principles of effective oral communication through developing and giving a formal presentation on their internship. Students must also take EARTHSYS 210P, Earth Systems Capstone Project, in the quarter following the Senior Capstone and Reflection Course.
EARTHSYS	SENIOR CAPSTONE AND REFLECTION	210C	GR		X	The Earth Systems Senior Capstone and Reflection, required of all seniors, provides students with opportunities to synthesize and reflect on their learning in the major. Students participate in guided career development and planning activities and initiate work on an independent or group capstone project related to an Earth Systems problem or question of interest. In addition, students learn and apply principles of effective oral communication through developing and giving a formal presentation on their internship. Students must also take EARTHSYS 210P, Earth Systems Capstone Project, in the quarter following the Senior Capstone and Reflection Course.
EARTHSYS	EARTH SYSTEMS CAPSTONE PROJECT	210P	GR		X	Students work independently or in groups to complete their Senior Capstone Projects. They will participate in regular advising meetings with the instructor(s), and will give a final presentation on their projects at the end of the quarter in a special Earth Systems symposium.
EARTHSYS	ATMOSPHERE, OCEAN, AND CLIMATE	246A	GR		X	Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the atmospheric circulation. Topics include the global energy balance, the greenhouse effect, the vertical and meridional structure of the atmosphere, dry and moist convection, the equations of motion for the atmosphere and ocean, including the effects of rotation, and the poleward transport of heat by the large-scale atmospheric circulation and storm systems.
EASTASN	U.S., CHINA, & GLOBAL SECURITY	285	GR	X		This graduate-level seminar will be taught simultaneously on the campuses of Stanford University and Peking University and will feature a lecture series in which prominent American and Chinese scholars provide presentations that focus on key global security issues. The course content will highlight topics relevant to current U.S.- China relations and their respective roles in Asian and global security. Proposed lecture topics include: an introduction to U.S.- China relations; finance, trade, and investment; cyber security; nonproliferation; maritime security; terrorism; and energy and the environment. Hosted jointly by Stanford University and Peking University, enrollment will be limited to 20 students at each campus and, at Stanford, will be restricted to graduate students. Enrollment is competitive, so potential students must complete an application by February 5, 2016 (noon): http://ceas.stanford.edu/students/courses.php
EASTASN	TOPICS IN KOREAN RELATIONS	189K	GR	X		The Republic of Korea (i.e. Korea) has become an exemplar of economic development, and has become an important player in the global manufacturing, technology and cultural industries. Today, Korea faces new challenges as a developed economy, and risks joining many other developed countries in economic stagnation. How has Korea developed its economy and how has its development trajectory affected its social, political and economic structures today? How can Korea mobilize its considerable resources to find the new engines of economic growth that have proven so elusive over the past decade? This course examines the past and present of the Korean economy to search for a pathway into the future, a challenge that many if not most developed economies are facing today.
ECON	WORLD FOOD ECON	206	GR		X	The economics of food production, consumption, and trade. The micro- and macro- determinants of food supply and demand, including the interrelationship among food, income, population, and public-sector decision making. Emphasis on the role of agriculture in poverty alleviation, economic development, and environmental outcomes. (graduate students enroll in 206)
ECON	DEVELOPMENT ECONOMICS	118	UG	X		The microeconomic problems and policy concerns of developing countries. Topics include: land productivity; risk and insurance; microfinance; health and nutrition; education; gender; politics and corruption. Emphasis is on economic models and econometric evidence.
ECON	ENVIRONMENTAL ECONOMICS	250	GR		X	Theoretical and empirical analysis of sources of and solutions to environmental problems, with application to local pollution challenges and global environmental issues such as climate change. Topics include: analysis of market failure, choice of environmental policy instruments, integrating environmental and distortionary taxes, environmental policy making under uncertainty, valuing environmental amenities, and measuring /promoting sustainable development.

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ECON	MARKET DESIGN	136	UG	X		Use of economic theory and analysis to design allocation mechanisms and market institutions. Course focuses on three areas: the design of matching algorithms to solve assignment problems, with applications to school choice, entry-level labor markets, and kidney exchanges; the design of auctions to solve general resource allocation problems, with applications to the sale of natural resources, financial assets, and advertising; and the design of platforms and exchanges, with applications to internet markets. Emphasis on connecting economic theory to practical applications. Students must write term paper.
ECON	WORLD FOOD ECON	106	UG	X		The economics of food production, consumption, and trade. The micro- and macro- determinants of food supply and demand, including the interrelationship among food, income, population, and public-sector decision making. Emphasis on the role of agriculture in poverty alleviation, economic development, and environmental outcomes. (graduate students enroll in 206)
ECON	ECON HLTH IN DEVLPING CNTRYS	127	UG	X		Application of economic paradigms and empirical methods to health improvement in developing countries. Emphasis is on unifying analytic frameworks and evaluation of empirical evidence. How economic views differ from public health, medicine, and epidemiology; analytic paradigms for health and population change; the demand for health; the role of health in international development.
ECON	ENVIRONMENTAL ECONOMICS & POLI	155	UG		X	Economic sources of environmental problems and alternative policies for dealing with them (technology standards, emissions taxes, and marketable pollution permits). Evaluation of policies addressing regional air pollution, global climate change, water allocation in the western U.S., and the use of renewable resources. Connections between population growth, economic output, environmental quality, and human welfare.
ECON	HONORS MARKET DESIGN	182	UG	X		Rigorous introduction to the theory of matching and resource allocation, and its application to practical market design. Theory covers two-sided matching, "house allocation" problems, random assignment, and their variants. Applied topics include school choice, labor market, house allocation, and organ allocation for transplantation. Final paper required.nForms a sequence with ECON 180 and ECON 181, but can be taken independently.nPrerequisites: Experience with abstract mathematics and willingness tonwork hard. No prior knowledge of economics is required, although basic knowledge in game theory is useful.
ECON	DEVELOPMENT ECONOMICS III	216	GR	X		Use of quantitative theory to understand various aspects of the growth and development process. Emphasis on family and demographic issues and their importance for development. Theoretical models of fertility and marriage decisions, and their empirical relevance. Unified growth theories: demographic transition and industrial revolution. Family institutions such as marriage payments and polygamy. The political economy of family-related institutions, e.g. the evolution of women's and children's rights. Female labor supply and development. Theories of disease and development.
ECON	NATURAL RESOURCE AND ENERGY	251	GR		X	Economic theory and empirical analysis of non-renewable and renewable natural resources, with considerable attention to energy provision and use. Topics include: exhaustible resources; renewable resources; and energy industry market structure, pricing, and performance.
ECON	INDUSTRIAL ORGANIZATION III	260	GR	X		Current research and policy questions in industrial organization. Course combines lectures by the instructors with student presentations, with an emphasis on initiating dissertation research in industrial organization.
ECON	DEVELOPMENT WORKSHOP	315	GR	X		no course description
ECON	PUBLIC ECON & ENVIRONMNTL ECO	341	GR		X	Issues in measuring and evaluating the economic performance of government tax, expenditure, debt, and regulatory policies; their effects on levels and distribution of income, wealth, and environmental quality; alternative policies and methods of evaluation. Workshop format combines student research, faculty presentations, and guest speakers.
ECON	ENERGY, ENVIRONMENT & ECONOMY	17N	GR		X	Examines the intimate relationship between environmental quality and the production and consumption of energy. Assesses the economics efficiency and political economy implications of a number of current topics in energy and environmental economics. Topics include: the economic theory of exhaustible resources, Greenhouse Gas Emissions (GHG) control (cap and trade mechanisms and carbon fees), GHG emissions offsets, the Strategic Petroleum Reserve (SPR), the "smart" transmission grid for electricity, nuclear energy and nuclear waste, the real cost of renewable energy, natural gas and coal-fired electricity production, the global coal and natural gas markets, Corporate Average Fuel Efficiency (CAFE) and Low-Carbon Fuel Standards (LCFS), Energy Efficiency Investments and Demand Response, and Carbon Capture and Sequestration (CCS). For all topics, there will be reading to explain the economics and engineering behind the topic and class discussion to clarify and elaborate on this interaction.

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EDUC	SOCIAL IMPACT	377E	GR		X	(Also GSBGEN 322). This course focuses on strategy and actionable measurement in government, non-profit organizations, market-based social enterprises, philanthropy, and impact investing. ¿Actionable¿ means that measurement is used by managers, investors, and other stakeholders in improving outcomes. The course explores the intersection of several ideas that seem to be in some tension with each other. (1) ¿In preparing for battle I have always found that plans are useless, but planning is indispensable.¿ (Dwight D. Eisenhower), (2) You can¿t manage what you can¿t measure, (3) Measurement is expensive and its results are often ignored, (4) ¿Not everything that counts can be counted and not everything that can be counted counts¿ (apocryphally attributed to Einstein), (5) ¿The more any quantitative social indicator is used for decision making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor.¿ (Campbell¿s Law). Specifically, the course will include: strategic planning, logic models, theories of change, monitoring, and evaluation; measuring the social impact of governments, non-governmental organizations, and market-based social enterprises, and asking how philanthropists and impact investors can assess their own impact; impact investing, performance contracting, and social impact bonds; and techniques for improving the behavior and accountability of individuals and organizations. These issues will be addressed mainly through business school case studies, which place the students in the position of CEOs, managers, and investors called upon to make major decisions. WARNING: The course has a fair amount of reading - not more than is common in undergraduate and graduate courses, but more than is typical for MBA courses in the GSB.
EDUC	PUBLIC SERVICE INTERNSHIP PREP	9	UG	X		Are you prepared for your internship this summer? This workshop series will help you make the most of your internship experience by setting learning goals in advance; negotiating and communicating clear roles and expectations; preparing for a professional role in a non-profit, government, or community setting; and reflecting with successful interns and community partners on how to prepare sufficiently ahead of time. You will read, discuss, and hear from guest speakers, as well as develop a learning plan specific to your summer or academic year internship placement. This course is primarily designed for students who have already identified an internship for summer or a later quarter. You are welcome to attend any and all workshops, but must attend the entire series and do the assignments for 1 unit of credit.
EDUC	SERVICE LEARNING PRACTICUM	98	UG	X		For Alternative Spring Break program leaders. The skills and philosophical framework to develop and lead an ASB experience.
EDUC	ENVIRONMENTAL EDUCATION	332	GR		X	Foundational understanding of the history, theoretical underpinnings, and practice of environmental education as a tool for addressing today's pressing environmental issues. The purpose, design, and implementation of environmental education in formal and nonformal settings with youth and adult audiences. Field trip and community-based project offer opportunities for experiencing and engaging with environmental education initiatives.
EDUC	PREPARATION FOR PUBLIC SERV	170	UG	X		Open only to recipients of the Haas Summer Fellowship, which offers students the opportunity to initiate and carry out an innovative service project in collaboration with a community partner. Goal is to expand upon the work fellows did during the application process with respect to the feasibility and sustainability of their field projects.
EDUC	BHV DSGN: CNNCT PPL TO NATURE	302	GR	X		Students learn Behavior Design and practice applying the methods to change human behavior in measurable ways. In this particular course, all projects will focus on one theme: Connecting people to nature.
EDUC	SCIENCE IN INFORMAL CONTEXTS	357	GR	X		There are ever-expanding opportunities to learn science in contexts outside the formal classroom, in settings such as zoos, museums, and science centers. How are issues around science and the environment presented in these contexts, how do people behave and learn in these contexts, and what messages do they take away? This course will cover the learning theories and empirical research that has been conducted in these settings. Case studies of nearby science centers will add an experiential dimension.
EDUC	INTRO TO PUBLIC SERVICE LEADER	126A	GR	X		Offered through the Haas Center for Public Service. A foundation and vision for a future of public service leadership. Students identify personal values and assess strengths as leaders. The ethics of public service and leadership theory.
EDUC	INTEGRATING THE GARDEN INTO TH	267G	GR		X	This mini-course uses the garden and kitchen environments to provide teacher candidates with real-world contexts in which to explore some of the key issues that children face in health, nutrition, and sustainability. Teacher candidates will gain an understanding of how to integrate the various themes with content areas and standards and an appreciation for the importance of addressing children's health needs in an era when the country is facing increased obesity and other health problems.

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EDUC	STRAT. MGMT. OF NONPROFITS	377B	GR	X		(Same as STRAMGT 368). This course seeks to provide a survey of the strategic, governance, and management issues facing a wide range of nonprofit organizations and their executive and board leaders, in the era of venture philanthropy and social entrepreneurship. The students will also be introduced to core managerial issues uniquely defined by this sector such as development/fundraising, investment management, performance management and nonprofit finance. The course also provides an overview of the sector, including its history and economics. Cases involve a range of nonprofits, from smaller, social entrepreneurial to larger, more traditional organizations, including education, social service, environment, health care, religion, NGO's and performing arts. In exploring these issues, this course reinforces the frameworks and concepts of strategic management introduced in the core first year courses. In addition to case discussions, the course employs role plays, study group exercises and many outsider speakers.
EDUC	METHODOLOGY: STATA	401B	GR	X		The goal of this course is to familiarize students with the Stata statistical software package for use in quantitative research. By the end of the course, students should be able to import and export data, clean and manage data, conduct standard statistical tests (e.g., correlation, t-test, regression), and produce a graph.
EE	POWER ELECTRONICS	153	UG		X	Addressing the energy challenges of today and the environmental challenges of the future will require efficient energy conversion techniques. This course will discuss the circuits used to efficiently convert ac power to dc power, dc power from one voltage level to another, and dc power to ac power. The components used in these circuits (e.g., diodes, transistors, capacitors, inductors) will also be covered in detail to highlight their behavior in a practical implementation. A lab will be held with the class where students will obtain hands on experience with power electronic circuits. Formerly EE 292J. Prerequisite: EE 101B.
EE	POWER ELECTRONICS	253	GR		X	Addressing the energy challenges of today and the environmental challenges of the future will require efficient energy conversion techniques. This course will discuss the circuits used to efficiently convert ac power to dc power, dc power from one voltage level to another, and dc power to ac power. The components used in these circuits (e.g., diodes, transistors, capacitors, inductors) will also be covered in detail to highlight their behavior in a practical implementation. A lab will be held with the class where students will obtain hands on experience with power electronic circuits. Formerly EE 292J. Prerequisite: EE 101B.
EE	ADVANCED CIRCUIT TECHNIQUES	308	GR	X		Design of advanced analog circuits at the system level, including switching power converters, amplitude-stabilized and frequency-stabilized oscillators, voltage references and regulators, power amplifiers and buffers, sample-and-hold circuits, and application-specific op-amp compensation. Approaches for finding creative design solutions to problems with difficult specifications and hard requirements. Emphasis on feedback circuit techniques, design-oriented thinking, and hands-on experience with modern analog building blocks. Several designs will be built and evaluated, along with associated laboratory projects. Prerequisite: EE 251 or EE 314A.
EE	ANALOG COMMUN DESIGN LAB	133	UG	X		Design, testing, and applications. Amplitude modulation (AM) using multiplier circuits. Frequency modulation (FM) based on discrete oscillator and integrated modulator circuits such as voltage-controlled oscillators (VCOs). Phased-lock loop (PLL) techniques, characterization of key parameters, and their applications. Practical aspects of circuit implementations. Labs involve building and characterization of AM and FM modulation/demodulation circuits and subsystems. Enrollment limited to 30 undergraduates and coterminal EE students. Prerequisite: EE101B. Undergraduate students enroll in EE133 and Graduate students enroll in EE233. Recommended: EE114/214A.
EE	SUSTAINABLE ENERGY SOLUTIONS	151	UG		X	Energy demand is expected to grow by 30% by 2025, while at the same time the European Union is demanding a carbon footprint at 1990 levels. We examine energy flow in the US and Europe, and deduce from it a strategy for sustainable growth. Potential solutions include distributed small scale networked energy generation, solar energy, wind and water, as well as nuclear energy. A systems perspective allows optimization. Fundamental concepts will be demonstrated in class through hands-on experiments.
EE	FUNDAMENTALS OF ENERGY PROCESS	293B	GR		X	For seniors and graduate students. Covers scientific and engineering fundamentals of renewable energy processes involving heat. Thermodynamics, heat engines, solar thermal, geothermal, biomass. Recommended: MATH 19-21, or Math 41,42; PHYSICS 41, 43, 45

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EE	NANOMANUFACTURING	292L	GR	X		Fundamentals of nanomanufacturing technology and applications. Topics include recent developments in process technology, lithography and patterning. Technology for FinFET transistors, NAND flash and 3D chips. Manufacturing of LEDs, thin film and crystalline solar cells. Flip classroom model is used supplementing classroom lectures with short videos. Guest speakers include distinguished engineers, entrepreneurs and venture capitalists actively engaged in nanomanufacturing. Prerequisite: background in device physics and process technology.
EE	ADVANCED TOPICS IN POWER ELECT	254	GR	X		In this course, we will study the practical issues related to the practical design of power electronic converters. We will also explore the trade-offs involved in selecting among the different circuits used to convert ac to dc, dc to ac and back to dc over a wide range of power levels suitable for different applications. In Advanced Topics in Power Electronic, as a multidisciplinary field, we will discuss power electronics circuits, extraction of transfer functions in Continuous and discontinuous conduction mode, voltage and current control of power converters, design of input/output filters to meet Electro Magnetic Interference specifications, layout of power electronics circuits and put this knowledge in a very practical context. Prerequisites: EE 153/253.
EE	DIGITAL MOS INTEGRATED CIRCUIT	213	GR	X		Looks a little more deeply at how digital circuits operate, what makes a gate digital, and how to "cheat" to improve performance or power. To aid this analysis we create a number of different models for MOS transistors and choose the simplest one that can explain our the circuit's operation, using both hand and computer analysis. We explore static, dynamic, pulse-mode, and current mode logic, and show how they are are used in SRAM design. Topics include sizing for min delay, noise and noise margins, power dissipation. The class uses memory design (SRAM) as a motivating example. DRAM and EEPROM design issues are also covered. Formerly EE 313. Prerequisites: EE 101B, EE 108. Recommended: EE 271.
EE	GREEN ELECTRONICS	155	UG		X	Many green technologies including hybrid cars, photovoltaic energy systems, efficient power supplies, and energy-conserving control systems have at their heart intelligent, high-power electronics. This course examines this technology and uses green-tech examples to teach the engineering principles of modeling, optimization, analysis, simulation, and design. Topics include power converter topologies, periodic steady-state analysis, control, motors and drives, photovol-taic systems, and design of magnetic components. The course involves a hands-on laboratory and a substantial final project. Formerly EE 152. Required: EE101B, EE102A, EE108. Recommended: ENGR40 or EE122A.
EE	GREEN ELECTRONICS	255	GR		X	Many green technologies including hybrid cars, photovoltaic energy systems, efficient power supplies, and energy-conserving control systems have at their heart intelligent, high-power electronics. This course examines this technology and uses green-tech examples to teach the engineering principles of modeling, optimization, analysis, simulation, and design. Topics include power converter topologies, periodic steady-state analysis, control, motors and drives, photovol-taic systems, and design of magnetic components. The course involves a hands-on laboratory and a substantial final project. Formerly EE 152. Required: EE101B, EE102A, EE108. Recommended: ENGR40 or EE122A.
EE	RESONANT CONVERTERS	356A	GR		X	Miniaturization of efficient power converters remain a challenge in power electronics whose goal is to improving energy use and reducing waste.nIn this course, we will study the design of Resonant converters which are capable of operating at higher frequencies than their 'hard-switch' counterparts. Resonant converter are found in high performance applications where high control bandwidth and high power density are required. We will also explore practical design issues and trade off in selecting converter topologies in high performance applications. Prerequisites: EE153/ EE253.

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EE	NANOBIOTECHNOLOGY, NANOSCIENCE	292G	GR	X		Nanobiotechnology, which may be called a "Fundamental Technology of the 21st Century", is a new frontier for Biology with extremely important applications in medical diagnostics, therapeutics and drug discovery based on the development of new materials and sensors. The goal of this course is to provide an insight into the fundamentals of nanotechnology in biological and biomedical research by providing an overview of current topics in Nanoscience and Engineering and their modern day applications in biotechnology. This course will provide a bridge for students from a non-biology background at all levels to the world of Nanobiotechnology. Basic biological molecules and the importance of their detection as well as a thorough understanding of the interfaces between electronics, fluidics, and molecular biology are discussed. Focus is also provided on solid-state materials, Nanostructures and Nano devices and systems as related to biological applications especially detection and sensing, covering top-down MEMS fabrication and integration of sensors with microfluidics to bottom-up biochemistry, applications of Nanostructures and Nanobiotechnology in drug discovery, delivery, and controlled release andnNanobiotechnological applications in environment and food detection and mitigation.
EE	SOLAR & FUEL CELLS & BATTERIES	293A	GR		X	Operating principles and applications of emerging technological solutions to the energy demands of the world. The scale of global energy usage and requirements for possible solutions. Basic physics and chemistry of solar cells, fuel cells, and batteries. Performance issues, including economics, from the ideal device to the installed system. The promise of materials research for providing next generation solutions. Undergraduates register in 156 for 4 units; graduates register in 256 for 3 units.
EE	ELECTRONIC STRUCTURE SURFACE	329	GR	X		Physical concepts and phenomena for surface science techniques probing the electronic and chemical structure of surfaces, interfaces and nanomaterials. Microscopic and atomic models of microstructures; applications including semiconductor device technology, catalysis and energy. Physical processes of UV and X-ray photoemission spectroscopy, Auger electron spectroscopy, surface EXAFS, low energy electron diffraction, electron/photon stimulated ion desorption, scanning tunneling spectroscopy, ion scattering, energy loss spectroscopy and related imaging methods; and experimental aspects of these surface science techniques. Prerequisites: PHYSICS 70 and MATSCI 199/209, or consent of instructor.
EE	MAN VERSUS NATURE	60N	GR	X		Preference to freshman. Natural hazards, earthquakes, volcanoes, floods, hurricanes, and fires, and how they affect people and society; great disasters such as asteroid impacts that periodically obliterate many species of life. Scientific issues, political and social consequences, costs of disaster mitigation, and how scientific knowledge affects policy. How spaceborne imaging technology makes it possible to respond quickly and mitigate consequences; how it is applied to natural disasters; and remote sensing data manipulation and analysis. GER:DB-EngrAppSci
EE	ENERGY IN ELECTRONICS	323	GR	X		This course examines energy in modern nanoelectronics, from fundamentals to system-level issues. Topics include fundamental aspects like energy transfer through electrons and phonons, ballistic limits of current and heat, meso- to macroscale mobility and thermal conductivity. The course also nexamines applied topics including power dissipation in nanoscale devices (FinFETs, phase-change memory, nanowires, graphene, nanotubes), circuit leakage, thermal breakdown, thermometry, heat sinks, and thermal challenges in densely integrated systems. Recommended: EE 216 or equivalent.
EE	MODERN PHYSICS FOR ENGINEERS	65	UG	X		This course introduces the core ideas of modern physics that enable applications ranging from solar energy and efficient lighting to the modern electronic and optical devices and nanotechnologies that sense, process, store, communicate and display all our information. Though the ideas have broad impact, the course is widely accessible to engineering and science students with only basic linear algebra and calculus through simple ordinary differential equations as mathematics background. Topics include the quantum mechanics of electrons and photons (Schrödinger's equation, atoms, electrons, energy levels and energy bands; absorption and emission of photons; quantum confinement in nanostructures), the statistical mechanics of particles (entropy, the Boltzmann factor, thermal distributions), the thermodynamics of light (thermal radiation, limits to light concentration, spontaneous and stimulated emission), and the physics of information (Maxwell¿s demon, reversibility, entropy and noise in physics and information theory). Pre-requisite: Physics 41. Pre- or co-requisite: Math 53 or CME 102.

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EE	PRIN/MODELS SEMICOND DEVICES	216	GR	X		Carrier generation, transport, recombination, and storage in semiconductors. Physical principles of operation of the p-n junction, heterojunction, metal semiconductor contact, bipolar junction transistor, MOS capacitor, MOS and junction field-effect transistors, and related optoelectronic devices such as CCDs, solar cells, LEDs, and detectors. First-order device models that reflect physical principles and are useful for integrated-circuit analysis and design.
EE	SEMI-CONDUCTOR OPTOELECTRONIC	243	GR	X		Semiconductor physics and optical processes in semiconductors. Operating principles and practical device features of semiconductor optoelectronic materials and heterostructures. Devices include: optical detectors (p-i-n, avalanche, and MSM); light emitting diodes; electroabsorptive modulators (Franz-Keldysh and QCSE), electrorefractive (directional couplers, Mach-Zehnder), switches (SEEDs); and lasers (waveguide and vertical cavity surface emitting).
EE	ENGRING, ENTR, & CLIMATE CHANG	292H	GR		X	The purpose of this seminar series course is to help students and professionals develop the tools to apply the engineering and entrepreneurial mindset to problems that stem from climate change, in order to consider and evaluate possible stabilizing, remedial and adaptive approaches. This course is not a crash course on climate change or policy. Instead we will focus on learning about and discussing the climate problems that seem most tractable to these approaches. Each week Dr. Field and/or a guest speaker will lead a short warm-up discussion/activity and then deliver a talk in his/her area of expertise. We¿ll wrap up with small-group and full-class discussions of related challenges/opportunities and possible engineering-oriented solutions.nClass members are asked to do background reading before each class, to submit a question before each lecture, and to do in-class brainstorming. May be repeated for credit.
EE	SMARTGRIDS AND ADVANCED POWER	292T	GR		X	A series of seminar and lectures focused on power engineering. Renowned researchers from universities and national labs will deliver bi-weekly seminars on the state of the art of power system engineering. Seminar topics may include: power system analysis and simulation, control and stability, new market mechanisms, computation challenges and solutions, detection and estimation, and the role of communications in the grid. The instructors will cover relevant background materials in the in-between weeks. The seminars are planned to continue throughout the next academic year, so the course may be repeated for credit.
EE	TOPICS INTNTL TECH MANAGEMENT	402A	GR		X	Theme for Autumn 2015 is ¿International Partnerships for Advanced Intelligent Systems.¿ This series features distinguished speakers from industry and government who are involved with international R&D projects in areas such as IOT (Internet of Things), autonomous vehicles and other robotics, smart medical devices and services, and next generation energy and transportation systems. The focus is on projects involving at least one Asia-based partner. Please see syllabus for specific requirements, which may differ from those of other seminars at Stanford.
EMED	BIOSECURITY/BIOTERRISM RESPONS	122	UG	X		Overview of the most pressing biosecurity issues facing the world today. Guest lecturers have included former Secretary of State Condoleezza Rice, former Special Assistant on BioSecurity to Presidents Clinton and Bush Jr. Dr. Ken Bernard, Chief Medical Officer of the Homeland Security Department Dr. Alex Garza, eminent scientists, innovators and physicians in the field, and leaders of relevant technology companies. How well the US and global healthcare systems are prepared to withstand a pandemic or a bioterrorism attack, how the medical/healthcare field, government, and the technology sectors are involved in biosecurity and pandemic or bioterrorism response and how they interface, the rise of synthetic biology with its promises and threats, global bio-surveillance, making the medical diagnosis, isolation, containment, hospital surge capacity, stockpiling and distribution of countermeasures, food and agriculture biosecurity, new promising technologies for detection of bio-threats and countermeasures. Open to medical, graduate, and undergraduate students. No prior background in biology necessary. 4 units for twice weekly attendance (Mon. and Wed.); additional 1 unit for writing a research paper for 5 units total maximum. PLEASE NOTE: This class will meet for the first time on Wednesday, March 30.

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EMED	BIOSECURITY/BIOTERRISM RESPONS	222	GR	X		Overview of the most pressing biosecurity issues facing the world today. Guest lecturers have included former Secretary of State Condoleezza Rice, former Special Assistant on BioSecurity to Presidents Clinton and Bush Jr. Dr. Ken Bernard, Chief Medical Officer of the Homeland Security Department Dr. Alex Garza, eminent scientists, innovators and physicians in the field, and leaders of relevant technology companies. How well the US and global healthcare systems are prepared to withstand a pandemic or a bioterrorism attack, how the medical/healthcare field, government, and the technology sectors are involved in biosecurity and pandemic or bioterrorism response and how they interface, the rise of synthetic biology with its promises and threats, global bio-surveillance, making the medical diagnosis, isolation, containment, hospital surge capacity, stockpiling and distribution of countermeasures, food and agriculture biosecurity, new promising technologies for detection of bio-threats and countermeasures. Open to medical, graduate, and undergraduate students. No prior background in biology necessary. 4 units for twice weekly attendance (Mon. and Wed.); additional 1 unit for writing a research paper for 5 units total maximum. PLEASE NOTE: This class will meet for the first time on Wednesday, March 30.
ENERGY	ENERGIZING CALIFORNIA	101A	GR		X	A weekend field trip featuring renewable and nonrenewable energy installations in Northern California. Tour geothermal, bioenergy, and natural gas field sites with expert guides from the Department of Energy Resources Engineering.
ENERGY	OIL AND GAS VALUE	267	GR	X		Appraisal of development and remedial work on oil and gas wells; appraisal of producing properties; estimation of productive capacity, reserves; operating costs, depletion, and depreciation; value of future profits, taxation, fair market value; original or guided research problems on economic topics with report. Prerequisite: consent of instructor.
ENERGY	CHEMICAL KINETICS	282	GR	X		Chemical kinetics are an integral part of optimizing recovery of fossil fuels. After reviewing the genesis of various kinds of fossil fuels and the history of their use, the course describes the molecular structure of the various types and how that influences their pyrolysis kinetics. Methods for deriving reliable kinetics are covered, including how to determine which phenomenological models are appropriate. Applications discussed are petroleum formation, oil shale retorting, heavy oil upgrading, and coal liquefaction.
ENERGY	QUANTITATIVE METHODS IN BPSM	275	GR	X		Examine the physical processes operating in sedimentary basins by deriving the basic equations of fundamental, coupled geologic processes such as fluid flow and heat flow, deposition, compaction, mass conservation, and chemical reactions. Through hands-on computational exercises and instructor-provided "recipes," students will deconstruct the black box of basin modeling software. Students write their own codes (Matlab) as well as gain expertise in modern finite-element modeling software (PetroMod, COMSOL).
ENERGY	GEOSTATISTICS	240	GR	X		Geostatistical theory and practical methodologies for quantifying and simulating spatial and spatio-temporal patterns for the Earth Sciences. Real case development of models of spatial continuity, including variograms, Boolean models and training images. Estimation versus simulation of spatial patterns. Loss functions. Estimation by kriging, co-kriging with secondary data. Dealing with data on various scales. Unconditional and conditional Boolean simulation, sequential simulation for continuous and categorical variables. Multi-variate geostatistical simulation. Probabilistic and pattern-based approaches to multiple-point simulation. Trend, secondary variable, auxiliary variable and probability-type constraints. Quality control techniques on generated models. Workflows for practical geostatistical applications in mining, petroleum, hydrogeology, remote sensing and environmental sciences.
ENERGY	THE ENERGY SEMINAR	301	GR	X		Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
ENERGY	THE ENERGY SEMINAR	301	GR	X		Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
ENERGY	THE ENERGY SEMINAR	301	GR	X		Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
ENERGY	OPTIMIZATION OF ENERGY SYSTEMS	291	GR	X		Introductory mathematical programming and optimization using examples from energy industries. Emphasis on problem formulation and solving, secondary coverage of algorithms. Problem topics include optimization of energy investment, production, and transportation; uncertain and intermittent energy resources; energy storage; efficient energy production and conversion. Methods include linear and nonlinear optimization, as well as multi-objective and goal programming. Tools include Microsoft Excel and AMPL mathematical programming language. Prerequisites: MATH 20, 41, or MATH 51, or consent of instructor. Programming experience helpful (e.g,, CS 106A, CS 106B).

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ENERGY	GAS INJECTION	225	GR	X		Lectures, problems. Theory of multicomponent, multiphase flow in porous media. Miscible displacement: diffusion and dispersion, convection-dispersion equations and its solutions. Method of characteristic calculations of chromatographic transport of multicomponent mixtures. Development of miscibility and interaction of phase behavior with heterogeneity. May be repeated for credit. Prerequisite: CME 200.
ENERGY	MULTIPHASE FLOW	221	GR	X		Multiphase flow in porous media. Wettability, capillary pressure, imbibition and drainage, Leverett J-function, transition zone, vertical equilibrium. Relative permeabilities, Darcy's law for multiphase flow, fractional flow equation, effects of gravity, Buckley-Leverett theory, recovery predictions, volumetric linear scaling, JBN and Jones-Rozelle determination of relative permeability. Frontal advance equation, Buckley-Leverett equation as frontal advance solution, tracers in multiphase flow, adsorption, three-phase relative permeabilities.
ENERGY	DEEPWATER HORIZON BLOWOUT	123	UG		X	The Deepwater Horizon blowout and spill in April 2010 occurred on one of the most advanced deepwater drilling rigs in the world operated by one of the most experienced companies. In this course we will look at and discuss the technologies and management practices involved in deepwater drilling and discuss how an accident like this happens and what could have been done differently to avoid it. We will focus on the Horizon and also look briefly at other high profile industrial and technological accidents.
ENERGY	ENGINEERING ECONOMICS	110	UG		X	The success of energy projects and companies is judged by technical, economic and financial criteria. This course will introduce concepts of engineering economy, e.g., time value of money, life cycle costs and financial metrics, and explore their application to the business of energy. We will use case studies, business school cases and possibly industry guest lecturers. Examples from the hydrocarbon businesses that dominate energy today will provide the framework for the analysis of both conventional and renewable energy.
ENERGY	THERMAL RECOVERY METHODS	226	GR	X		Theory and practice of thermal recovery methods: steam drive, cyclic steam injections, and in situ combustion. Models of combined mass and energy transport. Estimates of heated reservoir volume and oil recovery performance. Wellbore heat losses, recovery production, and field examples.
ENERGY	ENERGY FROM WIND AND WATER	293C	GR		X	This course focuses on the extraction of energy from wind, waves and tides.nThe emphasis in the course is technical leading to a solid understanding ofnestablished extraction systems and discussion of promising new technologies.nWe will also cover resource planning and production optimization through observations and computer simulations.nThe course includes at least one weekend field trip, and may include experimentsnin wind tunnel and/or flume.nnPrerequisites: CEE176B or EE293B, programming experience, understanding of fluid mechanics, electrical systems, and engineering optimization.
ENERGY	LUNCH WITH NUMERICS	122	UG	X		This course provides students hands-on experience in the design and implementationnof numerical methods for challenging fluid flow problems in the earth sciences.nThe base software used it the public domain code MRST. Students will explorencommon pitfalls of well-known numerical approaches, assess effectivenessnof numerical methods for heterogeneous and strongly nonlinear problems andngain more insight into numerical accuracy and stability concepts.
ENERGY	THE GLOBAL PRICE OF OIL	214	GR		X	Understanding the current and future price of oil requires the synthesis of geologic, engineering, financial, geopolitical, and macroeconomic information. In this seminar, we will build a global supply curve for petroleum by studying the marginal and full-cycle production costs for each of the major resource categories. We will study how reserve classification varies globally, and how global petroleum resources and reserves have changed and are likely to change over time. We will further investigate how the time lag between resource discovery, project sanctioning, and full production will affect future supply. Finally, we will study the elasticity of oil demand and how that demand is likely to change over time as the developing world gets richer and as competition from other energy sources increases.
ENERGY	ENERGY AND THE ENVIRONMENT	101	UG		X	Energy use in modern society and the consequences of current and future energy use patterns. Case studies illustrate resource estimation, engineering analysis of energy systems, and options for managing carbon emissions. Focus is on energy definitions, use patterns, resource estimation, pollution.

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ENERGY	RENEWABLE & GREENER ENERGY	102	UG		X	Do you want a much better understanding of renewable power technologies? Did you know that wind and solar are the fastest growing forms of electricity generation? Are you interested in hearing about the most recent, and future, designs for green power? Do you want to understand what limits power extraction from renewable resources and how current designs could be improved? This course dives deep into these and related issues for wind, solar, biomass, geothermal, tidal and wave power technologies. We welcome all student, from non-majors to MBAs and grad students. If you are potentially interested in an energy or environmental related major, this course is particularly useful.
ENERGY	SUSTAINABLE ENERGY	104	UG		X	This course explores the transition to a sustainable energy system at large scales (national and global), and over long time periods (decades). Explores the drivers of global energy demand and the fundamentals of technologies that can meet this demand sustainably. Focuses on constraints affecting large-scale deployment of technologies, as well as inertial factors affecting this transition. Problems will involve modeling global energy demand, deployment rates for sustainable technologies, technological learning and economics of technical change.
ENERGY	FUNDAMENTALS OF PETR ENGINRG	120	UG		X	Lectures, problems, field trip. Engineering topics in petroleum recovery; origin, discovery, and development of oil and gas. Chemical, physical, and thermodynamic properties of oil and natural gas. Material balance equations and reserve estimates using volumetric calculations. Gas laws. Single phase and multiphase flow through porous media.
ENERGY	MULTIPHASE FLOW	121	UG		X	Multiphase flow in porous media. Wettability, capillary pressure, imbibition and drainage, Leverett J-function, transition zone, vertical equilibrium. Relative permeabilities, Darcy's law for multiphase flow, fractional flow equation, effects of gravity, Buckley-Leverett theory, recovery predictions, volumetric linear scaling, JBN and Jones-Rozelle determination of relative permeability. Frontal advance equation, Buckley-Leverett equation as frontal advance solution, tracers in multiphase flow, adsorption, three-phase relative permeabilities.
ENERGY	WELL LOG ANALYSIS I	130	UG		X	For earth scientists and engineers. Interdisciplinary, providing a practical understanding of the interpretation of well logs. Lectures, problem sets using real field examples: methods for evaluating the presence of hydrocarbons in rock formations penetrated by exploratory and development drilling. The fundamentals of all types of logs, including electric and non-electric logs.
ENERGY	RESERVOIR CHARACT & FLOW MODEL	146	UG	X		Project addressing a reservoir management problem by studying an outcrop analog, constructing geostatistical reservoir models, and performing flow simulation. How to use outcrop observations in quantitative geological modeling and flow simulation. Relationships between disciplines. Weekend field trip.
ENERGY	CARBON CAPTURE AND SEQ	153	UG		X	CO2 separation from syngas and flue gas for gasification and combustion processes. Transportation of CO2 in pipelines and sequestration in deep underground geological formations. Pipeline specifications, monitoring, safety engineering, and costs for long distance transport of CO2. Comparison of options for geological sequestration in oil and gas reservoirs, deep unmineable coal beds, and saline aquifers. Life cycle analysis.
ENERGY	MODELING UNCERTAINTY	160	UG	X		Whether Earth Science modeling is performed on a local, regional or global scale, for scientific or engineering purposes, uncertainty is inherently present due to lack of data and lack of understanding of the underlying phenomena. This course highlights the various issues, techniques and practical tools available for modeling uncertainty of complex Earth systems as well as the impact uncertainty has on practical decisions for geo-engineering problems. The course focuses on practical breadth rather than theoretical depth. Topics covered are: the process of building models, sources of uncertainty, probabilistic techniques, spatial data analysis and geostatistics, grid and scale, spatio-temporal uncertainty, visualizing uncertainty in large dimensions, Monte Carlo simulation, sensitivity analysis, reducing uncertainty with data, value of information. Applications to both local (reservoir, aquifer) and global (climate) are covered through literature study. Extensive software use with SGEMS.
ENERGY	OIL AND GAS VALUE	167	UG	X		Appraisal of development and remedial work on oil and gas wells; appraisal of producing properties; estimation of productive capacity, reserves; operating costs, depletion, and depreciation; value of future profits, taxation, fair market value; original or guided research problems on economic topics with report.

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ENERGY	ENERGY INFRASTRUCTURE	171	UG	X		Oil and gas represents more than 50% of global primary energy. In delivering energy at scale, the industry has developed global infrastructure with supporting technology that gives it enormous advantages in energy markets; this course explores how the oil and gas industry operates. From the perspective of these established systems and technologies, we will look at the complexity of energy systems, and will consider how installed infrastructure enables technology development and deployment, impacts energy supply, and how existing infrastructure and capital invested in fossil energy impacts renewable energy development.
ENERGY	WELL TEST ANALYSIS	175	UG		X	Lectures, problems. Application of solutions of unsteady flow in porous media to transient pressure analysis of oil, gas, water, and geothermal wells. Pressure buildup analysis and drawdown. Design of well tests. Computer-aided interpretation.
ENERGY	OPTIMIZATION OF ENERGY SYSTEMS	191	UG	X		Introductory mathematical programming and optimization using examples from energy industries. Emphasis on problem formulation and solving, secondary coverage of algorithms. Problem topics include optimization of energy investment, production, and transportation; uncertain and intermittent energy resources; energy storage; efficient energy production and conversion. Methods include linear and nonlinear optimization, as well as multi-objective and goal programming. Tools include Microsoft Excel and AMPL mathematical programming language.
ENERGY	SENIOR PROJECT	199	UG	X		Individual or group capstone project in Energy Resources Engineering. Emphasis is on report preparation. May be repeated for credit.
ENERGY	MEASUREMENT OF RESERVOIR ROCK	201	GR		X	In this course, students will learn methods for measuring reservoir rock properties. Techniques covered include core preservation and sample preparation; Rock petrography; Interfacial tension of fluids; Measurement of contact angles of fluids on reservoir media; Capillary pressure measurement and interpretation; Absolute and effective porosities; Absolute permeability; Multiphase flow including relative permeability and residual saturation. The class will be 1 3-hour lecture/lab per week, with readings and weekly assignments. A field trip to a professional core characterization lab may be included.
ENERGY	ADV RESRVR ENG	222	GR		X	Lectures, problems. General flow equations, tensor permeabilities, steady state radial flow, skin, and succession of steady states. Injectivity during fill-up of a depleted reservoir, injectivity for liquid-filled reservoirs. Flow potential and gravity forces, coning. Displacements in layered reservoirs. Transient radial flow equation, primary drainage of a cylindrical reservoir, line source solution, pseudo-steady state. May be repeated for credit.
ENERGY	RESERVOIR SIMULATION	223	GR		X	Fundamentals of petroleum reservoir simulation. Equations for multicomponent, multiphase flow between gridblocks comprising a petroleum reservoir. Relationships between black-oil and compositional models. Techniques for developing black-oil, compositional, thermal, and dual-porosity models. Practical considerations in the use of simulators for predicting reservoir performance. Class project.
ENERGY	ADVANCED RES SIMULATION	224	GR		X	Topics include modeling of complex wells, coupling of surface facilities, compositional modeling, dual porosity models, treatment of full tensor permeability and grid nonorthogonality, local grid refinement, higher order methods, streamline simulation, upscaling, algebraic multigrid solvers, unstructured grid solvers, history matching, other selected topics.
ENERGY	ADVANCED TOPICS WELL LOGGING	230	GR		X	State of the art tools and analyses; the technology, rock physical basis, and applications of each measurement. Hands-on computer-based analyses illustrate instructional material. Guest speakers on formation evaluation topics. Prerequisites: 130 or equivalent; basic well logging; and standard practice and application of electric well logs.
ENERGY	SEISMIC RESERVOR DATA INTEGRAT	241	GR		X	(Same as GP241) Practical methods for quantitative characterization and uncertainty assessment of subsurface reservoir models integrating well-log and seismic data. Multidisciplinary combination of rock-physics, seismic attributes, sedimentological information and spatial statistical modeling techniques. Student teams build reservoir models using limited well data and seismic attributes typically available in practice, comparing alternative approaches. Software provided (SGEMS, Petrel, Matlab).
ENERGY	RESERVOIR CHARACT & FLOW MODEL	246	GR		X	Project addressing a reservoir management problem by studying an outcrop analog, constructing geostatistical reservoir models, and performing flow simulation. How to use outcrop observations in quantitative geological modeling and flow simulation. Relationships between disciplines. Weekend field trip.
ENERGY	THERMODYNAMICS	251	GR		X	Lectures, problems. The volumetric behavior of fluids at high pressure. Equation of state representation of volumetric behavior. Thermodynamic functions and conditions of equilibrium, Gibbs and Helmholtz energy, chemical potential, fugacity. Phase diagrams for binary and multicomponent systems. Calculation of phase compositions from volumetric behavior for multicomponent mixtures. Experimental techniques for phase-equilibrium measurements. May be repeated for credit.

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ENERGY	CARBON CAPTURE AND SEQ	253	GR		X	CO2 separation from syngas and flue gas for gasification and combustion processes. Transportation of CO2 in pipelines and sequestration in deep underground geological formations. Pipeline specifications, monitoring, safety engineering, and costs for long distance transport of CO2. Comparison of options for geological sequestration in oil and gas reservoirs, deep unmineable coal beds, and saline aquifers. Life cycle analysis.
ENERGY	ENERGY INFRASTRUCTURE	271	GR		X	Oil and gas represents more than 50% of global primary energy. In delivering energy at scale, the industry has developed global infrastructure with supporting technology that gives it enormous advantages in energy markets; this course explores how the oil and gas industry operates. From the perspective of these established systems and technologies, we will look at the complexity of energy systems, and will consider how installed infrastructure enables technology development and deployment, impacts energy supply, and how existing infrastructure and capital invested in fossil energy impacts renewable energy development.
ENERGY	TEACHING EXPER	359	GR	X		For TAs in Energy Resources Engineering. Course and lecture design and preparation; lecturing practice in small groups. Classroom teaching practice in an Energy Resources Engineering course for which the participant is the TA (may be in a later quarter). Taught in collaboration with the Center for Teaching and Learning.
ENERGY	SOLAR & FUEL CELLS & BATTERIES	293A	GR	X		Operating principles and applications of emerging technological solutions to the energy demands of the world. The scale of global energy usage and requirements for possible solutions. Basic physics and chemistry of solar cells, fuel cells, and batteries. Performance issues, including economics, from the ideal device to the installed system. The promise of materials research for providing next generation solutions. Undergraduates register in 156 for 4 units; graduates register in 256 for 3 units.
ENERGY	FUNDAMENTALS OF ENERGY PROCESS	293B	GR	X		For seniors and graduate students. Covers scientific and engineering fundamentals of renewable energy processes involving heat. Thermodynamics, heat engines, solar thermal, geothermal, biomass.
ENGLISH	1960S COUNTERCULTURES	151G	GR	X		From the poetry of the Beats to the protest of the Black Panthers, 1960s countercultures loudly challenged social, aesthetic, and political conventions. While some dissented to mainstream American culture by burning bras, marching for peace, dropping out, and tuning in, others experienced countercultures largely through the media. This course uses the rich resources available only in Stanford¿s Special Collections to explore the ideas, sensibilities, and media representations of 1960s countercultures including civil rights, anti-war, back-to-nature environmentalism, the Beats, feminism, hippies, gay liberation, and Black Power. Meeting each week in Special Collections, students will examine unique archival sources (Allen Ginsberg¿s recordings of Howl, underground comics, letters, photographs, psychedelic rock posters, scrapbooks, LIFE magazine, and more) in order to understand how 1960s countercultural movements sought to revolutionize every aspect of American culture, from individual consciousness to foreign and military policy. This course will be of particular interest to student activists who want to better understand and build on the dissenting traditions of the past. In the spirit of the student-led classrooms of the 1960s, students will become primary investigators of their own original research questions. Course readings will lighten as students spend more time doing independent research in Special Collections.
ENGLISH	WASTELANDS	151H	GR	X		Have human beings ruined the world? Was it war, or industry, or consumerism, or something else that did it? Beginning with an in-depth exploration of some of the key works of literary modernism, this class will trace the image of the devastated landscape as it develops over the course of the 20th and 21st centuries, arriving finally at literary representations of the contemporary zombie apocalypse. Authors to include T.S Eliot, Ernest Hemingway, Nathanael West, Willa Cather, Cormac McCarthy, and others.
ENGLISH	IMAGINING THE OCEANS	168	UG	X		How has Western culture constructed the world's oceans since the beginning of global ocean exploration? How have imaginative visions of the ocean been shaped by marine science, technology, exploration, commerce and leisure? Authors read might include Cook, Equiano, and Steinbeck; Defoe, Verne, Stevenson, Conrad, Woolf and Hemingway; Coleridge, Baudelaire, Moore, Bishop and Walcott. Films by Painlevé and Bigelow. Seminar co-ordinated with a spring 2015 Cantor Arts Center public exhibition. Visits to Cantor; other possible field trips include Hopkins Marine Station and SF Maritime Historical Park.

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ENGLISH	IMAGINING THE OCEANS	368A	GR	X		How has Western culture constructed the world's oceans since the beginning of global ocean exploration? How have imaginative visions of the ocean been shaped by marine science, technology, exploration, commerce and leisure? Primary authors read might include Cook, Banks, Equiano, Ricketts, and Steinbeck; Defoe, Cooper, Verne, Conrad, Woolf and Hemingway; Coleridge, Baudelaire, Moore, Bishop and Walcott. Critical readings include Schmitt, Rediker and Linebaugh, Baucom, Best, Corbin, Auden, Sontag and Heller-Roazen. Films by Sekula, Painlevé and Bigelow. Seminar coordinated with a 2015 Cantor Arts Center public exhibition. Visits to the Cantor; other possible field trips include Hopkins Marine Station and SF Maritime Historical Park. Open to graduate students only.
ENGLISH	THE AMERICAN WEST	124	UG	X		The American West is characterized by frontier mythology, vast distances, marked aridity, and unique political and economic characteristics. This course integrates several disciplinary perspectives into a comprehensive examination of Western North America: its history, physical geography, climate, literature, art, film, institutions, politics, demography, economy, and continuing policy challenges. Students examine themes fundamental to understanding the region: time, space, water, peoples, and boom and bust cycles.
ENGR	TECHNOLOGY ENTREPRENEURSHIP	145	UG	X		How do you create a successful start-up? What is entrepreneurial leadership in a large firm? What are the differences between an idea and true opportunity? How does an entrepreneur form a team and gather the resources necessary to create a great enterprise? This class mixes mentor-guided team projects, in-depth case studies, research on the entrepreneurial process, and the opportunity to network and ask questions of Silicon Valley's top entrepreneurs and venture capitalists. For undergraduates of all majors who seek to understand the formation and growth of high-impact start-ups in areas such as information, green/clean, medical and consumer technologies.
ENGR	TECHNOLOGY ENTREPRENEURSHIP	145	UG	X		How do you create a successful start-up? What is entrepreneurial leadership in a large firm? What are the differences between an idea and true opportunity? How does an entrepreneur form a team and gather the resources necessary to create a great enterprise? This class mixes mentor-guided team projects, in-depth case studies, research on the entrepreneurial process, and the opportunity to network and ask questions of Silicon Valley's top entrepreneurs and venture capitalists. For undergraduates of all majors who seek to understand the formation and growth of high-impact start-ups in areas such as information, green/clean, medical and consumer technologies.
ENGR	INTRO TO CHEMICAL ENGINEERING	20	UG	X		Overview of chemical engineering through discussion and engineering analysis of physical and chemical processes. Topics: overall staged separations, material and energy balances, concepts of rate processes, energy and mass transport, and kinetics of chemical reactions. Applications of these concepts to areas of current technological importance: biotechnology, energy, production of chemicals, materials processing, and purification. Prerequisite: CHEM 31.
ENGR	EXPANDING ENGINEERING LIMITS	311C	GR	X		This course considers how culture shapes and impacts engineering, with a particular focus on the cultural aspects of gender that affect who becomes an engineer, what problems get solved, and the quality of solutions, design, technology, and products. We will examine engineering cultures and gender through the lens of ¿design thinking¿, which is an increasingly visible component of engineering education and practice. Design processes are determined by the designers, their disciplinary backgrounds, and the methods they use. How do the background characteristics of the designer affect products and development in innovation and research? Does gender matter? What about other characteristics of the designer? How can design thinking help to find sustainable solutions and also consider gender and diversity perspectives?
ENGR	COMMUNITY ENGAGEMENT PREP	119	UG	X		This seminar is designed for engineering students who have already committed to an experiential learning program working directly with a community partner on a project of mutual benefit. This seminar is targeted at students participating in the Summer Service Learning Program offered through Stanford¿s Global Engineering Program.
ENGR	COMMUNITY ENGAGEMENT PREP	219	GR	X		This seminar is designed for engineering students who have already committed to an experiential learning program working directly with a community partner on a project of mutual benefit. This seminar is targeted at students participating in the Summer Service Learning Program offered through Stanford¿s Global Engineering Program.
ENGR	ENVIRO SCI & TECHNOLOGY	90	UG		X	Introduction to environmental quality and the technical background necessary for understanding environmental issues, controlling environmental degradation, and preserving air and water quality. Material balance concepts for tracking substances in the environmental and engineering systems.

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ENGR	ETHICAL ISSUES IN ENGINEERING	131	UG	X		Moral rights and responsibilities of engineers in relation to society, employers, colleagues, and clients; cost-benefit-risk analysis, safety, and informed consent; the ethics of whistle blowing; ethical conflicts of engineers as expert witnesses, consultants, and managers; ethical issues in engineering design, manufacturing, and operations; ethical issues arising from engineering work in foreign countries; and ethical implications of the social and environmental contexts of contemporary engineering. Case studies, guest practitioners, and field research. Limited enrollment.
ENVRES	INTRO ENVIRONMENTAL SCIENCE	280	GR		X	For E-IPER Joint M.S. students only. This course functions as a gateway for E-IPER Joint M.S. students to learn about the variety of environmental science conducted by the program's affiliated faculty. Topics include oceans, green chemistry, water policy, energy, and others. Students engage in problem solving related to the application of science to business, law, and the conservation of natural resources.
ENVRES	ENERGY TRANSFORM COLLAB	201	GR		X	Research seminar. Evaluate the technologies, economics, policy mechanisms and drivers, and business model innovations to enable East Palo Alto to transition to a sustainable, resilient future. Exploration of the social, economic, and political drivers that have led to the current state of the city along four major technological streams: buildings, energy infrastructure, water infrastructure, and transportation. Teams create a research-based proposal to the City Manager laying out a transition pathway for their technological stream.
ENVRES	E-IPER PHD WRITING SEMINAR	340	GR	X		Restricted to second year E-IPER PhD students only. Actively pursue one or more writing goals relevant to this stage in their graduate studies in a structured setting. Set specific writing goals, create and follow a plan for reaching these goals, and receive substantive feedback on their written products from their peers. Examples of writing products include, but are not limited to, the student¿s dissertation proposal, E-IPER Fields of Inquiry essay, a literature review, or a grant or fellowship application. By the end of the course, students are expected to have completed or have made substantial progress toward their writing goal.
ENVRES	METHODS IN SYSTEMS THINKING	382	GR	X		The workshop-style class will expose you to the fundamentals of Systems Thinking, and how to combine it with methods in human-centered design. You will learn how to interrogate the dynamics of the system, understand the stakeholder networks, and understand the actions and beliefs of the people that shape the current outcomes. You will then use design tools to frame the vision of a future state, and decide where to intervene in a complex multi-stakeholder system. Simultaneously, you will use Design Thinking processes to ensure that your interventions are grounded in reality, is human-centered, and deeply transformative. Course admission is by application only. Applications are due March 15, 2016.
ENVRES	ENVIRONMENTAL GOVERNANCE	250	GR		X	This interdisciplinary course presents an overview of environmental governance through an examination of how and why societies manage the relationships between human beings and the natural world. By comparing regulatory, community-based, and incentive-based environmental management systems, we address why certain environmental problems are managed as they are, and what approaches to environmental management are more (or less) successful. Designed for graduate students and upper-level undergraduates with some exposure to both the natural sciences (ecology/environmental chemistry), and the social sciences (anthropology, economics, political science, or sociology). A pre-course incoming survey is required.
ENVRES	THE SOCIAL OCEAN	220	GR		X	This interdisciplinary seminar examines current ocean issues and ideas through a series of readings, discussions, and guest lecturer presentations of seminal works about the complex relationships of human beings to the marine world. Through the lenses offered by several classic readings, we will examine and reinterpret the challenges of fisheries collapse, climate change, shipping, marine spatial planning, biodiversity conservation, and the management of land-sea interactions. Though the seminar is open to all undergraduate and graduate students, our course is designed especially for those with a particular interest in studying and solving key issues of ocean policy and management, from coastal adaption to fisheries management to cumulative impacts assessments. In addition to this interest, students must be willing to take the time to dig deeper into the foundations of environmental thinking about the relationship of human beings and the sea.
ENVRES	CLEAN ENERGY SYSTEMS AND SERVI	203	GR		X	This project-based course focuses on innovation to accelerate the transformation of energy systems and the services they enable. Students will pilot solutions to challenges at the nexus of energy, water, food, IT and off-grid services. Teams will build on projects from past courses to develop a pilot and hypothesis that can be tested to validate their solution pathway. Scoping, analysis, testing, and evaluation of solutions will drive policy and business model innovation. Team written reports and presentations are required.

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ENVRES	TRANSFORMING CLEAN ENERGY	202	GR		X	This project-based course focuses on innovation to accelerate the transformation of energy systems. Students will address challenges at the nexus of energy and water, energy and IT, energy and food, and off-grid services. Teams will develop well-defined problem statements, a thesis and solution pathway, and conduct research toward validating the thesis value propositions. Scoping, analysis and evaluation of proposed solutions can include any combination of technology, policy and business model innovation. Team written reports and presentations are required.
ENVRES	E-IPER CURRENT TOPICS	225	GR	X		For E-IPER Ph.D and Joint M.S. students only. Weekly presentations of E-IPER students' research and other program-related projects. Occasional guest speakers. Individual or team presentation, active participation, and regular attendance required for credit. May be taken for credit a maximum of two times.
ENVRES	CAPSTONE PROJECT SEM ENV RES	290	GR	X		Required for and limited to E-IPER Joint M.S. students. Propose, conduct and publicly present final individual or team projects demonstrating the integration of professional (M.B.A., J.D., or M.D.) and M.S. in Environment and Resources degrees. Presentation and submission of final product required. 3 total units required; can all be taken during one quarter or divided over two sequential quarters.
ENVRES	INTRO TO RES ENERGY ENVIR ECON	300	GR		X	Examination of environmental, energy and natural resource management problems through the lens of economics, with an emphasis on hands-on practical problem-solving. Topics include market failure, cost-benefit analysis, finance, risk & uncertainty, non-market valuation, regulation, green accounting, rent, renewable resources, exhaustible resources, including energy, and biodiversity. Prerequisite: proficiency in multivariate calculus. Knowledge of basic microeconomics helpful but not essential. Open only to E-IPER PhD students.
ENVRES	ENV RSCH DESIGN SEM	315	GR		X	Required core course for first year E-IPER Ph.D. students; optional for Joint M.S. students; other graduate students with instructor's permission. Series of faculty presentations and student-led discussions on interdisciplinary research design as exemplars of the research design theories discussed in ENVRES 320. Designing Environmental Research. Topics parallel the ENVRES 320 syllabus. Corequisite: ENVRES 320.
ENVRES	DESIGN ENVIRONMENTAL RESEARCH	320	GR		X	Required core course restricted to first year E-IPER Ph.D. students. Research design options for causal inference in environmentally related research. Major philosophies of knowledge and how they relate to research objectives and design choices. Identification of critical elements within a broad range of research designs. Evaluation of the types of research questions for which different designs are suited, emphasizing fit between objectives, design, methods, and argument. Development of individual research design proposals, including description and justification understandable to a non-specialist.
ESS	PHYSICAL HYDROGEOLOGY	220	GR	X		(Formerly GES 230.) Theory of underground water occurrence and flow, analysis of field data and aquifer tests, geologic groundwater environments, solution of field problems, and groundwater modeling. Introduction to groundwater contaminant transport and unsaturated flow. Lab. Prerequisite: elementary calculus.
ESS	SOIL AND WATER CHEMISTRY	256	GR	X		(Graduate students register for 256.) Practical and quantitative treatment of soil processes affecting chemical reactivity, transformation, retention, and bioavailability. Principles of primary areas of soil chemistry: inorganic and organic soil components, complex equilibria in soil solutions, and adsorption phenomena at the solid-water interface. Processes and remediation of acid, saline, and wetland soils. Recommended: soil science and introductory chemistry and microbiology.
ESS	CLIMATE CHANGE	305	GR		X	A graduate-level, seminar-style class on climate change structured around the IPCC's AR5. Significant reading load and weekly talks by a rotating roster of contributing and lead authors from the IPCC. The focus will be on the physical science basis, adaptation and impacts (working groups 1 and 2), with some material drawn from mitigation (working group 3).
ESS	ADVANCED GEOGRAPHIC	165	UG	X		Building on the Fundamentals of Geographic Information Systems course, this class delves deeper into geospatial analysis and mapping techniques. The class is heavily project-based and students are encouraged to bring their own research questions. Topics include topographic analysis, interpolation, spatial statistics, network analysis, and scripting using Python and Acrpy. All students are required to attend a weekly lab. ESS 164 or equivalent is a prerequisite.

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ESS	ADVANCED GEOGRAPHIC	265	GR	X		Building on the Fundamentals of Geographic Information Systems course, this class delves deeper into geospatial analysis and mapping techniques. The class is heavily project-based and students are encouraged to bring their own research questions. Topics include topographic analysis, interpolation, spatial statistics, network analysis, and scripting using Python and Acrpy. All students are required to attend a weekly lab. ESS 164 or equivalent is a prerequisite.
ESS	HYDROGEOLOGY	322B	GR	X		Current topics. May be repeated for credit. Prerequisite: consent of instructor.
ESS	CONTAMINANT HYDROGEOLOGY	221	GR		X	For earth scientists and engineers. Environmental, geologic, and water resource problems involving migration of contaminated groundwater through porous media and associated biogeochemical and fluid-rock reactions. Conceptual and quantitative treatment of advective-dispersive transport with reacting solutes. Predictive models of contaminant behavior controlled by local equilibrium and kinetics. Modern methods of contaminant transport simulation and reactive transport modeling using geochemical transport software. Some Matlab programming / program modification required. Prerequisite: Physical Hydrogeology ESS 220 / CEE 260A (Gorelick) or equivalent. Recommended: course work in environmental chemistry or geochemistry (e.g., one or more of the following: ESS 155, ESS 156/256 GS 90, GS 170/279, GS 171, CEE 177 or CEE 270).
ESS	REMOTE SENSING OF THE OCEAN	241	GR		X	How to observe and interpret physical and biological changes in the oceans using satellite technologies. Topics: principles of satellite remote sensing, classes of satellite remote sensors, converting radiometric data into biological and physical quantities, sensor calibration and validation, interpreting large-scale oceanographic features.
ESS	RESEARCH PROPOSAL DEV	307	GR	X		In this class students will learn how to write rigorous, high yield, multidisciplinary proposals targeting major funding agencies. The skills gained in this class are essential to any professional career, particularly in research science. Students will write a National Science Foundation style proposal involving testable hypotheses, pilot data or calculations, and broader impact. Restricted to EESS first-year, graduate students.
ESS	HUMAN SOCIETY & ENVIRO CHANGE	112	UG		X	Interdisciplinary approaches to understanding human-environment interactions with a focus on economics, policy, culture, history, and the role of the state. Prerequisite: ECON 1.
ESS	ADVANCED STATISTICAL METHODS	260	GR	X		Introduction for graduate students to important issues in data analysis relevant to earth system studies. Emphasis on methodology, concepts and implementation (in R), rather than formal proofs. Likely topics include the bootstrap, non-parametric methods, regression in the presence of spatial and temporal correlation, extreme value analysis, time-series analysis, high-dimensional regressions and change-point models. Topics subject to change each year. Prerequisites: STATS 110 or equivalent.
ESS	INTRODUCTION TO GEOSTATISTICS	214	GR	X		Introduction of fundamental geostatistical tools for modeling spatial variability and uncertainty, and mapping of environmental attributes. Additional topics include sampling design and incorporation of different types of information (continuous, categorical) in prediction. Assignments consist of small problems to familiarize students with theoretical concepts, and applications dealing with the analysis and interpretation of various data sets (soil, water pollution, atmospheric constituents, remote sensing) primarily using Matlab. No prior programming experience is required. Open to graduates. Open to undergraduates with consent from the instructor. 3-credit option includes midterm/final or student-developed project. 4-credit option requires both. Prerequisite: College-level introductory statistics.
ESS	MARINE CHEMISTRY	252	GR	X		Introduction to the interdisciplinary knowledge and skills required to critically evaluate problems in marine chemistry and related disciplines. Physical, chemical, and biological processes that determine the chemical composition of seawater. Air-sea gas exchange, carbonate chemistry, and chemical equilibria, nutrient and trace element cycling, particle reactivity, sediment chemistry, and diagenesis. Examination of chemical tracers of mixing and circulation and feedbacks of ocean processes on atmospheric chemistry and climate. Designed to be taken concurrently with Biological Oceanography (EESS/ EARTHSYS 151/251)
ESS	ATMOSPHERE, OCEAN, AND CLIMATE	146A	GR		X	Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the atmospheric circulation. Topics include the global energy balance, the greenhouse effect, the vertical and meridional structure of the atmosphere, dry and moist convection, the equations of motion for the atmosphere and ocean, including the effects of rotation, and the poleward transport of heat by the large-scale atmospheric circulation and storm systems. Prerequisites: MATH 51 or CME100 and PHYSICS 41.

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ESS	ATMOSPHERE, OCEAN, AND CLIMATE	246A	GR		X	Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the atmospheric circulation. Topics include the global energy balance, the greenhouse effect, the vertical and meridional structure of the atmosphere, dry and moist convection, the equations of motion for the atmosphere and ocean, including the effects of rotation, and the poleward transport of heat by the large-scale atmospheric circulation and storm systems. Prerequisites: MATH 51 or CME100 and PHYSICS 41.
ESS	ATMOSPHERE, OCEAN, AND CLIMATE	246B	GR		X	Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the large-scale ocean circulation. This course will give an overview of the structure and dynamics of the major ocean current systems that contribute to the meridional overturning circulation, the transport of heat, salt, and biogeochemical tracers, and the regulation of climate. Topics include the tropical ocean circulation, the wind-driven gyres and western boundary currents, the thermohaline circulation, the Antarctic Circumpolar Current, water mass formation, atmosphere-ocean coupling, and climate variability. Prerequisites: EESS 146A or EESS 246A, or CEE 164 or CEE 262D, or consent of instructor.
ESS	MICROBIAL PHYSIOLOGY	255	GR	X		Introduction to the physiology of microbes including cellular structure, transcription and translation, growth and metabolism, mechanisms for stress resistance and the formation of microbial communities. These topics will be covered in relation to the evolution of early life on Earth, ancient ecosystems, and the interpretation of the rock record. Recommended: introductory biology and chemistry.
ESS	SCIENCE OF SOILS	155	UG	X		Physical, chemical, and biological processes within soil systems. Emphasis is on factors governing nutrient availability, plant growth and production, land-resource management, and pollution within soils. How to classify soils and assess nutrient cycling and contaminant fate. Recommended: introductory chemistry and biology.
ESS	ELKHORN SLOUGH	46N	GR		X	Preference to freshmen. Field trips to sites in the Elkhorn Slough, a small agriculturally impacted estuary that opens into Monterey Bay, a model ecosystem for understanding the complexity of estuaries, and one of California's last remaining coastal wetlands. Readings include Jane Caffrey's *Changes in a California Estuary: A Profile of Elkhorn Slough* . Basics of biogeochemistry, microbiology, oceanography, ecology, pollution, and environmental management.
ESS	MEASUREMENTS IN EARTH SYSTEMS	212	GR		X	Preference will be given to ESS first-year grad students. Techniques to track biological, chemical, and physical processes operating across the San Francisquito Creek watershed, encompassing upland, aquatic, estuarine, and marine environments. Topics include gas and water flux measurement, assessment of microbiological communities, determination of biological productivity, isotopic analysis, soil and water chemistry determination, and identification of rock strata and weathering processes.
ESS	TOPICS IN GEOBIOLOGY	208	GR	X		Reading and discussion of classic and recent papers in the field of Geobiology. Co-evolution of Earth and life; critical intervals of environmental and biological change; geomicrobiology; paleobiology; global biogeochemical cycles; scaling of geobiological processes in space and time.
ESS	BIOLOGICAL OCEANOGRAPHY	251	GR	X		Required for Earth Systems students in the oceans track. Interdisciplinary look at how oceanic environments control the form and function of marine life. Topics include distributions of planktonic production and abundance, nutrient cycling, the role of ocean biology in the climate system, expected effects of climate changes on ocean biology. Local weekend field trips. Designed to be taken concurrently with Marine Chemistry (EESS/ EARTHSYS 152/252). Prerequisites: BIO 43 andEESS 8 or equivalent.
ESS	FUNDAMENTALS OF MODELING	211	GR	X		Simulation models are a powerful tool for environmental research, if used properly. The major concepts and techniques for building and evaluating models. Topics include model calibration, model selection, uncertainty and sensitivity analysis, and Monte Carlo and bootstrap methods. Emphasis is on gaining hands-on experience using the R programming language. Prerequisite: Basic knowledge of statistics.
ESS	FUNDAMENTALS OF GIS	164	UG	X		Survey of geographic information including maps, satellite imagery, and census data, approaches to spatial data, and tools for integrating and examining spatially-explicit data. Emphasis is on fundamental concepts of geographic information science and associated technologies. Topics include geographic data structure, cartography, remotely sensed data, statistical analysis of geographic data, spatial analysis, map design, and geographic information system software. Computer lab assignments. All students are required to attend a weekly lab on Tuesdays or Thursdays from 6 pm to 9 pm.

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ESS	ENVIRONMNTL MICROBIAL GENOMICS	259	GR	X		The application of molecular and environmental genomic approaches to the study of biogeochemically-important microorganisms in the environment without the need for cultivation. Emphasis is on genomic analysis of microorganisms by direct extraction and cloning of DNA from natural microbial assemblages. Topics include microbial energy generation and nutrient cycling, genome structure, gene function, physiology, phylogenetic and functional diversity, evolution, and population dynamics of uncultured communities.
ESS	OCEANS:INTRO MARINE ENVIRON	8	UG		X	The course will provide a basic understanding of how the ocean functions as a suite of interconnected ecosystems, both naturally and under the influence of human activities. Emphasis is on the interactions between the physical and chemical environment and the dominant organisms of each ecosystem. The types of ecosystems discussed include coral reefs, deep-sea hydrothermal vents, coastal upwelling systems, blue-water oceans, estuaries, and near-shore dead zones. Lectures, multimedia presentations, group activities, and tide-pooling day trip.
ESS	FOOD AND SECURITY	61Q	GR		X	The course will provide a broad overview of key policy issues concerning agricultural development and food security, and will assess how global governance is addressing the problem of food security. At the same time the course will provide an overview of the field of international security, and examine how governments and international institutions are beginning to include food in discussions of security.
ESS	WORLD FOOD ECON	106	UG		X	The economics of food production, consumption, and trade. The micro- and macro- determinants of food supply and demand, including the interrelationship among food, income, population, and public-sector decision making. Emphasis on the role of agriculture in poverty alleviation, economic development, and environmental outcomes. (graduate students enroll in 206)
ESS	WORLD FOOD ECON	206	GR		X	The economics of food production, consumption, and trade. The micro- and macro- determinants of food supply and demand, including the interrelationship among food, income, population, and public-sector decision making. Emphasis on the role of agriculture in poverty alleviation, economic development, and environmental outcomes. (graduate students enroll in 206)
ESS	NITROGEN IN THE MARINE ENVIRON	275	GR	X		The goal of this seminar course is to explore current topics in marine nitrogen cycle. We will explore a variety of processes, including primary production, nitrogen fixation, nitrification, denitrification, and anaerobic ammonia oxidation, and their controls. We will use the book Nitrogen in the Marine Environment and supplement with student-led discussions of recent literature. A variety of biomes, spatial and temporal scales, and methodologies for investigation will be discussed.
ESS	REMOTE SENSING OF LAND	262	GR	X		The use of satellite remote sensing to monitor land use and land cover, with emphasis on terrestrial changes. Topics include pre-processing data, biophysical properties of vegetation observable by satellite, accuracy assessment of maps derived from remote sensing, and methodologies to detect changes such as urbanization, deforestation, vegetation health, and wildfires.
ESS	CONTROL OF NATURE	107	UG		X	Think controlling the earth¿s climate is science fiction? It is when you watch Snowpiercer or Dune, but scientists are already devising geoengineering schemes to slow climate change. Will we ever resurrect the woolly mammoth or even a T. Rex (think Jurassic Park)? Based on current research, that day will come in your lifetime. Who gets to decide what species to save? And more generally, what scientific and ethical principles should guide our decisions to control nature? In this course, we will examine the science behind ways that people alter and engineer the earth, critically examining the positive and negative consequences. We¿ll explore these issues first through popular movies and books and then, more substantively, in scientific research.
ESS	HAZARDS, RISKS, RISILIENCE	118	UG		X	This class connects the science behind natural disasters with the real-world constraints of disaster management and development. In each iteration of this class we will focus on a specific, disaster-prone location as case study. By collaborating with local stakeholders we will explore how science and engineering can make a make a difference in reducing disaster risk in the future. Offered every other year.
ESS	HAZARDS, RISKS, RISILIENCE	218	GR		X	This class connects the science behind natural disasters with the real-world constraints of disaster management and development. In each iteration of this class we will focus on a specific, disaster-prone location as case study. By collaborating with local stakeholders we will explore how science and engineering can make a make a difference in reducing disaster risk in the future. Offered every other year.

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ESS	BIOGEO CYCL ON EARTH	232	GR		X	This course examines biogeochemical cycles and how they developed through the interaction between the atmosphere, hydrosphere, biosphere, and lithosphere. Emphasis is on the long-term carbon cycle and how it is connected to other biogeochemical cycles on Earth. The course consists of lectures, discussion of research papers, and quantitative modeling of biogeochemical cycles. Students produce a model on some aspect of the cycles discussed in this course. Grades based on class interaction, student presentations, and the modeling project.
ESS	SCIENCE LIT HIST POLAR EXPLORA	38N	GR	X		This course examines the motivations and experiences of polar explorers under the harshest conditions on Earth, as well as the chronicles of their explorations and hardships, dating to the 1500s for the Arctic and the 1700s for the Antarctic. Materials include The Worst Journey in the World by Aspley Cherry-Garrard who in 1911 participated in a midwinter Antarctic sledging trip to recover emperor penguin eggs. Optional field trip into the high Sierra in March.
ESS	ANALYZ LAND USE IN GLOBL WORLD	270	GR		X	This is a graduate level course that examines the dynamics of land use in relation to the multiple dimensions of globalization. The objective is to understand and analyze how the expansion of global trade, the emergence of new global actors, and public and private regulations affect land use changes. Beyond getting a better understanding of the dynamics of land use change, the course will enable students to better understand how to effectively influence land use change, from different vantage points: government, NGO, information broker, corporate actor. The main emphasis is on tropical regions. Lectures introduce various topics related to theories, practical cases, and evaluation tools to better understand and analyze contemporary land use dynamics. Data analyses will be conducted in the lab section, based on case studies.
ESS	FRESHWATER OCEANS TO LAND SYS	306	GR	X		Within this class we will have cover Earth System processes ranging from nutrient cycles to ocean circulation. We will also address global environmental challenges of the twenty-first century that include maintaining freshwater resources, land degradation, health of our oceans, and the balance between food production and environmental degradation. Weekly readings and problem sets on specific topics will be followed by presentations of Earth System Science faculty and an in-depth class discussion. ESS first year students have priority enrollment.
ESS	TOPICS IN ESS	301	GR		X	Current topics, issues, and research related to interactions that link the oceans, atmosphere, land surfaces and freshwater systems. May be repeated for credit.
ESS	LOCAL SUSTAINABLE AGRICULTURE	280B	GR		X	Field-based training in ecologically sound agricultural practices at the Stanford Community Farm. Weekly lessons, field work, and group projects. Field trips to educational farms in the area. Topics include: soils, composting, irrigation techniques, IPM, basic plant anatomy and physiology, weeds, greenhouse management, and marketing.
ETHICSOC	ETHICAL THEORY	170	UG	X		A more challenging version of Phil 2 designed primarily for juniors and seniors (may also be appropriate for some freshmen and sophomores - contact professor). Fulfills the Ethical Reasoning requirement. Graduate section (270) will include supplemental readings and discussion, geared for graduate students new to moral philosophy, as well as those with some background who would like more.
ETHICSOC	ECONOMIC JUSTICE	186M	GR	X		Seminar. The focus is on private property. Questions include: Is property a natural right or a social construction? How does our current, global system of property allocation work? What things are fit to be private property/a commodity? (Can we sell our bodies? Our vote? Natural resources?) The readings are a mix of philosophical classics (such as Locke and Marx), recent publications (e.g. Thomas Piketty, David Graeber), and empirical case studies. Prerequisites: none.

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ETHICSOC	ETHICS ON THE EDGE	234R	GR	X		The objective of the course is to explore the increasing ethical challenges in a world in which technology, global risks, and societal developments are accelerating faster than our understanding can keep pace. We will unravel the factors contributing to the seemingly pervasive failure of ethics today among organizations and leaders across all sectors: business, government and non-profit. A framework for ethical decision-making underpins the course. The relationship between ethics and culture, global risks (poverty, cyber-terrorism, climate change, etc.) leadership, and the law and policy will inform discussion. Prominent guest speakers will attend certain sessions interactively. A broad range of international case studies might include: Ebola; Facebook's mood manipulation research and teen suicides from social media bullying; Google's European "right to be forgotten" and driverless cars; Space X (Elon Musk's voyages to Mars); ISIS' interaction with international NGOs; sexual assault on U.S. university campuses and in the U.S. military; the ethics of corporate social responsibility (through companies such as L'Oreal, Whole Foods and Walmart); corporate and financial sector scandals; and non-profit sector ethics challenges. Final project in lieu of exam on a topic of student's choice. Attendance required. Class participation important (with multiple opportunities beyond speaking in class). Final project in lieu of exam. Strong emphasis on critical thinking and testing ideas in real-world contexts. There will be a limited numbers of openings above the set enrollment limit of 40 students. If the enrollment limit is reached, students wishing to take the course should contact Dr. Susan Liautaud at susan11@stanford.edu. The course offers credit toward Ethics in Society, Public Policy core requirements (if taken in combination with Public Policy 103E), and Science, Technology and Society and satisfies the Ways of Thinking requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. *Public Policy majors taking the course to complete the core requirements must obtain a letter grade. Other students may take the course for a letter grade or C/NC.
ETHICSOC	SUSTAINABILITY & SOCIAL JUSTIC	11Q	GR		X	At its core, sustainability is a conversation about equity. Equity between people today and people tomorrow. Equity between the many diverse people today who are all trying to pursue their hopes and dreams. Equity between human beings and the myriad other living creatures we share this planet with. Movements for environmental sustainability and social justice share a concern for equity, but have largely evolved in parallel. Mounting evidence however shows that environmental and social change are almost always inextricably linked, and the climate crisis is pushing together these two areas of study like never before. That is good news, but tough questions remain. What happens when the environmental costs of personal freedom can no longer be sustained? Should the needs of the many always outweigh the needs of the few? Are we responsible for repairing the injustices of our parents' and grandparents' generations? Where are the win-win solutions? In this interdisciplinary seminar, we will explore the theory and practice of sustainability and social justice, examining case studies where they have intersected, and where they have not. Readings will draw from sustainability science, environmental justice, environmental ethics, religious studies, social psychology, and ecological economics. Through weekly readings, discussions, and journal writing, students will develop a personal sustainability manifesto and analyze a policy, technology, or social movement through the lens of social and environmental sustainability.
ETHICSOC	INTRODUCTION TO GLOBAL JUSTICE	136R	GR	X		This course provides an overview of core ethical problems in international politics, with special emphasis on the question of what demands justice imposes on institutions and agents acting in a global context. The course is divided into three sections. The first investigates the content of global justice, and comprises of readings from contemporary political theorists and philosophers who write within the liberal contractualist, utilitarian, cosmopolitan, and nationalist traditions. The second part of the course looks at the obligations which global justice generates in relation to five issues of international concern ¿ global poverty, climate change, immigration, warfare, and well-being of women. The final section of the course asks whether a democratic international order is necessary for global justice to be realized.

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ETHICSOC	COLLECTIVE ACTION	180M	GR		X	Collective action problems arise when actions that are individually rational give rise to results that are collectively irrational. Scholars have used such a framework to shed light on various political phenomena such as revolutions, civil disobedience, voting, climate change, and the funding of social services. We examine their findings and probe the theoretical foundations of their approach. What does this way of thinking about politics bring into focus, and what does it leave out? What role do institutions play in resolving collective action problems? And what if the required institutions are absent? Can we, as individuals, be required to cooperate even if we expect that others may not play their part? Readings drawn from philosophy, political science, economics, and sociology.
ETHICSOC	CONTEMPORARY MORAL PROBLEMS	185M	GR	X		This course addresses moral issues that play a major role in contemporary public discourse. The course aims to encourage students to consider moral problems in a reflective, systematic manner, and to equip students with skills that will enable them to do so. Questions to be addressed include: Do rich countries have an obligation to accept refugees from other parts of the world? Do such obligations conflict with the right of individuals to protect their culture? Is there anything principally wrong in the use of drones for purposes of warfare? Do we have obligations to the environment, and if so why? What is racism and what makes it wrong? And what are feminist ideals?
FEMGEN	LOVE/SOCIAL CHANGE	86Q	GR	X		Preference to sophomores. Biological, psychological, religious, social and cultural perspectives on the concept of agape love. How love is conceptualized across cultures; agape love as the basis of many religions; different kinds of love; the biology of love; love in action for social justice; the languages of love, including art, literature, music, and poetry. Emphasis is on blog writing, participation, and oral presentation.
FEMGEN	EXPANDING ENGINEERING LIMITS	311C	GR	X		This course considers how culture shapes and impacts engineering, with a particular focus on the cultural aspects of gender that affect who becomes an engineer, what problems get solved, and the quality of solutions, design, technology, and products. We will examine engineering cultures and gender through the lens of ¿design thinking¿, which is an increasingly visible component of engineering education and practice. Design processes are determined by the designers, their disciplinary backgrounds, and the methods they use. How do the background characteristics of the designer affect products and development in innovation and research? Does gender matter? What about other characteristics of the designer? How can design thinking help to find sustainable solutions and also consider gender and diversity perspectives?
FEMGEN	COMMUNITY ORGANIZING	100X	GR	X		This course explores the theory, practice and history of grassroots community organizing as a method for developing community power to promoting social justice. We will develop skills for 1-on-1 relational meetings, media messaging, fundraising strategies, power structure analysis, and strategies organizing across racial/ethnic difference. And we will contextualize these through the theories and practices developed in the racial, gender, queer, environmental, immigrant, housing and economic justice movements to better understand how organizing has been used to engage communities in the process of social change. Through this class, students will gain the hard skills and analytical tools needed to successfully organize campaigns and movements that work to address complex systems of power, privilege, and oppression. As a Community-Engaged Learning course, students will work directly with community organizations on campaigns to address community needs, deepen their knowledge of theory and history through hands-on practice, and develop a critical analysis of inequality at the structural and interpersonal levels. Placements with community organizations are limited. Enrollment will be determined on the first day through a simple application process. Students will have the option to continue the course for a second quarter in the Winter, where they will execute a campaign either on campus or in collaboration with their community partner.
FEMGEN	GLOBAL MED ISSUES WOMEN	206	GR	X		This course probes the principal issues affecting women and girls medically around the world. Through interactive discussions, guest lectures, case studies, and academic readings, students become acquainted with the most critical challenges to women¿s health globally, and use selected analytical tools to assess how these may be addressed efficiently, cost-effectively, and sustainably. Topics include women¿s cancer, birth control, infertility, female genital mutilation, midwifery, obstetric fistula, breastfeeding, violence against women, and women's representation in biomedical research. The aim is to cultivate in students a nuanced appreciation of women¿s unique needs, roles, and challenges in the contemporary global health landscape.

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FILMSTUD	VISUAL CULTURE OF THE ARCTIC	273	GR		X	In what ways does contemporary art address the slowly unfolding catastrophes of melting ice and thawing permafrost in the Arctic due to climate change? How might contemporary art and experimental cinema help us come to grips with the emotional disturbance of living amidst the deep-seated changes that are happening in our environment? These are the key questions this course attempts to answer.nThe first part of the class attempts to outline the complex history of Arctic visual and cultural representations through an interdisciplinary lens. The second part focuses on the more recent artistic and cinematic responses to climate change in the arctic. For their final projects, students will be able to combine analytical writing with creative projects that could take the form of photography, installation art, web-based art, fiction, video or poetry.
FRENCH	IMAGINING THE OCEANS	168	UG	X		How has Western culture constructed the world's oceans since the beginning of global ocean exploration? How have imaginative visions of the ocean been shaped by marine science, technology, exploration, commerce and leisure? Authors read might include Cook, Equiano, and Steinbeck; Defoe, Verne, Stevenson, Conrad, Woolf and Hemingway; Coleridge, Baudelaire, Moore, Bishop and Walcott. Films by Painlevé and Bigelow. Seminar co-ordinated with a spring 2015 Cantor Arts Center public exhibition. Visits to Cantor; other possible field trips include Hopkins Marine Station and SF Maritime Historical Park.
FRENCH	IMAGINING THE OCEANS	368A	GR	X		How has Western culture constructed the world's oceans since the beginning of global ocean exploration? How have imaginative visions of the ocean been shaped by marine science, technology, exploration, commerce and leisure? Primary authors read might include Cook, Banks, Equiano, Ricketts, and Steinbeck; Defoe, Cooper, Verne, Conrad, Woolf and Hemingway; Coleridge, Baudelaire, Moore, Bishop and Walcott. Critical readings include Schmitt, Rediker and Linebaugh, Baucom, Best, Corbin, Auden, Sontag and Heller-Roazen. Films by Sekula, Painlevé and Bigelow. Seminar coordinated with a 2015 Cantor Arts Center public exhibition. Visits to the Cantor; other possible field trips include Hopkins Marine Station and SF Maritime Historical Park. Open to graduate students only.
FRENCH	THE ENLIGHTENMENT	244	GR	X		The Enlightenment as a philosophical, literary, and political movement. Themes include the nature and limits of philosophy, the grounds for critical intellectual engagement, the institution of society and the public, and freedom, equality and human progress. Authors include Voltaire, Montesquieu, Rousseau, Hume, Diderot, and Condorcet.
FRENCH	POLITICS OF DISASTERS	228	GR	X		How STS and the Humanities can together help think out the looming catastrophes that put the future of humankind in jeopardy.
GEOPHYS	RESERVOIR GEOMECHANICS	202	GR	X		Basic principles of rock mechanics and the state of stress and pore pressure in sedimentary basins related to exploitation of hydrocarbon and geothermal reservoirs. Mechanisms of hydrocarbon migration, exploitation of fractured reservoirs, reservoir compaction and subsidence, hydraulic fracturing, utilization of directional and horizontal drilling to optimize well stability.Given alternate years.
GEOPHYS	CRUSTAL DEFORMATION	288A	GR	X		Earthquake and volcanic deformation, emphasizing analytical models that can be compared to data from GPS, InSAR, and strain meters. Deformation, stress, and conservation laws. Dislocation models of strike slip and dip slip faults, in 2 and 3 dimensions. Crack models, including boundary element methods. Dislocations in layered and elastically heterogeneous earth models. Models of volcano deformation, including sills, dikes, and magma chambers. Offered every other year, autumn quarter.
GEOPHYS	CRUSTAL DEFORMATION	288B	GR	X		Earthquake and volcanic deformation, emphasizing analytical models that can be compared to data from GPS, InSAR, and strain meters. Viscoelasticity, post-seismic rebound, and viscoelastic magma chambers. Effects of surface topography and earth curvature on surface deformation. Gravity changes induced by deformation and elastogravitational coupling. Poro-elasticity, coupled fluid flow and deformation. Earthquake nucleation and rate-state friction. Models of earthquake cycle at plate boundaries.
GEOPHYS	SEN SEM: ISSUES IN EARTH SCIEN	199	UG		X	Focus is on written and oral communication in a topical context. Topics from current frontiers in earth science research and issues of concern to the public. Readings, oral presentations, written work, and peer review.

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GEOPHYS	MAGNETOTELLURICS	292	GR	X		Geophys 292 approved, also can meet PhD requirement for 4 200-level classesnGEOPHYS 292 Magnetotellurics: introduction, practical data analysis and inversion. Designed for those with no knowledge of magnetotellurics or electromagnetic induction methods, this class will cover the theory and practice of the MT method with application to both commercial (mineral, oil/gas, and geothermal exploration) and academic (crustal and lithospheric studies). The second half of the class is a hands-on analysis and modelling workshop that will require use of a laptop and instructor-provided codes and data. The analysis will be using various methods to determine dimensionality and directionality, and testing the apparent resistivities and phases for internal consistency. The modelling will be 1D only, but knowledge and skills gained from understanding 1D inversion are equally applicable to 2D and 3D.nTextbook is ¿The Magnetotelluric Method: Theory and Practice¿ (Chave and Jones, CUP, 2012).
GEOPHYS	REMOTE SENSING OF THE OCEAN	141	UG	X		How to observe and interpret physical and biological changes in the oceans using satellite technologies. Topics: principles of satellite remote sensing, classes of satellite remote sensors, converting radiometric data into biological and physical quantities, sensor calibration and validation, interpreting large-scale oceanographic features.
GEOPHYS	EARTHQUAKES AND VOLCANOES	90	UG		X	Is the "Big One" overdue in California? What kind of damage would that cause? What can we do to reduce the impact of such hazards in urban environments? Does "fracking" cause earthquakes and are we at risk? Is the United States vulnerable to a giant tsunami? The geologic record contains evidence of volcanic super eruptions throughout Earth's history. What causes these gigantic explosive eruptions, and can they be predicted in the future? This course will address these and related issues. For non-majors and potential Earth scientists. No prerequisites. More information at:https://stanford.box.com/s/tpwwqpl2ryxfty6stq8wo2j78fj06ikg
GEOPHYS	LABORATORY METHODS GEOPHYSICS	162	UG	X		Lab. Types of equipment used in experimental rock physics. Principles and measurements of geophysical properties such as porosity, permeability, acoustic wave velocity, and resistivity through lectures and laboratory experiments. Training in analytical project writing skills and understanding errors for assessing accuracy and variability of measured data. Students may investigate a scientific problem to support their own research. Prerequisites: Physics 45 (Light and Heat); and CME 100 (Vector Calculus).
GEOPHYS	LABORATORY METHODS GEOPHYSICS	259	GR	X		Lab. Types of equipment used in experimental rock physics. Principles and measurements of geophysical properties such as porosity, permeability, acoustic wave velocity, and resistivity through lectures and laboratory experiments. Training in analytical project writing skills and understanding errors for assessing accuracy and variability of measured data. Students may investigate a scientific problem to support their own research. Prerequisites: Physics 45 (Light and Heat); and CME 100 (Vector Calculus).
GEOPHYS	ELECTROMAGNETIC PROPERTIES	270	GR	X		Laboratory observations and theoretical modeling of the electromagnetic properties and nuclear magnetic resonance response of geological material. Relationships between these properties and water-saturated materials properties such as composition, water content, surface area, and permeability.
GEOPHYS	MAN VERSUS NATURE	60N	GR	X		Preference to freshman. Natural hazards, earthquakes, volcanoes, floods, hurricanes, and fires, and how they affect people and society; great disasters such as asteroid impacts that periodically obliterate many species of life. Scientific issues, political and social consequences, costs of disaster mitigation, and how scientific knowledge affects policy. How spaceborne imaging technology makes it possible to respond quickly and mitigate consequences; how it is applied to natural disasters; and remote sensing data manipulation and analysis. GER:DB-EngrAppSci
GEOPHYS	ROCK PHYSICS	262	GR	X		Properties of and processes in rocks as related to geophysical exploration, crustal studies, and tectonic processes. Emphasis is on wave velocities and attenuation, hydraulic permeability, and electrical resistivity in rocks. Application to in situ problems, using lab data and theoretical results. Offered every year, autumn quarter.
GEOPHYS	IMAGING RADAR + APPLICATIONS	265	GR	X		Radar remote sensing, radar image characteristics, viewing geometry, range coding, synthetic aperture processing, correlation, range migration, range/Doppler algorithms, wave domain algorithms, polar algorithm, polarimetric processing, interferometric measurements. Applications: surfafe deformation, polarimetry and target discrimination, topographic mapping surface displacements, velocities of ice fields. Prerequisites: EE261. Recommended: EE254, EE278, EE279.
GEOPHYS	PHYSICAL VOLCANOLOGY	385R	GR	X		Research on volcanic processes.

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GEOPHYS	SEISMIC IMAG. EARTHQUAKE DATA	293	GR	X		Seismic imaging using earthquake and ambient noise data has developed into one of the most powerful tools to study the Earth's internal structure from regional to global scales. This class will give a (slightly futuristic) account of this topic.n In the first part we will focus on regional- to global-scale full-waveform inversion (FWI) using earthquake data. We will review the theoretical foundations of visco-elastic FWI, discuss data requirements, study modern techniques to quantify resolution using second-order adjoints and random probing techniques, and finally highlight some recent applications.In the second part of this class, we will extend the earthquake-based inversions to inversions using the ambient seismic noise field. We will develop interferometric techniques that do not require the traditional assumption of an equipartitioned wavefield, and that allow us to jointly invert for Earth structure and the sources of seismic noise. Furthermore, we will analyze how common noise processing techniques lead to an effective, i.e. distorted, view of Earth structure and noise sources. In the third part we will study how the first and second part maybe combined into a new class of techniques where earthquake and ambient noise data are inverted jointly, instead of following traditional approaches where one is removed from the other.This class will be complemented by small programming examples in order to illustrate basic concepts. Since we will mostly cover ongoing research, this class is also intended to provoke discussions and collaborations.
GEOPHYS	THE WATER COURSE	70	UG	X		The pathway that water takes from rainfall to the tap using student home towns as an example. How the geological environment controls the quantity and quality of water; taste tests of water from around the world. Current U.S. and world water supply issues.
GEOPHYS	REFLECTION SEISMOLOGY	182	UG	X		The principles of seismic reflection profiling, focusing on methods of seismic data acquisition and seismic data processing for hydrocarbon exploration.
GEOPHYS	REFLECTION SEISMOLOGY	222	GR	X		The principles of seismic reflection profiling, focusing on methods of seismic data acquisition and seismic data processing for hydrocarbon exploration.
GEOPHYS	REFLECT SEISMOGRAM	223	GR	X		The structural and stratigraphic interpretation of seismic reflection data, emphasizing hydrocarbon traps in two and three dimensions on industry data, including workstation-based interpretation. Lectures only, 1 unit. Prerequisite: 222, or consent of instructor. (Geophys 183 must be taken for a minimum of 3 units to be eligible for Ways credit).
GEOPHYS	D^3:DISASTERS, DECISIONS, DEV	160	UG		X	This class connects the science behind natural disasters with the real-world constraints of disaster management and development. In each iteration of this class we will focus on a specific, disaster-prone location as case study. By collaborating with local stakeholders we will explore how science and engineering can make a make a difference in reducing disaster risk in the future. Offered every other year.
GEOPHYS	HAZARDS, RISKS, RISILIENCE	218	GR	X		This class connects the science behind natural disasters with the real-world constraints of disaster management and development. In each iteration of this class we will focus on a specific, disaster-prone location as case study. By collaborating with local stakeholders we will explore how science and engineering can make a make a difference in reducing disaster risk in the future. Offered every other year.
GEOPHYS	UNCONV. RESERVOIR GEOMECHANICS	208	GR	X		This course will investigate oil and gas production from extremely low permeability reservoirs. Lectures and exercises will address 1) the physical and fluid transport properties of unconventional reservoir formations, 2) stimulation techniques such as hydraulic fracturing and 3) understanding microseismicity associated with hydraulic stimulation and induced seismicity associated with wastewater injection. Prerequisite: GEOPHYS 202 or concurrent enrollment inGEOPHYS 202.
GEOPHYS	TOPICS IN CLIMATE CHANGE	212	GR		X	This introductory classroom course presents Earth's climate system and explores the science and politics of global climate change. Students will learn how the climate system works, the factors that cause climate to change across different time scales, the use of models and observations to make predictions about future climate. The course will discuss possible consequences of climate change in the Earth, and it will explore the evidence for changes due to global warming. There are no prerequisites.
GEOPHYS	WATER GOVERNANCE	192	UG		X	Water is subject to competing uses and interpretations. A critical socioeconomic input and ecosystem service, water is simultaneously imbued with aesthetic, cultural, and spiritual significance. This seminar is predicated on a shared interest in exploring interdisciplinary perspectives on freshwater challenges. The course will draw upon contemporary scholarship in the natural sciences, social sciences, and humanities. We will engage in critical analyses of water challenges (e.g. the water-food-energy nexus, water-related implications of climate change, human access to safe drinking water) and responses (e.g. multi-scalar water governance, integrated water resources management). Case studies from around the world will be used. Students from any discipline are welcome.

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GEOPHYS	OBSERVING FRESHWATER	191	UG	X		We will study estimates of the components of the land hydrological cycle using in-situ and satellite observations and model output. Hydrological variables are rainfall, snow, water vapor, soil moisture, stream discharge and groundwater; other variables are vegetation, surface temperature, soil types, land use and surface topography. We focus on observations and their role in the water balance of the land surface. In-class lab experience working with data. Group/individual term project & paper & presentation; no final. Pre-requisite: basic familiarity with MATLAB.
GEOPHYS	SEISMIC DATA PROCESSING	224	GR	X		Workshop in computer processing of 2D and 3D seismic reflection data. Students individually process a seismic reflection profile (of their own choice or instructor-provided) from field recordings to migrated sections and subsurface images, using interactive software (OpenCPS from OpenGeophysical.com). Prerequisite: GEOPHYS 222 or consent of instructor.
GEOPHYS	EARTH ON THE EDGE	110	UG	X		Introduction to the foundations of contemporary geophysics. Topics drawn from four broad themes in: whole Earth geodynamics, geohazards, natural resources, and environment/sustainability. In each case the focus is on how the interpretation of a variety of geophysical measurements (e.g., gravity, seismology, heat flow, magnetism, electromagnetics, and geodesy) can be used to provide fundamental insight into the behavior of the Earth's complex geosystems.
GEOPHYS	SENIOR THESIS IN GEOPHYSICS	197	UG	X		For seniors writing a thesis based on Geophysics research in 196 or as a summer research fellow. Seniors defend the results of their research at a public oral presentation.
GEOPHYS	ATMOSPHERE, OCEAN, AND CLIMATE	146A	GR		X	Introduction to the physics governing the circulation of the atmosphere and ocean and their control on climate with emphasis on the atmospheric circulation. Topics include the global energy balance, the greenhouse effect, the vertical and meridional structure of the atmosphere, dry and moist convection, the equations of motion for the atmosphere and ocean, including the effects of rotation, and the poleward transport of heat by the large-scale atmospheric circulation and storm systems.
GEOPHYS	REFLECTION SEISMOLOGY	385A	GR	X		Research in reflection seismology and petroleum prospecting. May be repeated for credit.
GEOPHYS	RESEARCH SEMINAR: ENVIRON GES	385B	GR	X		Research on the use of geophysical methods for near-surface environmental problems. May be repeated for credit.
GEOPHYS	THEORETICAL GEOPHYSICS	385D	GR	X		Research on physics and mechanics of earthquakes, volcanoes, ice sheets, and nglaciers. Emphasis is on developing theoretical understanding of processes governing natural phenomena.
GERMAN	WHY HUMANS MATTER	103N	GR	X		We consider various mythic and religious conceptions of the human from antiquity to Renaissance humanism, key documents of modern secular humanism, and literary works that raise probing questions about humanity. What is peculiar to humans against the foil of animal life forms? Is there a human nature at all, or perhaps a human calling, that might transcend differences among people? Contemporary debates about the limits of the human species, the aspiration to overcome such limits through science, and ecological challenges to traditional views of humans' place in the world.
GS	FUND OF GEOCHEMICAL MODELING	225A	GR	X		A class devoted to geochemical models and the computational and analytical tools required to successfully construct and solve them. Topics include: box models, impulse responses, transfer functions, eigenvalues, advection-diffusion-reaction models, discretization schemes, numerical methods (Euler, Runge-Kutta, Gauss¿Seidel), Green's function, Laplace and Fourier transforms. The class will include a final project in which students will have the opportunity to apply the above tools to their own research or a problem of their choice.
GS	LANDSCAPES TECTONICS SF	42N	GR	X		Active faulting and erosion in the Bay Area, and its effects upon landscapes. Earth science concepts and skills through investigation of the valley, mountain, and coastal areas around Stanford. Faulting associated with the San Andreas Fault, coastal processes along the San Mateo coast, uplift of the mountains by plate tectonic processes, and landsliding in urban and mountainous areas. Field excursions; student projects.
GS	SEDIMENTARY BASINS	251	GR	X		Analysis of the depositional framework and tectonic evolution of sedimentary basins. Topics: tectonic and environmental controls on facies relations, synthesis of basin development through time in terms of depositional systems and tectonic settings. Weekend field trip required. Prerequisites: 110, 151.
GS	QUANTITATIVE METHODS IN BPSM	256	GR	X		Examine the physical processes operating in sedimentary basins by deriving the basic equations of fundamental, coupled geologic processes such as fluid flow and heat flow, deposition, compaction, mass conservation, and chemical reactions. Through hands-on computational exercises and instructor-provided "recipes," students will deconstruct the black box of basin modeling software. Students write their own codes (Matlab) as well as gain expertise in modern finite-element modeling software (PetroMod, COMSOL).

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GS	OUR NATIONAL PARKS	14	UG	X		Explore the history and natural science of three national parks proximal to Stanford. Under the guidance of instructors, students will work in teams to learn about chosen aspects of these parks, develop dynamic self-guided tours for public consumption, and implement (and publish) these tours using the XibitEd app for iPhones. Students will learn how to present their findings to a general, non-scientific audience, delineate physical locations at which storytelling will take place through the XibitEd system, and create and configure the content for the system. The course will culminate in the publishing of the experiential learning tours, as well as a weekend-long field trip to the Pinnacles National Park
GS	OUR NATIONAL PARKS	114A	GR	X		Explore the history and natural science of three national parks proximal to Stanford. Under the guidance of instructors, students will work in teams to learn about chosen aspects of these parks, develop dynamic self-guided tours for public consumption, and implement (and publish) these tours using the XibitEd app for iPhones. Students will learn how to present their findings to a general, non-scientific audience, delineate physical locations at which storytelling will take place through the XibitEd system, and create and configure the content for the system. The course will culminate in the publishing of the experiential learning tours, as well as a weekend-long field trip to the Pinnacles National Park
GS	CA DESERT GEOLOGY	183	UG	X		Field seminar. Three class meetings during Winter quarter followed by a 6-day field trip over Spring Break to Mojave Desert, Death Valley, and Owens Valley. Basin-and-range faulting, alluvial fans, playas, sand dunes, metamorphic rocks, granites of the Sierra Nevada, lava flows and and the deposits of supervolcanic eruptions, hot springs, ore deposits, and desert landscapes. Involves camping and some hiking. Recommended: introductory geology. Enrollment limited to 25 students; preference given to freshman and sophomores; additionally graduate students in the School of Earth, Energy & Environmental Sciences.
GS	HISTORICAL GEOBIO FIELD TRIP	135A	GR	X		Field trip to a sedimentary succession of geobiological interest. Students will measure the stratigraphic section, describe fossils and trace fossils, and collect samples for geochemical analysis. Offered over spring break.
GS	SENIOR SEMINAR EARTH SCIENCES	150	UG		X	Focus is on written and oral communication in a topical context. Topics from current frontiers in earth science research and issues of concern to the public. Readings, oral presentations, written work, and peer review.
GS	INTERPRETATION OF LANDSCAPES I	311	GR	X		Focuses on interpreting various topographic attributes in terms of horizontal and vertical tectonic motions. Topics include identification, mapping, and dating of geomorphic markers, deducing tectonic motions from spatial changes in landscape steepness, understanding processes that give rise to different landscape elements, interrogating the role of climate and lithology in producing these landscape elements, and understanding relationships between tectonic motions, surface topography, and the spatial distribution of erosion. Consists of two one hour lectures per week and one laboratory section that help students gain proficiency in Quaternary mapping and interpretation of topographic metrics.
GS	CONTAMINANT HYDROGEOLOGY	225	GR	X		For earth scientists and engineers. Environmental, geologic, and water resource problems involving migration of contaminated groundwater through porous media and associated biogeochemical and fluid-rock reactions. Conceptual and quantitative treatment of advective-dispersive transport with reacting solutes. Predictive models of contaminant behavior controlled by local equilibrium and kinetics. Modern methods of contaminant transport simulation and reactive transport modeling using geochemical transport software. Some Matlab programming / program modification required. Prerequisite: Physical Hydrogeology ESS 220 / CEE 260A (Gorelick) or equivalent. Recommended: course work in environmental chemistry or geochemistry (e.g., one or more of the following: ESS 155, ESS 156/256 GS 90, GS 170/279, GS 171, CEE 177 or CEE 270).
GS	IGNEOUS PROCESSES	180	UG	X		For juniors, seniors and beginning graduate students in Earth Sciences. Structure and physical properties of magmas; use of phase equilibria and mineral barometers and thermometers to determine conditions of magmatic processes; melting and magmatic lineages as a function of tectonic setting; processes that control magma composition including fractional crystallization, partial melting, and assimilation; petrogenetic use of trace elements and isotopes. Labs emphasize identification of volcanic and plutonic rocks in thin section and interpretation of rock textures. Prerequisite 102, 103, or consent of instructor.

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GS	VOLCANOLOGY	185	UG	X		For juniors, seniors, and beginning graduate students. Eruptive processes that create volcanic deposits and landforms; shield, stratocone, and composite volcanoes, lava dome fields; calderas. Control of magma viscosity and water content on eruptive style. Fluid dynamic controls on the characteristics of lavas and pyroclastic flows. Submarine and subglacial eruptions and interaction of magma with groundwater. Rhyolitic supereruptions and flood basalts: effects on climate and atmospheric chemistry, relation to extinction events. Volcanic hazards and mitigating risk. Geophysical monitoring of active volcanoes. Volcanic-hosted geothermal systems and mineral resources. Those taking the class for 4 units will complete a 3-hour weekly lab that emphasizes recognizing types of lavas and products of explosive eruptions in hand specimen and thin section. Prerequisite: 1, for those taking the course for 3 units; 103 and 104 or equivalent for those taking the course for 4 units.
GS	VOLCANOLOGY	285A	GR	X		For juniors, seniors, and beginning graduate students. Eruptive processes that create volcanic deposits and landforms; shield, stratocone, and composite volcanoes, lava dome fields; calderas. Control of magma viscosity and water content on eruptive style. Fluid dynamic controls on the characteristics of lavas and pyroclastic flows. Submarine and subglacial eruptions and interaction of magma with groundwater. Rhyolitic supereruptions and flood basalts: effects on climate and atmospheric chemistry, relation to extinction events. Volcanic hazards and mitigating risk. Geophysical monitoring of active volcanoes. Volcanic-hosted geothermal systems and mineral resources. Those taking the class for 4 units will complete a 3-hour weekly lab that emphasizes recognizing types of lavas and products of explosive eruptions in hand specimen and thin section. Prerequisite: 1, for those taking the course for 3 units; 103 and 104 or equivalent for those taking the course for 4 units.
GS	INTRO GEOLOGY: PHYSICAL EARTH	1A	GR	X		For non-majors or prospective majors in the Earth Sciences. Lectures, hands-on laboratories, in-class activities, and one field trip. Focus is on the physical and chemical processes of heat and mass transfer within the earth and its fluid envelopes, including deep-earth, crustal, surface, and atmospheric processes. Topics include plate tectonics, the cycling and formation of different types of rocks, and how geologists use rocks to understand Earth's history. Only one of GS 1A, 1B, or 1C may be taken for credit.
GS	TOPICS IN PALEBIOLOGY	214	GR	X		For upper division undergraduates and graduate students. Topics vary each year; focus is on paleontological, sedimentological, and geochemical approaches to the history of life. Topics may include: mass extinction events; evolutionary radiations; the history of global biodiversity; links between evolutionary histories of primary producers and consumers; and the quality of the fossil record. Term paper. May be repeated for credit.
GS	MODELING OF LANDFORMS	313	GR	X		Geomorphic-transport-rule-based, as well as mass- and momentum-conservation based models to understand the evolution of Earth¿s topography. Topics include formulation of land-sculpting processes as geomorphic transport rules, coupling this mass-conservation approach with mechanical models of crustal deformation, and analysis of landscape forms in terms of events for which mass and momentum of fluid and sediment can be conserved. Both analytical, as well as numerical (finite-volume) treatments of particular problems in tectonic geomorphology will be covered. The specific problems addressed as part of the course will be tailored to those currently investigated by class participants.
GS	GEOSTATISTICS	240	GR	X		Geostatistical theory and practical methodologies for quantifying and simulating spatial and spatio-temporal patterns for the Earth Sciences. Real case development of models of spatial continuity, including variograms, Boolean models and training images. Estimation versus simulation of spatial patterns. Loss functions. Estimation by kriging, co-kriging with secondary data. Dealing with data on various scales. Unconditional and conditional Boolean simulation, sequential simulation for continuous and categorical variables. Multi-variate geostatistical simulation. Probabilistic and pattern-based approaches to multiple-point simulation. Trend, secondary variable, auxiliary variable and probability-type constraints. Quality control techniques on generated models. Workflows for practical geostatistical applications in mining, petroleum, hydrogeology, remote sensing and environmental sciences. prerequisites: Energy 160/260 or basic course in data analysis/statistics
GS	THE PETROLEUM SYSTEM	248	GR	X		How the petroleum system concept can be used to more systematically investigate how hydrocarbon fluid becomes an unconventional accumulation in a pod of active source rock and how this fluid moves from this pod to a conventional pool. How to identify, map, and name a petroleum system. The conventional and unconventional accumulation as well as the use of modeling.

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GS	ENVIRO IMPACT ENERGY SYSTEMS	46Q	GR		X	In order to reduce CO2 emissions and meet growing energy demands during the 21st Century, the world can expect to experience major shifts in the types and proportions of energy-producing systems. These decisions will depend on considerations of cost per energy unit, resource availability, and unique national policy needs. Less often considered is the environmental impact of the different energy producing systems: fossil fuels, nuclear, wind, solar, and other alternatives. One of the challenges has been not only to evaluate the environmental impact but also to develop a systematic basis for comparison of environmental impact among the energy sources. The course will consider fossil fuels (natural gas, petroleum and coal), nuclear power, wind and solar and consider the impact of resource extraction, refining and production, transmission and utilization for each energy source.
GS	RESEARCH METHODS HIST GEOBIO	235	GR	X		Introduction to research methods in historical geobiology. This research-based course will examine how life in ancient oceans, as recorded in the paleontological record, was affected by environmental change, as recorded in the geochemical record. Students will collect paleontological and geochemical data from a measured stratigraphic section in the western United States. In lab, students will learn low temperature geochemical techniques focusing on the cycling of biogeochemical elements (O, C, S, and Fe) in marine sediments throughout Earth history. This is a lab-based course complemented with lectures. Preference will be given to students able to attend a four-day field trip at the end of spring break to measure the stratigraphic section and collect samples.
GS	GEOCHEMICAL THERMODYNAMICS	171	UG	X		Introduction to the application of chemical principles and concepts to geologic systems. The chemical behavior of fluids, minerals, and gases using simple equilibrium approaches to modeling the geochemical consequences of diagenetic, hydrothermal, metamorphic, and igneous processes. Topics: reversible thermodynamics, solution chemistry, mineral-solution equilibria, reaction kinetics, and the distribution and transport of elements by geologic processes. Prerequisite:GS 102.
GS	PALEOBIOLOGY	123	UG	X		Introduction to the fossil record with emphasis on marine invertebrates. Major debates in paleontological research. The history of animal life in the oceans. Topics include the nature of the fossil record, evolutionary radiations, mass extinctions, and the relationship between biological evolution and environmental change. Fossil taxa through time. Exercises in phylogenetics, paleoecology, biostratigraphy, and statistical methods.
GS	PALEOBIOLOGY	223B	GR	X		Introduction to the fossil record with emphasis on marine invertebrates. Major debates in paleontological research. The history of animal life in the oceans. Topics include the nature of the fossil record, evolutionary radiations, mass extinctions, and the relationship between biological evolution and environmental change. Fossil taxa through time. Exercises in phylogenetics, paleoecology, biostratigraphy, and statistical methods.
GS	INTRO TO EARTH SYSTEM HISTORY	4	UG		X	Introduction to the history of the Earth, with a focus on processes that maintain or threaten habitability. Principles of stratigraphy, correlation, the geological timescale, the history of biodiversity, and the interpretation of fossils. The use of data from sedimentary geology, geochemistry, and paleontology to test theories for critical events in Earth history such as mass extinctions. One half-day field trip.
GS	MICROBIAL PHYSIOLOGY	233A	GR	X		Introduction to the physiology of microbes including cellular structure, transcription and translation, growth and metabolism, mechanisms for stress resistance and the formation of microbial communities. These topics will be covered in relation to the evolution of early life on Earth, ancient ecosystems, and the interpretation of the rock record. Recommended: introductory biology and chemistry.
GS	MICROSTRUCTURES	209	GR	X		Microstructures in metamorphic rocks reveal temperature, pressure, and rates of deformation in the crust and variations in its thermo-mechanical behavior. Topics include the rheology of rocks and minerals, strain partitioning, shear zones and brittle-ductile transition in the crust, mechanisms of foliation and lineation development, preferred crystallographic fabrics, and geochronologic methods useful for dating deformation. Labs involve microstructure analysis of suites of rocks from classic localities. 5 units for extra project.
GS	ENVIRONMENTAL PROBLEMS	43Q	GR		X	Preference to sophomores. Components of multidisciplinary environmental problems and ethical questions associated with decision making in the regulatory arena. Students lead discussions on environmental issues such as groundwater contamination from point and nonpoint sources, cumulative watershed effects related to timber and mining practices, acid rain, and subsurface disposal of nuclear waste.

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GS	CA GOLD RUSH	55Q	GR	X		Preference to sophomores. Topics include: geologic processes that led to the concentration of gold in the river gravels and rocks of the Mother Lode region of California; and environmental impact of the Gold Rush due to population increase, mining operations, and high concentrations of arsenic and mercury in sediments from hard rock mining and milling operations. Recommended: introductory geology.
GS	RESERVOIR CHARACT & FLOW MODEL	246	GR		X	Project addressing a reservoir management problem by studying an outcrop analog, constructing geostatistical reservoir models, and performing flow simulation. How to use outcrop observations in quantitative geological modeling and flow simulation. Relationships between disciplines. Weekend field trip.
GS	STRUCT GEOL & ROCK MECHANICS	215	GR	X		Quantitative field and laboratory data integrated with solutions to boundary value problems of continuum mechanics to understand tectonic processes in Earth's crust that lead to the development of geological structures including folds, faults, fractures and fabrics. Topics include: techniques and tools for structural mapping¿ differential geometry to characterize structures¿ dimensional analysis and scaling relations¿ kinematics of deformation and flow¿ traction and stress analysis, conservation of mass and momentum in a deformable continuum¿ linear elastic deformation and elastic properties¿ brittle deformation including fracture and faulting¿ model development and methodology. Data sets analyzed using MATLAB. Prerequisites: GS 1, MATH 53, MATLAB or equivalent.
GS	ANALYSIS OF LANDFORMS	312	GR	X		Quantitative methods to analyze digital topography and to interpret rates of tectonic and geomorphic processes from topographic metrics. Topics include analysis of digital topography using local and neighborhood-based methods, spectral methods, and wavelet methods. Course consists of two one hour lectures per week and one laboratory section that will help students gain proficiency in calculating topographic metrics using ArcGIS and Matlab.
GS	TOPICS IN GEOBIOLOGY	208	GR	X		Reading and discussion of classic and recent papers in the field of Geobiology. Co-evolution of Earth and life; critical intervals of environmental and biological change; geomicrobiology; paleobiology; global biogeochemical cycles; scaling of geobiological processes in space and time.
GS	TOPICS IN ORGANISMAL PALEOBIO	206	GR	X		Seminar course covering an area of structural biology, physiology, and ecology relevant to understanding the fossil record. Topic will change each time the course is offered. Examples of potential topics are biomineralization, fluid mechanics, biomechanics, taphonomy & biochemical preservation, and photosynthesis in air and water.
GS	SEDIMENTARY PETROGRAPHY	252	GR	X		Siliciclastic sediments and sedimentary rocks. Research in modern sedimentary mineralogy and petrography and the relationship between the composition and texture of sediments and their provenance, tectonic settings, and diagenetic histories. Topics vary yearly. Prerequisite: 151 or equivalent. Required lab section.
GS	STRUCTURAL GEOLOGY	111	UG	X		Techniques for mapping using GPS and differential geometry to characterize structures; dimensional analysis and scaling relations; kinematics of deformation and flow; measurement and analysis of stress; elastic deformation and properties of rock; brittle deformation including fracture and faulting; linear viscous flow including folding and magma dynamics; model development and methodology. Models of tectonic processes are constructed and solutions visualized using MATLAB. Prerequisites: GS 1, MATH 51
GS	40AR/39AR THERMOCHRONOMETRY	281	GR	X		The 40Ar/39Ar method is based upon the K-Ar decay scheme and allows high precision geochronology and thermochronology to be performed with K-bearing minerals. Provides a detailed exploration of the method including all practical considerations and laboratory procedures for standardization and instrument calibration. A laboratory component allows practical experience in making measurements and interpreting results.
GS	INTRO TO GEOCHEMISTRY	90	UG	X		The chemistry of the solid earth and its atmosphere and oceans, emphasizing the processes that control the distribution of the elements in the earth over geological time and at present, and on the conceptual and analytical tools needed to explore these questions. The basics of geochemical thermodynamics and isotope geochemistry. The formation of the elements, crust, atmosphere and oceans, global geochemical cycles, and the interaction of geochemistry, biological evolution, and climate. Recommended: introductory chemistry.
GS	INTRO TO MINERALOGY	102	UG	X		The minerals and materials that comprise the earth and their uses in modern society. How to identify, classify, and interpret rock-forming minerals. Emphasis is on information provided by common minerals about the nature of the Earth's interior and processes such as magmatism and metamorphism that operate there, as well as the major processes of weathering and erosion that link plate tectonics to earth cycles. Required lab section. Prerequisite: introductory geology course. Recommended: introductory chemistry.

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GS	SOIL PHYSICS & HYDROLOGY	130	UG	X		The occurrence, distribution, circulation, and reaction of water at the surface and within the near surface. Topics: precipitation, evapotranspiration, infiltration and vadose zone, groundwater, surface water and streamflow generation, and water balance estimates. Current and classic theory in soil physics and hydrology. Urban, rangeland, and forested environments.
GS	INTRO TO PETROLOGY	104	UG	X		The origin of igneous and metamorphic rocks as a function of geologic and plate tectonic setting. How to determine the temperature and pressure conditions of formation from mineral assemblages, textures, and compositions. Undergraduate students majoring in Geological Sciences must take the course for 4 units and complete a weekly lab section examining rocks in thin section. Prerequisite: introductory geology course, GS102; those taking the lab must also have completed GS103 or have equivalent experience with a petrographic microscope.
GS	INTRO TO PETROLOGY	204	GR	X		The origin of igneous and metamorphic rocks as a function of geologic and plate tectonic setting. How to determine the temperature and pressure conditions of formation from mineral assemblages, textures, and compositions. Undergraduate students majoring in Geological Sciences must take the course for 4 units and complete a weekly lab section examining rocks in thin section. Prerequisite: introductory geology course, GS102; those taking the lab must also have completed GS103 or have equivalent experience with a petrographic microscope.
GS	REFLECT SEISMOGRAM	223	GR	X		The structural and stratigraphic interpretation of seismic reflection data, emphasizing hydrocarbon traps in two and three dimensions on industry data, including workstation-based interpretation. Lectures only, 1 unit. Prerequisite: 222, or consent of instructor. (Geophys 183 must be taken for a minimum of 3 units to be eligible for Ways credit).
GS	TERRESTRIAL ECOSYSTEMS	128	UG		X	The what, when, and how do we know it regarding life on land¿including plants, fungi, invertebrates, and vertebrates (yes, dinosaurs)¿and how all of those components interact with each other and with changing climates, continental drift, atmospheric composition, and environmental perturbations like glaciation and mass extinction.
GS	TERRESTRIAL ECOSYSTEMS	228	GR		X	The what, when, and how do we know it regarding life on land¿including plants, fungi, invertebrates, and vertebrates (yes, dinosaurs)¿and how all of those components interact with each other and with changing climates, continental drift, atmospheric composition, and environmental perturbations like glaciation and mass extinction.
GS	STRUC GEOLOGY	110	UG	X		Theory, principles, and practical techniques to measure, describe, analyze, and interpret deformation-related structures on Earth. Collection of fault and fold data in the field followed by lab and computer analysis; interpretation of geologic maps and methods of cross-section construction; structural analysis of fault zone and metamorphic rocks; measuring deformation; regional structural styles and associated landforms related to plate tectonic convergence, rifting, and strike-slip faulting; the evolution of mountain belts and formation of sedimentary basins. Prerequisite: GS 1, calculus. Recommended: 102.
GS	HAZARDS, RISKS, RISILIENCE	118	UG	X		This class connects the science behind natural disasters with the real-world constraints of disaster management and development. In each iteration of this class we will focus on a specific, disaster-prone location as case study. By collaborating with local stakeholders we will explore how science and engineering can make a make a difference in reducing disaster risk in the future. Offered every other year.
GS	HAZARDS, RISKS, RISILIENCE	218	GR	X		This class connects the science behind natural disasters with the real-world constraints of disaster management and development. In each iteration of this class we will focus on a specific, disaster-prone location as case study. By collaborating with local stakeholders we will explore how science and engineering can make a make a difference in reducing disaster risk in the future. Offered every other year.
GS	TURBIDITE DEPOSITIONAL SYSTEMS	247	GR	X		This course considers the research that has led to current architectural models of turbidite deposits as we examine diverse data sets that allow us to test these models. Intense exploration and exploitation activities by the petroleum industry have significantly advanced understanding of turbidite systems. These activities stimulated research aimed at developing predictive models of the three common turbidite reservoir types: (1) confined channel systems, (2) weakly confined channel systems, and (3) unconfined lobe systems. Each of these reservoir types are examined in detail considering recognition criteria, internal structure, reservoir characteristics, and important issues related to reservoir potential and performance. Topics of discussion include controlling processes, hierarchy, variability, uncertainty and active areas of research.
GS	IGNEOUS PETROLOGY SEMINAR	381	GR	X		Topics vary by quarter. May be repeated for credit.

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GS	SEDIMENTARY GEOLOGY	151	UG	X		Topics: weathering, erosion and transportation, deposition, origins of sedimentary structures and textures, sediment composition, diagenesis, sedimentary facies, tectonics and sedimentation, and the characteristics of the major siliciclastic and carbonate depositional environments. Required Lab Section: methods of analysis of sediments in hand specimen and thin section. Field trips. Prerequisites: 1, 102, 103.
GS	RESEARCH IN THE FIELD	190	UG		X	Two to three-week long courses that provide students with the opportunity to collect data in the field as part of a team-based investigation of research questions or topics under the expert guidance of knowledgeable faculty and graduate students. Topics and locations vary. May be taken multiple times for credit. Prerequisites: GS 1, GS 102, GS 105.
GS	ROCKS IN THIN SECTION	103	UG	X		Use of petrographic microscope to identify minerals and common mineral associations in igneous, metamorphic, and sedimentary rocks. Crystallization histories, mineral growth and reaction relations, deformation textures in metamorphic rocks, and provenance of siliciclastic rocks. Required lab section. Prerequisite 102.
GS	LEGACY OF FUKUSHIMA DAIICHI	59N	GR		X	We will consider the case for nuclear power as an energy source through the lens of the Fukushima disaster. Specific topics will include the cause of the earthquake and tsunami, the causes for the nuclear power plant failure, the mechanisms for the release of radioactivity at the time of the accident and today, and the ongoing human impact of this tragedy. In addition to the details of the accident and the release of radioactivity, class discussions and readings will explore the health and economic impacts of nuclear power and examine how the accident has affected the future prospects of nuclear power in Japan, the U.S., and around the world.
GS	ALPINE PROJECT SEMINAR	336	GR	X		Weekly student presentations on continental collision tectonics, sedimentology, petrology, geomorphology, climate, culture, and other topics of interest. Students create a guidebook of geologic stops in advance of field trip. May be repeated for credit.
GS	SE3 FIELD TRIPS	191	UG	X		Four- to seven-day field trips to locations of geologic and environmental interest. Includes trips offered during Thanksgiving and Spring breaks. May be repeated for credit.
GS	DEPARTMENTAL SEMINAR IN GES	290	GR	X		Current research topics. Presentations by guest speakers from Stanford and elsewhere. May be repeated for credit.
GSBGEN	STRATEGIC PHILANTHROPY	381	GR	X		Appropriate for any student driven to effect positive social change from either the for-profit or nonprofit sector, Strategic Philanthropy (GSBGEN 381/ EDUC 377C) will challenge students to expand their own strategic thinking about philanthropic aspiration and action. In recent decades, philanthropy has become an industry in itself - amounting to nearly $300 billion in the year 2011. Additionally, the last decade has seen unprecedented innovation in both philanthropy and social change. This course explores the key operational and strategic distinctions between traditional philanthropic entities, such as community foundations, private foundations, and corporate foundations; and innovative models, including funding intermediaries, open-source platforms, technology-driven philanthropies, and venture philanthropy partnerships. Course work will include readings and case discussions that encourage students to analyze both domestic and global philanthropic strategies as they relate to foundation mission, grant making, evaluation, financial management, infrastructure, knowledge management, policy change, and board governance. Guest speakers will consist of high profile philanthropists, foundation presidents, social entrepreneurs and Silicon Valley business leaders creating new philanthropic models. The course will culminate in an individual project in which students will complete a business plan for a $10 million private foundation.
GSBGEN	CLEAN ENERGY PROJECT DEV & FIN	335	GR		X	This case study-oriented course will focus on the critical skills needed to evaluate, develop, finance (on a non-recourse basis), and complete standalone energy and infrastructure projects. The primary course materials will be documents from several representative projects - e.g. solar, wind, storage, carbon capture - covering key areas including market and feasibility studies, environmental permitting and regulatory decisions, financial disclosure from bank and bond transactions, and construction, input, and offtake contracts. Documents from executed transactions are highly customized. By taking a forensic approach, looking at several different deals, we can learn how project developers, financiers, and lawyers work to get deals over the finish line that meet the demands of the market, the requirements of the law, and (sometimes) broader societal goals, in particular climate change, economic competitiveness, and energy security.
GSBGEN	FOUNDATIONS IN SOCIAL IMPACT	589	GR	X		This course aims to introduce Social Impact Labs Fellows to different types of social impact organizations and nonprofit organizations, to their financial models, and to issues that arise in measuring their social impact. The course will also support development of the Social Impact Lab Fellows' projects, through peer and faculty discussion and feedback.

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GSBGEN	SUSTAINABLE ENERGY FUTURE	332	GR		X	This course examines trends and opportunities in the sustainable energy sector with a particular focus on low carbon energy. We examine these trends in the context of technological change, emerging business opportunities and the parameters set by public policy. nSpecific topics to be examined include: (i) the impact of regulatory policies and tax subsidies on the energy mix (ii) the growing competitiveness of renewable energy, in particular solar PV and wind, (iii) sustainable transportation (iv) adaptation by fossil fuel energy sources, (v) innovative financing mechanisms for energy projects, (vi) the venture capital perspective (vii) the changing role of utilities in the energy landscape.
GSBGEN	SOCIAL IMPACT	322	GR	X		This course focuses on strategy and actionable measurement in government, non-profit organizations, market-based social enterprises, philanthropy, and impact investing. "Actionable" means that measurement is used by managers, investors, and other stakeholders in improving outcomes. nn nThe course explores the intersection of several ideas that seem to be in some tension with each other. (1) "In preparing for battle I have always found that plans are useless, but planning is indispensable." (Dwight D. Eisenhower), (2) You can't manage what you can't measure, (3) Measurement is expensive and its results are often ignored, (4) "Not everything that counts can be counted and not everything that can be counted counts" (apocryphally attributed to Einstein), (5) "The more any quantitative social indicator is used for decision making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor." (Campbell's Law). nnnSpecifically, the course will include: strategic planning, logic models, theories of change, monitoring, and evaluation; measuring the social impact of governments, non-governmental organizations, and market-based social enterprises, and asking how philanthropists and impact investors can assess their own impact; impact investing, performance contracting, and social impact bonds; and techniques for improving the behavior and accountability of individuals and organizations. These issues will be addressed mainly through business school case studies, which place the students in the position of CEOs, managers, and investors called upon to make major decisions. nnnWARNING: The course has a fair amount of reading - not more than is common in undergraduate and graduate courses, but more than is typical for MBA courses in the GSB.
GSBGEN	ENERGY MARKETS AND POLICY	336	GR		X	Transforming the global energy system to reduce climate change impacts, ensure security of supply, and foster economic development of the world's poorest regions depends on the ability of commercial players to deliver the needed energy at an affordable price at scale. Technological innovation is a necessary but not sufficient condition for this to occur. The complex institutional frameworks that regulate energy markets in the United States and around the world will play a major role in determining the financial viability of firms in the energy sector. In this course we survey the economic, regulatory and technological constraints facing energy enterprises of all types and consider what kinds of business models work in each setting. We study in detail how markets function for carbon (assessing the advantages and disadvantages of different policy tools and considering in particular California?s implementation of A.B. 32); electricity markets (with a focus on understanding how both retail and wholesale electricity prices are determined and how market participants hedge short-term price risk); renewable energy technologies (focusing on ways to manage intermittency and on how renewable energy businesses respond to government incentives); nuclear power (as a case study of how the regulatory process affects investment decisions); oil and natural gas (treating both conventional and unconventional resources and emphasizing the key role of risk management in an industry characterized by uncertainty and high capital requirements); transportation fuels (discussing biofuels incentives, fuel efficiency standards, and other policy tools to lower carbon intensity in the transportation sector); and energy for low-income populations, for which affordability and distribution pose special challenges. The objective of the course is to provide a robust intellectual framework for analyzing how a business can most constructively participate in any sector like energy that is heavily affected by government policy.

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GSBGEN	VENTURES IN DEV ECONOMIES	314	GR	X		This course addresses the distinctive challenges and opportunities of launching high-potential new ventures in developing economies. Developing economies are attractive targets for entrepreneurs because many are just starting to move up the growth curve, and they offer low-cost operating environments that can be great development labs for potentially disruptive innovations. They increase in attractiveness when their political institutions stabilize and they become more market-friendly. At the same time, developing economies pose serious challenges. Pioneering entrepreneurs take on significant risks to gain early mover advantages. Specifically, entrepreneurs will not be able to count on the same kind of supportive operating environments that we take for granted in the developed world. They often face cumbersome permit and licensing processes, poorly developed financial and labor markets, problematic import and export procedures, unreliable local supply chains, weak infrastructure, corruption, currency risks, limited investment capital, lack of financial exits and more. This course is designed to help would-be entrepreneurs - both founders and members of entrepreneurial teams - better understand and prepare for these issues as they pursue the opportunities and address the challenges to start, grow, and harvest their ventures in these environments.nnGSB314 combines a seminar/discussion format (Tuesdays) with a team-based project (Thursdays). For the Tuesday sessions, students will read about and discuss the key challenges described above and potential solutions. Guests will describe their own startup and investing experiences in developing economies and answer questions. A framework based on the recently published World Economic Forum (WEF) report on "Entrepreneurial Ecosystems Around the Globe and Company Growth Dynamics" will be used to structure the course. Each student will prepare a short paper on a topic of interest from this portion of the course.nnThe Thursday sessions is a team-based exercise for students who either have a specific idea or want to join a team of classmates to pursue more deeply an understanding of the team's country of focus and an initial investigation of the idea's viability. Students must come in willing to be team players and do the work necessary to complete this exercise over the full quarter. Each team member's contributions will be assessed by fellow teammates. Teams will be formed before the start of class or on the first day at the latest. The team will describe, in a final presentation, the challenges and opportunities in their country using the WEF framework. The final presentation will also include the team's thoughts on the viability of their proposed venture and how it capitalizes on their country's assets and addresses its challenges. A detailed business plan is not required; however, specific recommendations and plans for next steps that would be carried out during a 3 to 6 month field and market research study in the country will be part of the final presentation.nnNote: Students who only want to participate in the seminar/discussion portion of the class and not do a team-based project (see details below) may enroll in GSB514 for 2 units.
HISTORY	HISTORY OF AMERICAN LAW	152	UG	X		(Same as LAW 318.) Modern history of American law, legal thought, legal institutions and the legal profession. Topics include law and regulation of corporate organizations and labor relations in the age of enterprise, law of race relations in the South and North, development of classical legalism, critiques of classical legalism, modern administrative state, organized legal profession, New Deal legal thought and legislation, legal order of the 50s, expansion of enterprise liability, civil rights movements from 1940, rights revolution of the Warren Court and Great Society.
HISTORY	HISTORY OF CALIFORNIA INDIANS	250A	GR	X		Demographic, political, and economic history of California Indians, 1700s-1950s. Processes and events leading to the destruction of California tribes, and their effects on the groups who survived. Geographic and cultural diversity. Spanish, Mexican, and Anglo-American periods. The mission system.
HISTORY	SPEED/POWER 20TH CENTURY	237K	GR	X		Europeans living in the 20th century witnessed an unprecedented (and, to many observers, frightening) acceleration in the pace of everyday life, wrought by the introduction of a host of new travel technologies. Focusing on the metropolises of Europe, this seminar will explore the various ways that trains, planes, and automobiles have shaped modern urban life. We'll also look at how 20th-century artists and writers have treated the interrelated themes of speed and power in their work.
HISTORY	SPEED/POWER 20TH CENTURY	337K	GR	X		Europeans living in the 20th century witnessed an unprecedented (and, to many observers, frightening) acceleration in the pace of everyday life, wrought by the introduction of a host of new travel technologies. Focusing on the metropolises of Europe, this seminar will explore the various ways that trains, planes, and automobiles have shaped modern urban life. We'll also look at how 20th-century artists and writers have treated the interrelated themes of speed and power in their work.

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HISTORY	WATER IN WORLD HISTORY	203J	GR		X	Examines the human relationship to water in various geographical, ecological, technological, cultural and sociopolitical settings, primarily during, but not limited to, the 19th and 20th centuries. Develops a broad historical understanding of the dwindling supply, deteriorating quality and inequitable distribution of freshwater today.
HISTORY	WATER IN WORLD HISTORY	303J	GR		X	Examines the human relationship to water in various geographical, ecological, technological, cultural and sociopolitical settings, primarily during, but not limited to, the 19th and 20th centuries. Develops a broad historical understanding of the dwindling supply, deteriorating quality and inequitable distribution of freshwater today.
HISTORY	PEOPLE, PLANTS, AND MEDICINE	343C	GR	X		Explores the global exchange of knowledge, technologies, plants, peoples, disease, and medicines. Considers primarily Africans, Amerindians, and Europeans in the eighteenth-century West but also takes examples from other knowledge traditions. Readings treat science and medicine in relation to voyaging, colonialism, slavery, racism, plants, and environmental exchange. Colonial sciences and medicines were important militarily and strategically for positioning emerging nation states in global struggles for land and resources.
HISTORY	WORDS & THINGS IN HISTORY	303F	GR	X		How have scholars used ancient texts and objects since the revival of the classical tradition? How did antiquarians study and depict objects and relate them to texts and reconstructions of the past? What changed and what stayed the same as humanist scholarship gave way to professional archaeologists, historians, and philologists? Focus is on key works in the history of classics, such as Erasmus and Winckelmann, in their scholarly, cultural, and political contexts, and recent critical trends in intellectual history and the history of disciplines.
HISTORY	HUMAN SOCIETY & ENVIRO CHANGE	103D	GR		X	Interdisciplinary approaches to understanding human-environment interactions with a focus on economics, policy, culture, history, and the role of the state. Prerequisite: ECON 1.
HISTORY	COMMODITIES AND CONSUMPTION	202B	GR	X		Many of the basic commodities that we consider staples of everyday life became part of an increasingly interconnected world of trade, goods, and consumption between 1200 and 1800. This seminar offers an introduction to the material culture of the late medieval and early modern world, with an emphasis on the role of European trade and empires in these developments. We will examine recent work on the circulation, use, and consumption of things, starting with the age of the medieval merchant, and followed by the era of the Columbian exchange in the Americas that was also the world of the Renaissance collector, the Ottoman patron, and the Ming connoisseur. This seminar will explore the material horizons of an increasingly interconnected world, with the rise of the Dutch East India Company and other trading societies, and the emergence of the Atlantic economy. It concludes by exploring classic debates about the "birth" of consumer society in the eighteenth century. How did the meaning of things and people's relationships to them change over these centuries? What can we learn about the past by studying things?
HISTORY	COMMODITIES AND CONSUMPTION	302B	GR	X		Many of the basic commodities that we consider staples of everyday life became part of an increasingly interconnected world of trade, goods, and consumption between 1200 and 1800. This seminar offers an introduction to the material culture of the late medieval and early modern world, with an emphasis on the role of European trade and empires in these developments. We will examine recent work on the circulation, use, and consumption of things, starting with the age of the medieval merchant, and followed by the era of the Columbian exchange in the Americas that was also the world of the Renaissance collector, the Ottoman patron, and the Ming connoisseur. This seminar will explore the material horizons of an increasingly interconnected world, with the rise of the Dutch East India Company and other trading societies, and the emergence of the Atlantic economy. It concludes by exploring classic debates about the "birth" of consumer society in the eighteenth century. How did the meaning of things and people's relationships to them change over these centuries? What can we learn about the past by studying things?
HISTORY	FAMINE IN THE MODERN WORLD	326E	GR	X		Open to medical students, graduate students, and undergraduate students. Examines the major famines of modern history, the controversies surrounding them, and the reasons that famine persists in our increasingly globalized world. Focus is on the relative importance of natural, economic, and political factors as causes of famine in the modern world. Case studies include the Great Irish Famine of the 1840s; the Bengal famine of 1943-44; the Soviet famines of 1921-22 and 1932-33; China's Great Famine of 1959-61; the Ethiopian famines of the 1970s and 80s, and the Somalia famines of the 1990s and of 2011.

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HISTORY	INTERNATIONAL FIELD WORK	299X	GR	X		Open to students in all classes, those planning internships abroad and those planning research, from juniors with honors theses and sophomores with Chappell Lougee grants to freshmen thinking ahead. Introduces resources on campus for planning international research and service. Raises issues that need to be considered in advance of going abroad: ethical concerns, Human Subjects Protocol, networking, personal safety and gender issues, confronting cultural differences. Exposes students to research methods: case studies, interviewing, working in foreign libraries and archives.
HISTORY	HISTORY OF IGNORANCE	203C	GR	X		Scholars pay a lot of attention to knowledge--how it arises and impacts society--but much less attention has been given to ignorance, even though its impacts are equally profound. Here we explore the political history of ignorance, through case studies including: corporate denials of harms from particular products (tobacco, asbestos), climate change denialism, and creationist rejections of Darwinian evolution. Students will be expected to produce a research paper tracing the origins and impact of a particular form of ignorance.
HISTORY	THE AMERICAN WEST	151	UG	X		The American West is characterized by frontier mythology, vast distances, marked aridity, and unique political and economic characteristics. This course integrates several disciplinary perspectives into a comprehensive examination of Western North America: its history, physical geography, climate, literature, art, film, institutions, politics, demography, economy, and continuing policy challenges. Students examine themes fundamental to understanding the region: time, space, water, peoples, and boom and bust cycles.
HISTORY	TECH/MODERN AMERICAN CULTURE	341K	GR	X		This class displays the significance of technology in American culture by examining two principal technologies and their implications for politics, business, leisure, and social interaction, as well as for other technological systems. As starting points, we consider how computing systems and atomic weapons emerged at particular moments in history, including how their developments were intimately connected. This contextual approach leads us to the related study of topics within the histories of space travel, nuclear power, amateur electronics, and the Web.
HISTORY	CURRENT GLOBAL EVENTS	3	UG	X		This one-unit lecture course aims to provide the historical and geographical context necessary for understanding the most important global issues of the day. Weekly lectures will explore two or more major issues in some detail, illustrating them with maps, timelines, photographs, and other images. Topics are not planned in advance, but will instead reflect stories currently in the news.
HISTORY	CURRENT GLOBAL EVENTS	13	UG	X		This three-unit course is designed to complement History 3, which aims to provide the historical and geographical context necessary for understanding important global issues of the day. Students taking the three-unit course will, in addition to attending the weekly lectures, participate in a weekly seminar in which the same topics addressed in lecture will be examined in greater depth. Students will also be required to write a research paper on a generally neglected news topic of their own choosing.
HISTORY	PEOPLE, PLANTS, AND MEDICINE	243C	GR	X		Explores the global exchange of knowledge, technologies, plants, peoples, disease, and medicines. Considers primarily Africans, Amerindians, and Europeans in the eighteenth-century West but also takes examples from other knowledge traditions. Readings treat science and medicine in relation to voyaging, colonialism, slavery, racism, plants, and environmental exchange. Colonial sciences and medicines were important militarily and strategically for positioning emerging nation states in global struggles for land and resources.
HUMBIO	HLTHY SUSTAINABLE FOOD SYSTEMS	113S	GR		X	(HumBio students must enroll in HumBio 113S) Discussion-based seminar. Focus on problems with and systems-based solutions to food system issues. Four particular settings are addressed: University, worksite, hospital, and school food. Traditional vs. disruptive food system models compared and contrasted. The goal is to determine how best to maximize sustainability across several dimensions, including health, economics, and the environment. Underlying class themes include social justice and the potential for changing social norms around food production and consumption.
HUMBIO	PUBLIC SERVICE INTERNSHIP PREP	9	UG	X		Are you prepared for your internship this summer? This workshop series will help you make the most of your internship experience by setting learning goals in advance; negotiating and communicating clear roles and expectations; preparing for a professional role in a non-profit, government, or community setting; and reflecting with successful interns and community partners on how to prepare sufficiently ahead of time. You will read, discuss, and hear from guest speakers, as well as develop a learning plan specific to your summer or academic year internship placement. This course is primarily designed for students who have already identified an internship for summer or a later quarter. You are welcome to attend any and all workshops, but must attend the entire series and do the assignments for 1 unit of credit.

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HUMBIO	THEORY OF ECO & ENVIRO ANTHRO	118	UG	X		Dynamics of culturally inherited human behavior and its relationship to social and physical environments. Topics include a history of ecological approaches in anthropology, subsistence ecology, sharing, risk management, territoriality, warfare, and resource conservation and management. Case studies from Australia, Melanesia, Africa, and S. America.
HUMBIO	ETHICS/POLITICS PUBLIC SERVICE	178	UG	X		Ethical and political questions in public service work, including volunteering, service learning, humanitarian assistance, and public service professions such as medicine and teaching. Motives and outcomes in service work. Connections between service work and justice. Is mandatory service an oxymoron? History of public service in the U.S. Issues in crosscultural service work. Integration with the Haas Center for Public Service to connect service activities and public service aspirations with academic experiences at Stanford.
HUMBIO	CONSERVATION BIOLOGY: LATIN AM	112	UG		X	Principles and application of the science of preserving biological diversity. Conceptually, this course is designed to explore 4 major components relevant to the conservation of biodiversity, as exemplified by the Latin American region. The conceptual frameworks and principles, however, should be generally applicable, and provide insights for all regions of the world, including those of lesser biodiversity. Satisfies Central Menu Area 4 for Bio majors. Prerequisite: BIO 101, orBIO 43 or HUMBIO 2A with consent of instructor. Graduate level students will be expected to conduct a literature research exercise leading to a written paper, addressing a topic of their choosing, derived from any of the themes discussed in class.
HUMBIO	HUMAN PHYSIOLOGY LABORATORY	136	UG	X		This laboratory course is active and inquiry based. Aspects of exercise and temperature are explored; however, the specific questions the class tackles differ each quarter. Samples of past questions: Does lactic acid accumulation correlate with exercise fatigue at different exercise and body temperatures? Does palm cooling during exercise mitigate the effect of body temperature on fatigue with or without evaporative cooling? Students participate both as experimenters and as subjects of the experiments in two-person teams. Participants must be in good physical condition, though not necessarily athletes, and must be willing to participate in strenuous exercise routines under adverse environmental conditions. Varsity athletes concurrently participating in a spring sport must consult the instructor before applying. Discussion sessions include student presentations of journal articles, data analyses, and feedback on individual WIM research proposals. By application only, see sites.stanford.edu/bio107humbio136 for the application form. Prerequisite: Bio 42 or HumBio 4A. Satisfies WIM for Biology.
HUMBIO	HUMAN-PLANT CONNECTION	113	UG		X	The intertwined biologies of humans and plants, particularly the ways in which people and plants have imposed selection pressures and ecological change on one another. Topics include evolution and basic plant structure; plant domestication; effects of agriculture on human health and physiology; plants in traditional and contemporary diets; and human influences on plant biology through genetic manipulation and environmental change. Class meetings center on journal articles. Final project includes written and multimedia presentations.
HUMBIO	BEYOND HEALTH CARE	122	UG	X		Available evidence at the national and cross-country level linking social welfare interventions and health outcomes. If and how non-health programs and policies could have an impact on positive health outcomes. Evaluation of social programs and policies that buffer the negative health impact of economic instability and unemployment among adult workers and their children. Examination of safety nets, including public health insurance, income maintenance programs, and disability insurance.
HUMBIO	CONTROVERSIES IN WOMEN'S HLTH	125	UG	X		Interdisciplinary. Focus is primarily on the U.S., with selected global women's health topics. Topics include: leading causes of morbidity and mortality across the life course; reproductive (e.g. gynecologic & obstetric) health issues; sexual function; importance of lifestyle (e.g. diet, exercise, weight control), including eating disorders; mental health; sexual and relationship abuse; issues for special populations. In-class Student Debates on key controversies in women's health. Guest lecturers. HUMBIO students must enroll in HumBio 125 for 3 units. PhD minor in FGSS, enroll in FEMGEN 256 for 2 - 3 units and for a letter grade. Med students enroll in OBGYN 256 for 2 units.

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HUMBIO	CHRONIC DISEASE PREVENTION	126	UG	X		(HUMBIO students must enroll in HumBio 126.) Disease prevention and health promotion topics pertinent to different stages of the life span emphasizing healthy lifestyle and reducing risk factors in both individuals and communities. Focus is on scientific investigation, the application of behavioral science to risk reduction strategies, and the importance of health promotion as a social and economic imperative. Topics include: epidemiology of chronic diseases; social determinants of health, behavior change; obesity, nutrition, and stress; children, young adult, mid-life and aging health issues; health care delivery and public health system; workplace wellness programs; and other additional issues.
HUMBIO	COMMUNITY HEALTH PSYCH	128	UG	X		Social ecological perspective on health emphasizing how individual health behavior is shaped by social forces. Topics include: biobehavioral factors in health; health behavior change; community health promotion; and psychological aspects of illness, patient care, and chronic disease management.
HUMBIO	INTL WOMEN'S HEALTH	129	UG	X		Women's lives, from childhood through adolescence, reproductive years, and aging. Economic, social, and human rights factors, and the importance of women's capacities to have good health and manage their lives in the face of societal pressures and obstacles. Emphasis is on life or death issues of women's health that depend on women's capacity to exercise their human rghts including maternal mortality, violence, HIV/AIDS, reproductive health, and sex trafficking. Organizations addressing these issues. A requirement of this class is participation in public blogs.
HUMBIO	HUMAN NUTRITION	130	UG	X		he study of food, and the nutrients and substances therein. Their action, interaction, and balance in relation to health and disease. Emphasis is on the biological, chemical, and physiological processes by which humans ingest, digest, absorb, transport, utilize, and excrete food. Dietary composition and individual choices are discussed in relationship to the food supply, and to population and cultural, race, ethnic, religious, and social economic diversity. The relationships between nutrition and disease; ethnic diets; vegetarianism; nutritional deficiencies; nutritional supplementation; phytochemicals.
HUMBIO	PARASITES/PESTILENCE	153	UG	X		Parasitic and other pestilence of public health importance. Pathogenesis, clinical syndromes, complex life cycles, and the interplay among environment, vectors, hosts, and reservoirs in historical context. Public health policy initiatives aimed at halting disease transmission. World Health Organization tropical disease targets including river blindness, sleeping sickness, leishmaniasis, schistosomiasis, mycobacterial disease (tuberculosis and leprosy), malaria, toxoplasmosis, dracunculiais, and intestinal helminthes. Guest lecturers with expertise in disease control.
HUMBIO	GENES/ENVIRON IN DISEASE CAUSA	159	UG	X		The historical, contemporary, and future research and practice among genetics, epidemiology, clinical medicine, and public health as a source of insight for medicine and public health. Genetic and environmental contributions to multifactorial diseases; multidisciplinary approach to enhancing detection and diagnosis. The impact of the Human Genome Project on analysis of cardiovascular and neurological diseases, and cancer. Ethical and social issues in the use of genetic information.
HUMBIO	GENETICS/EVOLUTION/ECOLOGY	2A	GR	X		Introduction to the principles of classical and modern genetics, evolutionary theory, and population biology. Topics: micro- and macro-evolution, population and molecular genetics, biodiversity, and ecology, emphasizing the genetics and ecology of the evolutionary process and applications to human populations. HUMBIO 2A and 2B must be taken concurrently.
HUMBIO	ENVIRONMENTAL/HEALTH POLICY	4B	GR	X		Connections among the life sciences, social sciences, public health, and public policy. The economic, social, and institutional factors that underlie environmental degradation, the incidence of disease, and inequalities in health status and access to health care. Public policies to address these problems. Topics include pollution regulation, climate change policy, biodiversity protection, health care reform, health disparities, and women's health policy. HUMBIO 4A and 4B must be taken concurrently.
HUMBIO	GLOBAL PUBLIC HEALTH	129S	GR	X		The class is an introduction to the fields of international public health and global medicine. It focuses on resource poor areas of the world and explores major global health problems and their relation to policy, economic development and human rights. The course is intended for students interested in global health, development studies, or international relations, and provides opportunities for in-depth discussion and interaction with experts in the field.

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INDE	POPULAR & CLINICAL NUTRITION	225	GR	X		Designed for medical students and other health care professionals. Lunchtime lectures review the epidemiological and clinical research related to eating patterns and misconceptions of the public, the mechanisms of pharmacological effects of food, and related topics common to patient nutritional concerns. Topics include fad diets, the impact of dietary addiction, longevity associated with caloric restriction, toxins in foods and the action of phytonutirents. Epidemiological, clinical, and biochemical studies are reviewed in the discussion of these and other topics.
INDE	WILDNESS LDSHP & MENTORSHP	235	GR	X		For MD/Master of Medicine wilderness pre-orientation trip (SWEAT) leaders. Training to engage with and prepare incoming first-year medical students for the rigors of medical school. Topics include: fundamentals of wilderness survival, wilderness equipment use, wilderness first aid, camping, outdoor leadership, mentorship, team building, improvisation, risk management, cultural competency, professionalism as a physician, reflection and resiliency, first-year curriculum, stress management and coping. Guest lectures from Stanford faculty, emergency medicine physicians, National Outdoor Leadership School wilderness instructors, learning strategy specialists, and mentorship development specialists.
INTNLREL	INTL ENVIRONMENTAL LAW	135A	GR		X	This course addresses the nature, content, and structure of international environmental law. We will discuss its sources (formal and informal) and general principles, along with the emerging principles (sustainable development, precautionary principle, etc.) We will evaluate the role of international and non-governmental organizations, as well as examine the negotiation, conclusion, and implementation of international environmental agreements. Problem areas to be examined include global warming, stratospheric ozone depletion, exports of hazardous substances, transboundary pollution, trade and environment, and development and environment. RECOMMENDED PREREQ: students have completedINTNLREL 1 and/or INTNLREL 140A
INTNLREL	INTRODUCTION TO GLOBAL JUSTICE	136R	GR	X		This course provides an overview of core ethical problems in international politics, with special emphasis on the question of what demands justice imposes on institutions and agents acting in a global context. The course is divided into three sections. The first investigates the content of global justice, and comprises of readings from contemporary political theorists and philosophers who write within the liberal contractualist, utilitarian, cosmopolitan, and nationalist traditions. The second part of the course looks at the obligations which global justice generates in relation to five issues of international concern ¿ global poverty, climate change, immigration, warfare, and well-being of women. The final section of the course asks whether a democratic international order is necessary for global justice to be realized.
INTNLREL	THE INTERNATIONAL SYSTEM	102	UG	X		After defining the characteristics of the international system at the beginning of the twentieth century, this course reviews the primary developments in its functioning in the century that followed. Topics include the major wars and peace settlements; the emergence of Nazism and Communism; the development of the Cold War and nuclear weapons; the rise of China, India, and the EU; and the impact of Islamic terrorism. The role of international institutions and international society will also be a focus as will the challenge of environment, health, poverty, and climate issues to the functioning of the system.
IPS	CHINA URBANIZATION SEMINAR	274	GR		X	Comparative approach to sustainable cities, with focus on international practices and applicability to China. Tradeoffs regarding land use, infrastructure, energy and water, and the need to balance economic vitality, environmental quality, cultural heritage, and social equity. Student teams collaborate with Chinese faculty and students partners to support urban sustainability projects. Limited enrollment via application; see internationalurbanization.org for details. Prerequisites: consent of the instructor(s).
IPS	ISSUES IN INT'L ECONOMICS	203	GR	X		Topics in international trade and international trade policy: trade, growth and poverty, the World Trade Organization (WTO), regionalism versus multilateralism, the political economy of trade policy, trade and labor, trade and the environment, and trade policies for developing economies.
IPS	INT'L HUMANITARIAN ACTION	210	GR	X		The relationship between humanitarianism and politics in international responses to civil conflicts and forced displacement. Focus is on policy dilemmas and choices, and the consequences of action or inaction. Case studies include northern Iraq (Kurdistan), Bosnia, Rwanda, Kosovo, and Darfur. In addition to class attendance, each student will meet with the instructor for multiple one-on-one sessions during the quarter.
IPS	TRANSITION WAR TO PEACE	211	GR	X		How to find sustainable solutions to intractable internal conflicts that lead to peace settlements. How institutions such as the UN, regional organizations, and international financial agencies attempt to support a peace process. Case studies include Bosnia, East Timor, Kosovo, Burundi, Liberia, and Afghanistan. In addition to class attendance, each student will meet with the instructor for multiple one-on-one sessions during the quarter.

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IPS	GEOPOLITICS OF ENERGY	270	GR		X	The global energy landscape is undergoing seismic shifts with game-changing economic, political and environmental ramifications. Technological breakthroughs are expanding the realms of production, reshuffling the competition among different sources of energy and altering the relative balance of power between energy exporters and importers. The US shale oil and gas bonanza is replacing worries about foreign oil dependence with an exuberance about the domestic resurgence of energy-intensive sectors. China¿s roaring appetite for energy imports propels its national oil companies to global prominence. Middle Eastern nations that used to reap power from oil wealth are bracing for a struggle for political relevance. Many African energy exporters are adopting promising strategies to break with a history dominated by the ¿resource curse¿.nThis course provides students with the knowledge, skill set and professional network to analyze how the present and past upheavals in oil and gas markets affect energy exporters and importers, their policymaking, and their relative power. Students will gain a truly global perspective thanks to a series of exciting international guest speakers and the opportunity to have an impact by working on a burning issue for a real world client. Satisfies the IPS Policy Writing Requirement.
ITALIAN	POLITICS OF DISASTERS	228	GR	X		How STS and the Humanities can together help think out the looming catastrophes that put the future of humankind in jeopardy.
LATINAM	SPANISH IN SCIENCE	207	GR	X		For graduate and undergraduate students interested in the natural sciences and the Spanish language. Students will acquire the ability to communicate in Spanish using scientific language and will enhance their ability to read scientific literature written in Spanish. Emphasis on the development of science in Spanish-speaking countries or regions. Course is conducted in Spanish and intended for students pursuing degrees in the sciences, particularly disciplines such as ecology, environmental science, sustainability, resource management, anthropology, and archeology.
LAW	PHILANTHROPY & CIVIL SOCIETY	781	GR	X		Associated with the Center for Philanthropy and Civil Society (PACS). Year-long workshop for doctoral students and advanced undergraduates writing senior theses on the nature of civil society or philanthropy. Focus is on pursuit of progressive research and writing contributing to the current scholarly knowledge of the nonprofit sector and philanthropy. Accomplished in a large part through peer review. Readings include recent scholarship in aforementioned fields. May be repeated for credit for a maximum of 3 units. Cross-listed with Education (EDUC 374), Political Science (POLISCI 334) and Sociology (SOC 374).

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LAW	CALIFORNIA DROUGHT	414X	GR		X	Students in this Policy Lab practicum will work with the Public Policy Institute of California (PPIC) as part of a broad study of lessons learned from the current California drought. The overall goal of the study is to assess the functioning of various aspects of California's water management system during the current drought and to develop tools and policy recommendations to help the state survive future droughts with fewer economic and environmental impacts. California is currently in its fourth year of drought. The drought's duration, along with increased temperatures due to climate change, have combined to make it perhaps the most intense drought since we have begun keeping records. These conditions have placed enormous strains on water management systems at all levels of government. The state's water rights system (among other laws) has had to cope with unprecedented hydrologic conditions, conflicting demands for water, and data gaps. As a result, state and federal water management agencies have faced unprecedented decisions along with untested rules for making those decisions. The overall PPIC study, including the work of the practicum, will seek to evaluate the performance of the state's institutions, management systems, infrastructure, and laws during these extreme conditions in order to make recommendations to better prepare California for future droughts. The practicum will focus primarily on the California water rights system and its interaction with other laws related to water quality and aquatic species protection in the context of the ongoing drought. Issues for research include case studies of the effectiveness of different legal mechanisms for protecting streamflows and aquatic species from conditions related to extreme drought. They may also include an analysis of temporary urgency change petitions (a mechanism to temporarily suspend water quality based limitations on water rights) during the drought, including their rationale and their effects on water quality. The practicum will contribute some written analysis a series of reports to be produced by PPIC. Students will also participate in planning and holding a workshop of experts that will help shape the project and its outputs. The practicum will accept up to eight students. Elements used in grading: Written Assignments. NOTE: Students may not count more than a combined total of eight units of directed research projects and policy lab practica toward graduation unless the additional counted units are approved in advance by the Petitions Committee. Such approval will be granted only for good cause shown. Even in the case of a successful petition for additional units, a student cannot receive a letter grade for more than eight units of independent research (Policy Lab practicum, Directed Research, Senior Thesis, and/or Research Track). Any units taken in excess of eight will be graded on a mandatory pass basis. For detailed information, see "Directed Research/Policy Labs" in the SLS Student Handbook. CONSENT APPLICATION: To apply for this course, students must complete and submit a Consent Application Form available on the SLS website (Click Courses at the bottom of the homepage and then click Consent of Instructor Forms). See Consent Application Form for instructions and submission deadline.
LAW	ENERGY LAW	455	GR		X	The supply of a reliable, low-cost, clean energy supply for the United States is a key determinant of current and future prosperity. Perhaps as a result, electricity suppliers are among the most heavily regulated of large firms. In this course, students will acquire a basic understanding of the electricity supply system, of rate based regulation of electric utilities, and of deregulated wholesale electricity markets. We will also interrogate the role of siting and cost recovery in development of a workable transmission grid. The course will then focus on various attempts at reform of both rate-regulated and wholesale market-based structures. In particular, we will examine various attempts to strengthen incentives for utility investment in energy efficiency. Finally, students will be familiarized with various approaches to subsidization of renewable energy.nnThroughout, the course will focus on the sometime cooperative, sometimes competing, but ever evolving federal and state roles in regulating the supply of electricity.
LAW	CLEAN ENERGY PROJECT DEV & FIN	774	GR		X	This case study-oriented course will focus on the critical skills needed to evaluate, develop, finance (on a non-recourse basis), and complete standalone utility-scale energy and infrastructure projects. The primary course materials will be documents from several representative projects - e.g. solar, wind, storage, and carbon capture - covering key areas including market and feasibility studies, environmental permitting and regulatory decisions, financial disclosure from bank and bond transactions, and construction, input, and offtake contracts. Documents from executed transactions are highly customized. By taking a forensic and cross-disciplinary approach, looking at several different deals, we can learn how project developers, financiers, and lawyers work to get deals over the finish line that meet the demands of the market, the requirements of the law, and (sometimes) broader societal goals, in particular climate change, economic competitiveness, and energy security. Elements used in grading: Class Participation (35 %), Lecture-based Assignment (15 %), Group Project (50 %). Absences affect grade. Also open to engineering graduate students. Cross-listed with Graduate School of Business (GSBGEN 335).

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LAW	ALW: TECH TRANSACTIONS	730	GR	X		This course covers the foundations of drafting contracts in a modern commercial setting, primarily through weekly hands-on writing exercises that illustrate business problems commonly found in today's technology transactions law practice. Topics to be addressed will include basic contract anatomy, common clause ambiguities, structuring for readable "flow", and drafting-for-negotiation techniques. Final examination will involve crafting a full-length technology license agreement from a rough term sheet that appears to have been pecked out on some sort of mobile device. No prior business law coursework, intellectual property background, or martial arts proficiency required. Elements used in grading: Class Participation, Attendance, Written Assignments, Final Exam.
LAW	INTL ENVIRONMENTAL LAW	605	GR		X	This course examines the legal, scientific, political, economic, and organizational issues associated with the creation of international environmental regimes. The principal emphasis will be on the issue of climate change, with a focus on the current regime(s) and the lead-up to the Paris Conference of the Parties to the UN Framework Convention. The course will also address the Montreal Protocol for Ozone Depleting Substances, the International Convention for Regulation of Whaling, and other multilateral agreements. The course examines the choice of legal instrument, as well as the implementation, evolution, and ultimate effectiveness of environmental regimes. Finally, close attention is paid to equity and development issues that are critical in bridging north-south divides on international environmental issues. Substantial student participation is expected and class participation will constitute twenty percent (20%) of the overall grade for the course. Elements used in grading: Class participation and final paper.
LAW	WATER LAW AND POLICY	437	GR		X	This course will study how society allocates and protects its most crucial natural resource -- water. The emphasis will be on current legal and policy debates, although we will also examine the history of water development and politics. Although the course will focus on United States law and policy, insights from the course are applicable to water regimes throughout the world, and we will occasionally look at law and policy elsewhere in the world for comparison. Among the many issues that we will consider are: how to allocate water during periods of scarcity; alternative means of responding to the world's growing demands for water (including active conservation); the appropriate role for the market and private companies in meeting society's water needs; protection of threatened groundwater resources; environmental limits on water development (including the U.S. Endangered Species Act and the "public trust" doctrine); constitutional issues in water governance; Indian water rights; protection of water quality; challenges to substantively reforming existing water law; and interstate and international disputes over water. Students will be expected to participate actively in classroom discussions. Elements Used in Grading: Class participation, attendance and final exam.
LAW	CHINA LAW AND BUSINESS	245	GR	X		This introductory course provides an overview of the Chinese legal system and business environment and examines Chinese legal rules and principles in selected business-related areas. These areas include intellectual property, dispute resolution, foreign investment, mergers and acquisitions, antimonopoly law, and environment. Through active class participation and analysis of business case studies, students will learn both the law in the books and the law in action in China, as well as strategies that businesses could use to overcome limitations in the Chinese legal system. Leaders from the legal and business communities will be invited to share their experiences and insights.

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LAW	INJURIES	681U	GR	X		Very generally speaking, we try, as individuals, to avoid injuring people and, collectively, to adopt policies that minimize injury, in the sense that we don't want to make people worse off, in some hedonic sense, or deprive them of options or capacities that we think they ought to have. Moreover, our legal system frequently compensates people who are injured (and therefore must ascertain if, and how badly, they are injured.)What we get the chance to investigate and discuss in this discussion group is what we mean when we say that people are injured by some particular practices or outcomes that might seem, without much reflection, to be obviously injurious. More particularly, we will discuss five issues: (1) In our first session, we will work out the implications of an academic literature that seems to explore what I see to be one of the finest of one-line jokes ("Nothing matters, and what if it did?"). The literature on hedonic adaptation might seem to suggest that we can neither injure others nor improve their lots: very quickly, people return to a (generally mildly positive) fixed equilibrium state even when seemingly very good or very bad things happen to them. We will explore the literature and its limits. (2) In the final four sessions, we will explore four conditions or practices that seem intuitively injurious and problematic and try to figure out more precisely what might be bad about them, or whether they are actually injurious in the ways that we might at first think: we will explore what is injurious about poverty, discrimination, sexual harassment, and even the big one, death. Begin in Winter Quarter and run through Spring Quarter. Class meeting dates: Meetings will be in the evenings. Exact meeting time and dates to be determined by consensus of the participants. DISCUSSIONS IN ETHICAL & PROFESSIONAL VALUES COURSES RANKING FORM: To apply for this course, 2L, 3L and Advanced Degree students must complete and submit a Ranking Form available on the SLS Registrar's Office website (see Registration). See Ranking Form for instructions and submission deadline. Elements used in grading: Class attendance at all sessions and class participation.
LAW	MANAGING NATURAL RESOURCES	432	GR		X	This workshop seminar will provide students with the opportunity to examine and critique cutting-edge research and work in the natural resources field, with a focus on how climate change and other stressors are affecting scientific, legal and policy issues arising in a number of natural resource contexts, including water, forestry, coastal resources, conventional and renewable energy development, and the like. Although it is open to all students, the seminar is designed especially for those with an interest in the field who wish to stay abreast of current issues, work, and ideas. In each class, an academic expert, policy maker, or practitioner will present their current research or work and engage in a robust discussion. Special Instructions: Grades will be based on class participation and reflection/discussion papers (Section 1) or (Section 2) a long research paper. After the term begins, students accepted into the course can transfer from Section (01) into Section (02) which meets the R requirement, with consent of the instructor. Students taking the course for R credit can take the course for either 2 or 3 units, depending on the paper length. Grading for Section 1 will be Mandatory P/R/F. Grading for Section 2 will be H/P/R/F. Elements used in grading: Class Participation, Attendance, Written Assignments, Final Paper.

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LAW	CALIFORNIA COAST	514	GR		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
LAW	SUSTAINABLE ENERGY	515	GR		X	This course examines trends and opportunities in the sustainable energy sector with a particular focus on low carbon energy. We examine these trends in the context of technological change, emerging business opportunities and the parameters set by public policy. Specific topics to be examined include: > The State of the Global Cleantech Industry.> The Impact of Regulatory Policies and Tax Subsidies.> Cost Competitiveness of Alternative Energy Technologies.> VC Perspective on Sustainable Energy Start-ups.> Project Finance > Fossil Fuels and Carbon Capture.> Renewable Energy, including Solar PV and Biofuels.> Energy Efficiency and Storage. Elements used in grading: Active class participation (30% of grade), case studies (30% of grade) and a course project (group project) to be delivered at the end of the fall quarter (40% of grade). The course project can alternatively (i) develop a (rough) business plan, (ii) analyze an existing business or technology in the sustainable energy domain, or (iii) analyze the impact of an existing regulation or proposed policy. Enrollment: Enrollment is capped at 60 students. The class is open to all MBA and Law School students. 10 seats will be set aside for graduate students from outside the two schools. These students are required to obtain instructors' permission for enrollment. Compressed class: Class will meet in weeks 3, 4, 5 and 7 of the Autumn Quarter. Cross-listed with the Graduate School of Business (GSBGEN 332).

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LAW	ENVIRONMENTAL LAW & POLICY	603	GR		X	This course provides an introduction to federal environmental law, regulation, and policy in the United States. The course emphasizes the cooperative and competing roles that the federal and state governments play in implementing environmental law in the United States. The course encourages students to adopt a comparative and dynamic view of environmental protection under U.S. law. We begin with a discussion of the property law roots of environmental law. Next we briefly touch on some aspects of U.S. administrative law that are essential to understanding the material that follows (students should feel free to take this class without having taken Administrative Law). This is followed by a discussion of the risk assessment and cost-benefit frameworks essential to understanding the current U.S. approach to environmental problems. We conclude this segment with a comparison of two approaches to chemical safety regulation - the U.S. Toxic Substances Control Act and the EU REACH directive. Next, we focus on three key substantive federal environmental statutes: the Clean Air Act, the Clean Water Act, and the Endangered Species Act. Next, we turn to the National Environmental Policy Act to understand how environmental concerns are included in the process of making agency decisions. The course concludes with a discussion of current EPA efforts to address emissions of greenhouse gases under the Clean Air Act. Special Instructions: Substantial participation is expected and class participation constitutes twenty percent (20%) of the overall grade for the course. In addition, students are expected to complete two 1000 word written assignments during the course that will constitute forty percent (40%) of the overall grade. Finally, an in-school exam will, similar in format and length to the written assignments, constitute the remaining forty percent (40%) of the overall grade. Elements used in grading: Class participation (20%), written assignments (40%) and final exam (40%).
LAW	ADV ENVIRONMENTAL LAW CLC	623	GR		X	The Advanced Environmental Law Clinic provides students who have already taken the Environmental Law Clinic the opportunity to continue intense individual project work. Advanced students often work on matters they worked on as full-time students, but they also have the chance to work on new matters and develop new skills. Advanced students work closely with supervising faculty on their designated projects and are expected to take increasing responsibility for managing their work and representing clients. In addition, advanced students often serve as mentors to less experienced full-time students and thereby receive training in basic team building and supervision. Advanced students may arrange to receive between two and seven credits. No student may receive more than 27 total clinical credits during the course of the student's law school career.
LAW	ADV NEGOTIATION: PUBLIC POLICY	650	GR	X		Advanced Negotiation courses are designed to take students beyond the two-party, lawyer-client negotiations that were the focus of the Negotiation Seminar, to examine many facets of negotiation complexity, both in terms of the participants and topics. This section of Advanced Negotiation will focus on multi-party negotiations, working in teams, group decision-making, and negotiating on behalf of organizations to solve complex problems. We will study negotiations and stakeholder dialogue processes involving a diverse set of public and private actors. In the context of both real and simulated case studies, we will address diverse public policy issues, both domestic (including civil rights, racial justice, economic inequality and natural resources management) and international (negotiating bilateral and multilateral agreements, including global security environmental treaties). The goals of the class are twofold, for students (1) to acquire an added theoretical base beyond what was covered in the Negotiation Seminar through which to analyze, prepare for, participate in and facilitate more complex, multiparty negotiations, and (2) to expand skills through deeper examination of various actual negotiation cases and complex simulations. Special Instructions: Attendance at and participation in the simulations is required. Passing is dependent upon active participation, submission of several assigned short reflection papers, and completion of a substantial group paper and presentation analyzing a selected case (a completed or ongoing multi-party public policy dialogue) and the team's internal negotiation process. Prerequisite: Negotiation Seminar (Law 615) or its substantial equivalent. Advanced degree students (and graduate students in other departments and programs) are encouraged to enroll provided that they have previous negotiation training or equivalent practice experience. After the term begins, students accepted into the course can transfer from section (01) into section (02), which meets the R requirement, with consent of the instructor. Students approved for "R" credit will be graded on the H/P/R/F system. Elements used in grading: Class participation and engagement, including simulations; attendance; preparation for and contributions to discussion; short written assignments; final project involving group and individual components.

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LAW	ADV NEGOTIATION: INTL	661	GR	X		This advanced seminar explores how lawyers, diplomats, members of civil society, and citizen advocates can successfully negotiate agreements and pursue conflict resolution in the public international field. The course has a special focus on conflict and dispute resolution processes that take place in contexts where governing laws may be ambiguous, contested, or unenforceable. The goal is to help students learn how to critically evaluate and prepare to participate in these kinds of processes, with special attention to what their role as lawyers or legal advisors can be. Through simulations and case studies, the course will expose students to various types of international conflict resolution processes. These processes include track 2 processes, governance/civil society engagement (particularly regarding resource management, transparency and accountability, extractive industries), transitional justice (including reparations, truth-telling, reconciliation efforts, victim-perpetrator dialogue, restorative justice), peace treaty development, and DDR (disarmament, demobilization and reintegration of armed groups). Prerequisites: Negotiation Seminar (LAW 615), its substantial academic equivalent, or substantial experience in the field. SPILS students are especially encouraged to enroll. This course is also open to cross-registration by graduate students in a variety of departments and programs including International Policy Studies, provided that they have had sufficient prior background in negotiation. Please describe prior negotiations coursework and experience on your Consent Form. Any student deemed to be lacking the required foundational knowledge may still be admitted to the course, but required to attend an intensive bootcamp in basic negotiation theory and methods prior to the first Wednesday Advanced Seminar session. Grading Criteria: The seminar requires that students do the required reading, actively participate in class and simulations, make a team presentation analyzing a case study in international negotiation process, and to submit occasional short writing assignments.
LAW	ENVIRON LAW & POLICY COLLOQ	706	GR		X	The Environmental Law & Policy Colloquium offers LLM students the opportunity to discuss cutting-edge legal topics related to, among others, the environment, natural resources management, or energy policy. The colloquium meets in all three quarters. During the autumn quarter, students will engage in group policy discussions. During the winter quarter, a leading expert in the field - a faculty member, a lawyer, a public official, a member of an advocacy groups, or an entrepreneur - will present his or her research, a paper, or his or her experiences to the class on a specific topic. Following these presentations, all students will participate with the lecturer in a class discussion based on assigned readings, the presentation, and students' own experience in the area. During the spring quarter, the students will present their research papers focused on the solution of an environmental or energy issue. Attendance and active participation are important to the success of the seminar and an important factor in the overall grade. Students are expected to have carefully read and reviewed assigned materials in advance of each session. During the first quarter, students will work in teams and will have to submit memos in preparation for the policy discussion. During the second quarter, students will individually write weekly commentary papers to be submitted before the lecture evaluating, critiquing, and/or discussing key issues from the assigned reading(s). In the third quarter, students are expected to present their papers and comment on the other students' research. Elements used in grading: Class Participation, Attendance, Written Assignments, Final Paper. This course is required for and limited to students in the Environmental Law & Policy LL.M. Program.

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LAW	ENV LAW CLC: CLC PRACTICE	622A	GR		X	Students enrolled in the Clinic provide legal assistance to national, regional and grassroots non-profit organizations on a variety of environmental issues, with a focus on complex natural resource conservation and biodiversity matters at the interface of law, science and policy. Working under the direct supervision of practicing environmental attorneys, Clinic students help screen new matters and potential clients; formulate strategies; research and develop factual and legal issues; and prosecute administrative and litigation proceedings. During the term, students may meet with clients, opposing counsel or agency decision-makers; review and prepare administrative records; develop expert testimony; draft comment letters, petitions, pleading or briefs; and/or attend and present arguments in administrative and court hearings. In regular one-on-one meetings with supervising faculty, there is a heavy emphasis on learning how to write persuasively and present oral arguments. Indeed, in any given quarter, our students typically prepare a mix of state and federal, and trial and appellate, court pleadings, and because all of our hearings during the academic year are conducted by students, many students also have the opportunity to present oral argument in front of one or more judges. In addition, students participate in a regular seminar where we examine strategic, ethical and substantive issues arising out of the Clinic's work. The Clinic is a particularly good place to learn how to conduct effective legal research, marshal facts in support of legal arguments, and, above all, write well. We practice at all levels of state and federal court and before many local, state and federal administrative agencies. Our work involves extensive motions practice and brief writing, and often involves administrative petitions and policy papers. Our work is inherently cross-disciplinary. No prior environmental experience or background is necessary, but an interest in learning about environmental and natural resources law is important. Special Instructions: General Structure of Clinical Courses - - The Law School's clinical courses are offered on a full-time basis for 12 credits. This allows students to immerse themselves in the professional experience without the need to balance clinical projects with other classes, exams and papers. Students enrolled in a clinic are not permitted to enroll in any other classes, seminars, directed research or other credit-yielding activities within the Law School or University during the quarter in which they are enrolled in a clinic. Nor are they allowed to serve as teaching assistants who are expected to attend a class on a regular basis. There is a limited exception for joint degree students who are required to take specific courses each quarter and who would be foreclosed from ever taking a clinic unless allowed to co-register. These exceptions are approved on a case-by-case basis. Clinic students are expected to work in their clinical office during most business hours Monday through Friday. Students are also expected to be available by e-mail or cell phone when elsewhere during those hours. Because students have no other courses (and hence no exams or papers), the clinical quarter begins the first day of classes and runs through the final day of the examination period. Students should not plan personal travel during the Monday to Friday work week without prior authorization from the clinical supervisor. The work during a typical week in a clinic is divided into three components. First, as they are for practicing attorneys, most of the hours of any week are taken up by work on client matters or case work (this time includes meetings with instructors to discuss the work). Again, as is the case for practicing lawyers, in some weeks these responsibilities demand time above and beyond "normal

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LAW	ENV LAW CLC: CLC METHODS	622B	GR		X	Students enrolled in the Clinic provide legal assistance to national, regional and grassroots non-profit organizations on a variety of environmental issues, with a focus on complex natural resource conservation and biodiversity matters at the interface of law, science and policy. Working under the direct supervision of practicing environmental attorneys, Clinic students help screen new matters and potential clients; formulate strategies; research and develop factual and legal issues; and prosecute administrative and litigation proceedings. During the term, students may meet with clients, opposing counsel or agency decision-makers; review and prepare administrative records; develop expert testimony; draft comment letters, petitions, pleading or briefs; and/or attend and present arguments in administrative and court hearings. In regular one-on-one meetings with supervising faculty, there is a heavy emphasis on learning how to write persuasively and present oral arguments. Indeed, in any given quarter, our students typically prepare a mix of state and federal, and trial and appellate, court pleadings, and because all of our hearings during the academic year are conducted by students, many students also have the opportunity to present oral argument in front of one or more judges. In addition, students participate in a regular seminar where we examine strategic, ethical and substantive issues arising out of the Clinic's work. The Clinic is a particularly good place to learn how to conduct effective legal research, marshal facts in support of legal arguments, and, above all, write well. We practice at all levels of state and federal court and before many local, state and federal administrative agencies. Our work involves extensive motions practice and brief writing, and often involves administrative petitions and policy papers. Our work is inherently cross-disciplinary. No prior environmental experience or background is necessary, but an interest in learning about environmental and natural resources law is important. Special Instructions: General Structure of Clinical Courses - - The Law School's clinical courses are offered on a full-time basis for 12 credits. This allows students to immerse themselves in the professional experience without the need to balance clinical projects with other classes, exams and papers. Students enrolled in a clinic are not permitted to enroll in any other classes, seminars, directed research or other credit-yielding activities within the Law School or University during the quarter in which they are enrolled in a clinic. Nor are they allowed to serve as teaching assistants who are expected to attend a class on a regular basis. There is a limited exception for joint degree students who are required to take specific courses each quarter and who would be foreclosed from ever taking a clinic unless allowed to co-register. These exceptions are approved on a case-by-case basis. Clinic students are expected to work in their clinical office during most business hours Monday through Friday. Students are also expected to be available by e-mail or cell phone when elsewhere during those hours. Because students have no other courses (and hence no exams or papers), the clinical quarter begins the first day of classes and runs through the final day of the examination period. Students should not plan personal travel during the Monday to Friday work week without prior authorization from the clinical supervisor. The work during a typical week in a clinic is divided into three components. First, as they are for practicing attorneys, most of the hours of any week are taken up by work on client matters or case work (this time includes meetings with instructors to discuss the work). Again, as is the case for practicing lawyers, in some weeks these responsibilities demand time above and beyond "normal

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LAW	ENV LAW CLC: CLC COURSEWK	622C	GR		X	Students enrolled in the Clinic provide legal assistance to national, regional and grassroots non-profit organizations on a variety of environmental issues, with a focus on complex natural resource conservation and biodiversity matters at the interface of law, science and policy. Working under the direct supervision of practicing environmental attorneys, Clinic students help screen new matters and potential clients; formulate strategies; research and develop factual and legal issues; and prosecute administrative and litigation proceedings. During the term, students may meet with clients, opposing counsel or agency decision-makers; review and prepare administrative records; develop expert testimony; draft comment letters, petitions, pleading or briefs; and/or attend and present arguments in administrative and court hearings. In regular one-on-one meetings with supervising faculty, there is a heavy emphasis on learning how to write persuasively and present oral arguments. Indeed, in any given quarter, our students typically prepare a mix of state and federal, and trial and appellate, court pleadings, and because all of our hearings during the academic year are conducted by students, many students also have the opportunity to present oral argument in front of one or more judges. In addition, students participate in a regular seminar where we examine strategic, ethical and substantive issues arising out of the Clinic's work. The Clinic is a particularly good place to learn how to conduct effective legal research, marshal facts in support of legal arguments, and, above all, write well. We practice at all levels of state and federal court and before many local, state and federal administrative agencies. Our work involves extensive motions practice and brief writing, and often involves administrative petitions and policy papers. Our work is inherently cross-disciplinary. No prior environmental experience or background is necessary, but an interest in learning about environmental and natural resources law is important. Special Instructions: General Structure of Clinical Courses - - The Law School's clinical courses are offered on a full-time basis for 12 credits. This allows students to immerse themselves in the professional experience without the need to balance clinical projects with other classes, exams and papers. Students enrolled in a clinic are not permitted to enroll in any other classes, seminars, directed research or other credit-yielding activities within the Law School or University during the quarter in which they are enrolled in a clinic. Nor are they allowed to serve as teaching assistants who are expected to attend a class on a regular basis. There is a limited exception for joint degree students who are required to take specific courses each quarter and who would be foreclosed from ever taking a clinic unless allowed to co-register. These exceptions are approved on a case-by-case basis. Clinic students are expected to work in their clinical office during most business hours Monday through Friday. Students are also expected to be available by e-mail or cell phone when elsewhere during those hours. Because students have no other courses (and hence no exams or papers), the clinical quarter begins the first day of classes and runs through the final day of the examination period. Students should not plan personal travel during the Monday to Friday work week without prior authorization from the clinical supervisor. The work during a typical week in a clinic is divided into three components. First, as they are for practicing attorneys, most of the hours of any week are taken up by work on client matters or case work (this time includes meetings with instructors to discuss the work). Again, as is the case for practicing lawyers, in some weeks these responsibilities demand time above and beyond "normal
LAW	THE SEA AROUND US	681I	GR	X		This colloquium examines current ocean law and policy issues through a series of readings of seminal works about ethical, physical, and emotional relationships of human beings to the marine world. Through the lenses offered by several classic readings, we will examine and reinterpret the challenges of fisheries collapse, climate change, shipping, marine spatial planning, biodiversity conservation, and the management of land-sea interactions. The course is open to all law students and will be particularly interesting for those interested in studying and solving key issues of ocean policy and management, from coastal adaptation to fisheries management to cumulative impacts assessments to the relationship of human beings and the sea. Begin in Winter Quarter and run through Spring Quarter. Class meeting dates: Exact meeting time and dates to be determined by instructor. Elements used in grading: Class attendance at all sessions and class participation. DISCUSSIONS IN ETHICAL & PROFESSIONAL VALUES COURSES RANKING FORM: To apply for this course, 2L, 3L and Advanced Degree students must complete and submit a Ranking Form available on the SLS Registrar's Office website (see Registration and Selection of Classes for Stanford Law Students and then see Consent of Instructor Forms). See Ranking Form for instructions and submission deadline.
MATH	APPLIED MATH: TOYS AND MAGIC	305	GR	X		This course is a series of case-studies in doing applied mathematics on surprising phenomena we notice in daily life. Almost every class will show demos of these phenomena (toys and magic) and suggest open projects. The topics range over a great variety and cut across areas traditionally pigeonholed as physics, biology, engineering, computer science, mathematics ¿ but, instead of developing sophisticated mathematics on simple material, our aim is to extract simple mathematical understanding from sophisticated material which, at first, we may not yet know how to pigeonhole. In each class I will try to make the discussion self-contained and to give everybody something to take home, regardless of the background.

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MATSCI	MATERIALS CHEMISTRY	192	UG	X		An introduction to the fundamental physical chemical principles underlying materials properties. Beginning from basic quantum chemistry, students will learn how the electronic configuration of molecules and solids impacts their structure, stability/reactivity, and spectra. Topics for the course include molecular symmetry, molecular orbital theory, solid-state chemistry, coordination compounds, and nanomaterials chemistry. Using both classroom lectures and journal discussions, students will gain an understanding of and be well-positioned to contribute to the frontiers of materials chemistry, ranging from solar-fuel generation to next-generation cancer treatments. Undergraduates register in 192 for 4 units; graduates register in 202 for 3 units.
MATSCI	MATERIALS CHEMISTRY	202	GR	X		An introduction to the fundamental physical chemical principles underlying materials properties. Beginning from basic quantum chemistry, students will learn how the electronic configuration of molecules and solids impacts their structure, stability/reactivity, and spectra. Topics for the course include molecular symmetry, molecular orbital theory, solid-state chemistry, coordination compounds, and nanomaterials chemistry. Using both classroom lectures and journal discussions, students will gain an understanding of and be well-positioned to contribute to the frontiers of materials chemistry, ranging from solar-fuel generation to next-generation cancer treatments. Undergraduates register in 192 for 4 units; graduates register in 202 for 3 units.
MATSCI	NANOCHARACTZN OF MATERIALS	320	GR	X		Current methods of directly examining the microstructure of materials. Topics: optical microscopy, scanning electron and focused ion beam microscopy, field ion microscopy, transmission electron microscopy, scanning probe microscopy, and microanalytical surface science methods. Emphasis is on the electron-optical techniques. Recommended: 193/203.
MATSCI	ELECTRONIC PHOTONIC MATLS LAB	174	UG	X		Lab course. Current electronic and photonic materials and devices. Device physics and micro-fabrication techniques. Students design, fabricate, and perform physical characterization on the devices they have fabricated. Established techniques and materials such as photolithography, metal evaporation, and Si technology; and novel ones such as soft lithography and organic semiconductors. Prerequisite: 152 or 199 or consent of instructor. Undergraduates register in 164 for 4 units; graduates register in 174 for 3 units.
MATSCI	SOLAR & FUEL CELLS & BATTERIES	256	GR		X	Operating principles and applications of emerging technological solutions to the energy demands of the world. The scale of global energy usage and requirements for possible solutions. Basic physics and chemistry of solar cells, fuel cells, and batteries. Performance issues, including economics, from the ideal device to the installed system. The promise of materials research for providing next generation solutions. Undergraduates register in 156 for 4 units; graduates register in 256 for 3 units.
MATSCI	NANOCHARACTERIZATION LAB	161	UG		X	Students use optical microscopy, x-ray diffraction, scanning electron microscopy, x-ray photoelectron spectroscopy, atomic force microscopy and other techniques to characterize recently discovered perovskite semiconductors that can be used to make highly efficient solar cells. This course fulfills the Writing in the Major Requirement for MSE undergrads. Instruction on writing, statistics, generating effective plots with curve fits, using databases to find information and giving oral scientific presentations is given. Instruction on characterization techniques is provided, but it is expected that the students will have already taken a course like MATSCI 153 that covers the fundamentals of the techniques. The emphasis on this course is on doing nanocharacterization experiments and writing up the results. Undergraduates register for 161 for 4 units; graduates register for 171 for 3 units.
MATSCI	NANOCHARACTERIZATION LAB	171	UG		X	Students use optical microscopy, x-ray diffraction, scanning electron microscopy, x-ray photoelectron spectroscopy, atomic force microscopy and other techniques to characterize recently discovered perovskite semiconductors that can be used to make highly efficient solar cells. This course fulfills the Writing in the Major Requirement for MSE undergrads. Instruction on writing, statistics, generating effective plots with curve fits, using databases to find information and giving oral scientific presentations is given. Instruction on characterization techniques is provided, but it is expected that the students will have already taken a course like MATSCI 153 that covers the fundamentals of the techniques. The emphasis on this course is on doing nanocharacterization experiments and writing up the results. Undergraduates register for 161 for 4 units; graduates register for 171 for 3 units.
MATSCI	ELEC & OPTICAL PROPS OF SOLIDS	199	UG	X		The concepts of electronic energy bands and transports applied to metals, semiconductors, and insulators. The behavior of electronic and optical devices including p-n junctions, MOS-capacitors, MOSFETs, optical waveguides, quantum-well lasers, light amplifiers, and metallo-dielectric light guides. Emphasis is on relationships between structure and physical properties. Elementary quantum and statistical mechanics concepts are used. Prerequisite: 195/205 or equivalent. Undergraduates register for 199 for 4 units; graduates register for 209 for 3 units.

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MATSCI	ELEC & OPTICAL PROPS OF SOLIDS	209	GR	X		The concepts of electronic energy bands and transports applied to metals, semiconductors, and insulators. The behavior of electronic and optical devices including p-n junctions, MOS-capacitors, MOSFETs, optical waveguides, quantum-well lasers, light amplifiers, and metallo-dielectric light guides. Emphasis is on relationships between structure and physical properties. Elementary quantum and statistical mechanics concepts are used. Prerequisite: 195/205 or equivalent. Undergraduates register for 199 for 4 units; graduates register for 209 for 3 units.
MATSCI	SOLAR CELLS	302	GR	X		Theory of conventional pn junction and excitonic solar cells. Design, fabrication and characterization of crystalline silicon, CdTe, CIGS, tandem and organic solar cells. The device simulator PC1D is used to predict the performance of solar cells with various designs, recombination lifetime and surface recombination rates. The materials science aspects of solar cells research is emphasized, but module design and economic hurdles that must be overcome for solar cell technology to generate a significant fraction of the world's electricity are also addressed.
MATSCI	ELECTRONIC MATERIALS ENGR	152	UG	X		Materials science and engineering for electronic device applications. Kinetic molecular theory and thermally activated processes; band structure; electrical conductivity of metals and semiconductors; intrinsic and extrinsic semiconductors; elementary p-n junction theory; operating principles of light emitting diodes, solar cells, thermoelectric coolers, and transistors. Semiconductor processing including crystal growth, ion implantation, thin film deposition, etching, lithography, and nanomaterials synthesis.
MATSCI	THERMODYNAMICS OF GREEN TECH	154	UG	X		Understand the thermodynamics and efficiency limits of modern green technologies such as carbon dioxide capture from air, fuel cells, batteries, and solar-thermal power.
MATSCI	SOLAR & FUEL CELLS & BATTERIES	156	UG		X	Operating principles and applications of emerging technological solutions to the energy demands of the world. The scale of global energy usage and requirements for possible solutions. Basic physics and chemistry of solar cells, fuel cells, and batteries. Performance issues, including economics, from the ideal device to the installed system. The promise of materials research for providing next generation solutions. Undergraduates register in 156 for 4 units; graduates register in 256 for 3 units.
MATSCI	ELECTRONIC PHOTONIC MATLS LAB	164	UG	X		Lab course. Current electronic and photonic materials and devices. Device physics and micro-fabrication techniques. Students design, fabricate, and perform physical characterization on the devices they have fabricated. Established techniques and materials such as photolithography, metal evaporation, and Si technology; and novel ones such as soft lithography and organic semiconductors.
MATSCI	ORGANIC SEMICO ELECTR & PHOTON	343	GR	X		The science of organic semiconductors and their use in electronic and photonic devices. Topics: methods for fabricating thin films and devices; relationship between chemical structure and molecular packing on properties such as band gap, charge carrier mobility and luminescence efficiency; doping; field-effect transistors; light-emitting diodes; lasers; biosensors; photodetectors and photovoltaic cells.
ME	AERIAL ROBOT DESIGN	271	GR	X		An introduction to the aerodynamic design of rotor-based drones, for students with a background in robotics, aerospace, or fluids. Focus is on rotor-based drones operating at low Reynolds numbers, but material is applicable to drones, aviation and wind energy in general. Topics include: airfoil simulation, fundamentals of rotor aerodynamics, blade element analysis, rotor simulation and performance (e.g. mission duration, distance, maneuverability, and reliability). Midterm is the design of an airfoil for a drone, final is the aerodynamic design of a rotor for a drone; these projects will be peer-reviewed by students in the class. Prereqs: background in fluid mechanics or aerodynamics; fluency with MATLAB. Recommended: take ME202 or AA241X before or after ME271, for practical applications in drone prototyping and control theory.
ME	PHYSICS OF WIND ENERGY	262	GR		X	An introduction to the analysis and modeling of wind energy resources and their extraction. Topics include the physical origins of atmospheric winds; vertical profiles of wind speed and turbulence over land and sea; the wind energy spectrum and its modification by natural topography and built environments; theoretical limits on wind energy extraction by wind turbines and wind farms; modeling of wind turbine aerodynamics and wind farm performance. Final project will focus on development of a new wind energy technology concept. Prerequisites: CEE 262A or ME 351A
ME	ADVANCED THERMAL SYSTEMS	140	UG	X		Capstone course. Thermal analysis and engineering emphasizing integrating heat transfer, fluid mechanics, and thermodynamics into a unified approach to treating complex systems. Mixtures, humidity, chemical and phase equilibrium, and availability. Labs apply principles through hands-on experience with a turbojet engine, PEM fuel cell, and hybrid solid/oxygen rocket motor. Use of MATLAB as a computational tool.

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ME	INTERNAL COMBUSTION ENGINES	250	GR	X		Internal combustion engines including conventional and turbocharged spark ignition, and diesel engines. Lectures: basic engine cycles, engine components, methods of analysis of engine performance, pollutant emissions, and methods of engine testing. Lab involves hands-on experience with engines and test hardware.
ME	GOOD PRODUCTS, BAD PRODUCTS	314	GR	X		The characteristics of industrial products that cause them to be successes or failures: the straightforward (performance, economy, reliability), the complicated (human and cultural fit, compatibility with the environment, craftsmanship, positive emotional response of the user), the esoteric (elegance, sophistication, symbolism). Engineers and business people must better understand these factors to produce more successful products. Projects, papers, guest speakers, field trips.
ME	GOOD PRODUCTS, BAD PRODUCTS	214	GR	X		The characteristics of industrial products that cause them to be successes or failures: the straightforward (performance, economy, reliability), the complicated (human and cultural fit, compatibility with the environment, craftsmanship, positive emotional response of the user), the esoteric (elegance, sophistication, symbolism). Engineers and business people must better understand these factors to produce more successful products. Projects, papers, guest speakers, field trips.
ME	HOW STUFF IS MADE	14N	GR	X		The design and engineering of products and processes, such as machining, fabric, food, and electrical goods. Tradeoffs in choice of materials, features, and process selection. Final project: students research and redesign the engineering and manufacturing aspects of a product and its processes with an eye toward sustainability. Includes several field trips to manufacturing facilities.
ME	THE FUTURE OF THE AUTOMOBILE	302B	GR	X		The objective of this course is to develop an understanding for the requirements that go into the design of a highly complex yet easy-to-use product, i.e. the automobile. Students will learn about very different interdisciplinary aspects that characterize the automobile and personal mobility. This is the second part of a 3-quarter seminar series, which build on one another but can be taken independently. This quarter, the seminar will discuss how various vehicle systems help drivers to maneuver their vehicles through traffic. Advanced driver assistance systems range from navigation, adaptive cruise control, night vision, and lane departure warning to automated parking, traffic jam assistance, and eventually self-driving cars. These systems play an important role in making traffic safer, more efficient, and more enjoyable. This course, lectured by an industry expert, will introduce students to the technology behind the systems, the benefits, challenges, and future perspectives of this exciting field. Students will develop an understanding for the interactions of the technology, business, and society with a specific automotive focus.
ME	INTRO TO AUTO AND TRANSP INNOV	302A	GR	X		The objective of this course is to survey the innovative automotive and transportation community within Stanford. Stanford University has become one of the best universities on earth to to change the future of transportation and this course is a 'who's who' of that world. This is the first part of a 3-quarter seminar series, which build on one another but can be taken independently. This quarter, the seminar will feature talks from Stanford experts in focus areas as varied as autonomous vehicles, entrepreneurship, design, ethics, aerodynamics, neuroscience, communications and security. At the end of the quarter, students will have developed an understanding of Stanford's portfolio of transportation work and know the specific individuals who are key to its future. To obtain credit, students must attend the first class (no exceptions) plus 7 additional classes for a total of 8 classes.
ME	THE CONSUMER MIND AND BEHAVIOR	224	GR	X		This course will introduce new theories and research concerning neuroscience and behavioral psychology to examine models for designing user habits. Students will learn how to use the latest behavior change methodologies from industry-leading experts to design or re-design a customer experience. Course topics will be taught in the context of design thinking: empathize-define-ideate-prototype-test. Students will leave the class having prototyped, tested, and improved a user behavior.
ME	DESIGNING FOR IMPACT	105	UG	X		This course will introduce the design thinking process and skills, and explore unique challenges of solving problems and initiating action for public good. Design skills such as need-finding, insight development, and prototyping will be learned through project work, with a particular emphasis on the elements required to be effective in the social sector. Prerequisite: ME101.

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ME	COMMERCIAL MEMS DEVICE DESIGN	429	GR		X	This course will provide insight into designing MEMS based devices for use in commercial/consumer and automotive sensor applications. Topics to be covered in this MEMS sensor design course will include electromechanical modeling/simulation, compensation for cross-wafer and wafer-to-wafer fabrication variations in a high volume semiconductor manufacturing facility, design for extreme environments (drop shock, temperature, etc.), and some discussion of the unique challenges with respect to consumer and automotive sensor markets. Student teams will develop a MEMS sensor/transducer design (capacitive 3-axis accelerometer), electro-mechanical system model (Matlab based), fabrication process flow with manufacturing analysis (Excel based) in response to a provided design specification sheet.
ME	THE FUTURE OF MECH ENGINEERING	228	GR	X		This seminar series provides an overview of current research in mechanical engineering and of its interface with other engineering and non-engineering disciplines. The seminar is targeted at senior mechanical engineering undergraduates and mechanical engineering graduate students. Presenters will be selected external speakers who feature exciting, cutting-edge applications of mechanical engineering.
ME	GLOBAL ENGINEERS' EDUCATION	177	UG	X		A project based course for those who would like to use their engineering backgrounds to address real world challenges faced by underserved communities globally. In direct collaboration with an underserved community from a rural village in India, students will develop engineering solutions to the challenge of sanitation and hygiene. Focus will be on working with the community rather than for them. Concepts covered will include designing with what designers care about at the center, articulating and realizing individual and community aspirations, ethics of engaging with underserved communities, and methodology of working sustainably with an underserved community.
ME	TURB & INTERN COMB ENGINES	257	GR	X		Principles of design analysis for aircraft gas turbines and automotive piston engines. Analysis for aircraft engines performed for Airbus A380 type aircraft. Design parameters determined considering aircraft aerodynamics, gas turbine thermodynamics, compressible flow physics, and material limitations. Additional topics include characteristics of main engine components, off-design analysis, and component matching. Performance of automotive piston engines including novel engine concepts in terms of engine thermodynamics, intake and exhaust flows, and in-cylinder flow.
ME	FUEL CELL SCIENCE & TECHNOLOGY	260	GR		X	Emphasis on proton exchange membrane (PEM) and solid oxide fuel cells (SOFC), and principles of electrochemical energy conversion. Topics in materials science, thermodynamics, and fluid mechanics.
ME	FORECASTING FOR INNOVATORS	297	GR	X		Technologies from the steam engine to the microprocessor have been mixed gifts, at once benefitting humankind and creating many of the problems facing humanity today. This class will explore how innovators can use forecasting methods to identify new challenges, develop responsive innovations and anticipate unintended consequences. Students will produce a long-range forecast project, applying a variety of methodologies including research, expert interviews and graphical exploration.
ME	FLUID MECHANICS	131A	GR	X		The principles of heat transfer by conduction, convection, and radiation with examples from the engineering of practical devices and systems. Topics include transient and steady conduction, conduction by extended surfaces, boundary layer theory for forced and natural convection, boiling, heat exchangers, and graybody radiative exchange. Prerequisites: 70,ENGR 30. Recommended: intermediate calculus, ordinary differential equations.
ME	FLUID MECHANICS	131B	GR	X		Engineering applications involving compressible flow: aircraft and rocket propulsion, power generation; application of mass, momentum, energy and entropy balance to compressible flows; variable area isentropic flow, normal shock waves, adiabatic flow with friction, flow with heat addition. Operation of flow systems: the propulsion system. Turbomachinery: pumps, compressors, turbines. Angular momentum analysis of turbomachine performance, centrifugal and axial flow machines, effect of blade geometry, dimensionless performance of turbomachines; hydraulic turbines; steam turbines; wind turbines. Compressible flow turbomachinery: the aircraft engine.
ME	BICYCLE DESIGN	204A	GR	X		Lecture/lab. The engineering and artistic execution of designing and building a bicycle frame. Fundamentals of bicycle dynamics, handling, and sizing. Manufacturing processes. Films, guest lecturers, field trips. Each student designs and fabricates a custom bicycle frame. This course is now a two part course series ME204A&B. Limited enrollment.

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ME	BICYCLE DESIGN	204B	GR	X		The engineering and artistic execution of designing and building a bicycle frame. The fundamentals of bicycle dynamics, handling, and sizing. Manufacturing processes. Films, guest lecturers, field trips. Each student designs a custom bicycle frame that they continue from ME204A in winter quarter. Limited enrollment, admission by consent of instructors. Attendance at first lecture is required. Both ME204A and ME204B must be taken.
ME	ENTREPRENEURIAL DESIGN	206A	GR		X	Project course jointly offered by School of Engineering and Graduate School of Business. Students apply engineering and business skills to design product prototypes, distribution systems, and business plans for entrepreneurial ventures in developing countries for a specified challenge faced by the world's poor. Topics include user empathy, appropriate technology design, rapid prototype engineering and testing, social technology entrepreneurship, business modeling, and project management. Weekly design reviews; final course presentation. Industry and adviser interaction. Limited enrollment via application; see extreme.stanford.edu
ME	DESIGN FOR AFFORDABILITY	206B	GR		X	Part two of two-quarter project course jointly offered by School of Engineering and Graduate School of Business. Second quarter emphasizes prototyping and implementation of specific projects identified in first quarter. Students work in cross-disciplinary project teams. Industry and adviser interaction, weekly design reviews; final course presentation. Prerequisite: 206A.n(Jointly offered as GSB OIT333B) Design Institute class; see http://dschool.stanford.edu.
ME	ADV PROD DESIGN: NEEDFINDING	216A	GR	X		Human needs that lead to the conceptualization of future products, environments, systems, and services. Field work in public and private settings; appraisal of personal values; readings on social ethnographic issues; and needfinding for a corporate client. Emphasis is on developing the flexible thinking skills that enable the designer to navigate the future. Prerequisites for undergraduates: ME115A, ME115B and ME203, or consent of the instructor.
ME	PRODUCT-BASED ENGINEERING	310A	GR	X		Three quarter sequence; for engineering graduate students intending to lead projects related to sustainability, automotive, biomedical devices, communication, and user interaction. Student teams collaborate with academic partners in Europe, Asia, and Latin America on product innovation challenges presented by global corporations to design requirements and construct functional prototypes for consumer testing and technical evaluation. Design loft format such as found in Silicon Valley consultancies. Typically requires international travel.
ME	PRODUCT-BASED ENGINEERING	310B	GR	X		Three quarter sequence; for engineering graduate students intending to lead projects related to sustainability, automotive, biomedical devices, communication, and user interaction. Student teams collaborate with academic partners in Europe, Asia, and Latin America on product innovation challenges presented by global corporations to design requirements and construct functional prototypes for consumer testing and technical evaluation. Design loft format such as found in Silicon Valley consultancies. Typically requires international travel.
ME	PROJECT-BASED ENGINEERING	310C	GR	X		Three quarter sequence; for engineering graduate students intending to lead projects related to sustainability, automotive, biomedical devices, communication, and user interaction. Student teams collaborate with academic partners in Europe, Asia, and Latin America on product innovation challenges presented by global corporations to design requirements and construct functional prototypes for consumer testing and technical evaluation. Design loft format such as found in Silicon Valley consultancies. Typically requires international travel.
ME	ENERGY SYSTEMS I-THERMODYNAMIC	370A	GR	X		Thermodynamic analysis of energy systems emphasizing systematic methodology for and application of basic principles to generate quantitative understanding. Exergy, mixtures, reacting systems, phase equilibrium, chemical exergy, and modern computational methods for analysis. Prerequisites: undergraduate engineering thermodynamics and computer skills such as Matlab.
ME	ENERGY SYSTEMS II-MODELING	370B	GR	X		Development of quantitative device models for complex energy systems, including fuel cells, reformers, combustion engines, and electrolyzers, using thermodynamic and transport analysis. Student groups work on energy systems to develop conceptual understanding, and high-level, quantitative and refined models. Advanced topics in thermodynamics and special topics associated with devices under study.

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MED	HUMAN RIGHTS AND HEALTH	108Q	GR	X		Preference to sophomores. History of human-rights law. International conventions and treaties on human rights as background for social and political changes that could improve the health of groups and individuals. Topics such as: regional conflict and health, the health status of refugees and internally displaced persons; child labor; trafficking in women and children; HIV/AIDS; torture; poverty, the environment and health; access to clean water; domestic violence and sexual assault; and international availability of drugs. Possible optional opportunities to observe at community sites where human rights and health are issues. Guest speakers from national and international NGOs including Doctors Without Borders; McMaster University Institute for Peace Studies; UC Berkeley Human Rights Center; Kiva. PowerPoint presentation on topic of choice required.
MED	GLOB HEALTH BEYOND DISEASE ORG	233	GR	X		Provides multidisciplinary trainees insight into over-arching themes of global health. Topics include systemic issues affecting healthcare progress globally, ethical and thoughtful approaches to solving these issues, as well as economics, water sanitation, public health, organizations in global health, human rights, involvement in NGOs, ethics of overseas work, and other non-medical aspects of this subject. This course will cover some of the essentials of patient care while working in the field as well including child health care, malaria, TB, and HIV.
MED	DISCUSSIONS IN GLOBAL HEALTH	232	GR	X		The goal of this interactive series is to encourage students to think broadly about the variety of activities encompassed within global health and the roles of various entities, including NGOs, governments, and healthcare providers, in responding to large-scale health crises, building health systems, and caring for patients in developing countries. Examines challenges in global health such as organizing medical responses to natural disasters, providing healthcare to societies in conflict, and integrating traditional and modern approaches to healing. Case studies are used to critique strategies employed by organizations that work to improve medical care in poor settings.
MED	FOODIES TO FREEGANS	158A	GR	X		This is a discussion-based survey course to introduce the complexities of many "pop topics" in food, such as obesity, sustainability, and local vs. organic food. Course offered over two quarters; second part is MED 158B. The course focuses on Silicon Valley and is taught through a food justice lens. The goal is to provide knowledge and new frameworks for conceptualizing food that transform the way students think about, eat, and purchase food. Furthermore, course content is aligned with Community Engaged Learning (CEL) so that students have the opportunity to collaborate with local partners to complete community-based projects relevant to course topics. Coursework involves class participation, critical reflection, and three papers written for different audiences in the food space.
MED	ASB CUISINE OF CHANGE	23	UG	X		Topics include obesity rates in America, the health and food education in our schools, the fundamentals of nutrition, the challenges of processed foods, the various lifestyle choices and fads surrounding healthy eating, and the complex ecology of food insecurity and welfare.
MED	COMMUNITY HEALTH ENGAGEMENT	157	UG	X		Open to undergraduate, graduate, and MD students. Examination and exploration of community health principles and their application at the local level. Designed to prepare students to make substantive contributions in a variety of community health settings (e.g. clinics, government agencies, non-profit organization, advocacy groups). Topics include community health assessment; health disparities; health promotion and disease prevention; strategies for working with diverse, low-income, and underserved populations; and principles of ethical and effective community engagement.
MED	PHYSICIANS AND SOCIAL RESPONSI	228	GR	X		Social and political context of the roles of physicians and health professionals in social change; policy, advocacy, and shaping public attitudes. How physicians have influenced governmental policy on nuclear arms proliferation; environmental health concerns; physicians in government; activism through research; the effects of poverty on health; homelessness; and gun violence. Guest speakers from national and international NGOs.
MED	INTRO TO GLOBAL HEALTH	229	GR	X		Provides an overview of global health and how it is similar to and different from public health and tropical medicine. Topics include the evolution, economics, politics of global health, major players in global health, and issues of geography, politics, humanitarianism, human rights, science, research, culture and disease.
MGTECON	HEALTH LAW: FINANCE & INSUR	331	GR	X		This course provides the legal, institutional, and economic background necessary to understand the financing and production of health services in the US. Potential topics include: health reform, health insurance (Medicare and Medicaid, employer-sponsored insurance, the uninsured), medical malpractice and quality regulation, pharmaceuticals, the corporate practice of medicine, regulation of fraud and abuse, and international comparisons.

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MI	PHOTOGRAPHING NATURE	70Q	GR	X		Utilizes the idiom of photography to learn about nature, enhance observation, and explore scientific concepts. Builds upon the pioneering photographic work of Eadweard J. Muybridge on human and animal locomotion. A secondary goal is to learn the grammar, syntax, composition, and style of nature photography to enhance the use of this medium as a form of scientific communication and also to explore the themes of change across time and space. Scientific themes to be explored include: taxonomy, habitat preservation, climate change; species diversity; survival and reproductive strategies; ecological niches and coevolution, carrying capacity and sustainability, population densities, predation, and predator-prey relationships, open-space management, the physics of photography. Extensive use of field trips and class critque.
MS&E	CLIMATE POLICY ANALYSIS	294	GR		X	Design and application of formal analytical methods in climate policy development. Issues include instrument design, technology development, resource management, multiparty negotiation, and dealing with complexity and uncertainty. Links among art, theory, and practice. Emphasis is on integrated use of modeling tools from diverse methodologies and requirements for policy making application. Prerequisites: ECON 50, MS&E 211, MS&E 252, or equivalents, or permission of instructor.
MS&E	THE ENERGY SEMINAR	494	GR		X	Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
MS&E	THE ENERGY SEMINAR	494	GR		X	Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
MS&E	THE ENERGY SEMINAR	494	GR		X	Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students.
MS&E	NETWORKS	135	UG	X		This course provides an introduction to how networks underly our social, technological, and natural worlds, with an emphasis on developing intuitions for broadly applicable concepts in network analysis. The course will include: an introduction to graph theory and graph concepts; social networks; information networks; the aggregate behavior of markets and crowds; network dynamics; information diffusion; the implications of popular concepts such as "six degrees of separation", the "friendship paradox", and the "wisdom of crowds".
MS&E	ENERGY/ENVRMTL POLICY ANALYSIS	243	GR		X	Concepts, methods, and applications. Energy/environmental policy issues such as automobile fuel economy regulation, global climate change, research and development policy, and environmental benefit assessment. Group project.
MS&E	ENERGY-ENVR SYS MODELS/ANALYS	391	GR	X		Restricted to PhD students, or by consent of instructor. Doctoral research seminar covering current topics in energy and environmental modeling and analysis. Current emphasis on approaches to incorporation of uncertainty and technology dynamics into complex systems models. May be repeated for credit.
MS&E	INT'L ENVIRONMENTAL POLICY	92Q	GR		X	Preference to sophomores. Science, economics, and politics of international environmental policy. Current negotiations on global climate change, including actors and potential solutions. Sources include briefing materials used in international negotiations and the U.S. Congress.
OB	BREAKTHROUGH VENTURES	512	GR	X		This course is designed to provide students with a summary of entrepreneurial processes that have successfully created, developed, and sustained breakthrough ventures. By "breakthrough" we mean ventures that have had a lasting and positive impact, touching millions of lives. We consider ventures that are not only software related, but also ones based on technology and business models that impact markets ranging from medical devices to small satellites to home robotics systems to clean water and more. nThe examples are based on the experiences of Norman Winarsky, formerly President of SRI Ventures, and Henry Kressel, Partner Emeritus at Warburg Pincus. They include companies like Siri, Nuance, Intuitive Surgical, Sandisk, and others. nThe course leads us from the source of breakthrough venture ideas, to building a great value proposition and business plan, recruiting a team, finding investors and board members, deciding whether to sell or go IPO, and ends with what it takes to build a company that can sustain itself through continuous innovation. At each step, we follow examples of companies we've helped build, and provide lessons of success as well as failure. We compare and contrast the strategies of these ventures with other popular strategies, such as those proposing "fail fast, develop minimal viable products, and pivot often..." nThe course will be highly interactive, and engage students in discussing their own experiences and future plans. Invited speakers will include venture capitalists and entrepreneurs who have created breakthrough companies.

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OBGYN	CONTROVERSIES IN WOMEN'S HLTH	256	GR	X		Interdisciplinary. Focus is primarily on the U.S., with selected global women's health topics. Topics include: leading causes of morbidity and mortality across the life course; reproductive (e.g. gynecologic & obstetric) health issues; sexual function; importance of lifestyle (e.g. diet, exercise, weight control), including eating disorders; mental health; sexual and relationship abuse; issues for special populations. In-class Student Debates on key controversies in women's health. Guest lecturers. HUMBIO students must enroll in HumBio 125 for 3 units. PhD minor in FGSS, enroll in FEMGEN 256 for 2 - 3 units and for a letter grade. Med students enroll in OBGYN 256 for 2 units.
OIT	DESIGN FOR AFFORDABILITY	333	GR	X		This course is a Bass Seminar. Project course jointly offered by School of Engineering and Graduate School of Business. Students apply engineering and business skills to design product or service prototypes, distribution systems, and business plans for entrepreneurial ventures that meet that challenges faced by the world's poor. Topics include user empathy, appropriate technology design, rapid prototype engineering and testing, social technology entrepreneurship, business modeling, and project management. Weekly design reviews; final course presentation. Industry and adviser interaction. Limited enrollment via application; see http://extreme.stanford.edu/index.html for details.
OIT	DESIGN FOR AFFORDABILITY	334	GR	X		This course is a Bass Seminar. Project course jointly offered by School of Engineering and Graduate School of Business. Students apply engineering and business skills to design product or service prototypes, distribution systems, and business plans for entrepreneurial ventures that meet that challenges faced by the world's poor. Topics include user empathy, appropriate technology design, rapid prototype engineering and testing, social technology entrepreneurship, business modeling, and project management. Weekly design reviews; final course presentation. Industry and adviser interaction. Limited enrollment via application; see http://extreme.stanford.edu/index.html for details.
OSPBEIJ	GLOBALIZATION & CHINESE CITY	82	UG	X		Dynamics of China¿s urban transformation and contemporary city life in the context of globalization. Applying interdisciplinary and comparative perspectives to selected themes related to the distinctive characteristics of China¿s urban development, students gain critical knowledge and understanding of how Chinese urban space is transformed by the forces of globalization, urbanization, marketization, and political decentralization; socio-spatial implications upon urban residents and the migrant population. Opportunities and challenges that Chinese cities face, given its current urban development strategies and trajectories. Field trips and site visits.
OSPBER	SUSTAINABLE ENERGY IN GERMANY	16	UG		X	Fundamental technologies for sustainable development, conversion, transmission, and use of energy in buildings, transportation, and industry. Diverse stakeholder involvement in the formulation and implementation of policy for sustainable energy. Key differences between Germany and the U.S. and other countries with energy-intensive economies regarding energy supply, use, policy, and results. Field trips and guest speakers to learn about German suppliers of energy technology, energy facilities, and decision makers and stakeholders in processes for energy policymaking.
OSPKYOTO	AN INTRO TO MAKING: WHAT IS EE	40M	GR	X		Is a hands-on class where students learn to make stuff. Through the process of building, you are introduced to the basic areas of EE. Students build a "useless box" and learn about circuits, feedback, and programming hardware, a light display for your desk and bike and learn about coding, transforms, and LEDs, a solar charger and an EKG machine and learn about power, noise, feedback, more circuits, and safety. And you get to keep the toys you build. Prerequisite: CS 106A.
OSPKYOTO	JAPAN ENERGY-ENVIRO CONUNDRUM	45	UG		X	Japan's energy-environment challenges and their consequences for Japan¿s wider society and economy. Question of how Japan's policy makers will balance energy and environmental needs and how the answers will affect the country's future as a leading regional power. Students will gain a sound understanding of the structure of Japan's energy-environment challenges and a practical analytical framework by which they can evaluate these challenges and develop their own balanced assessments.
OSPMADRD	TOWARD A SUSTAINABLE MADRID	8A	GR		X	Architecture and the city, with a focus on recent currents in the progress of both, such as sustainability, environmentalism and the relationship with nature. Topics underpinned by discussion of theory, and illustrated by a study of the city of Madrid: an example of a hybrid architectural/planning experiential environment that looks to the future with an ambition for modernization.

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OSPMADRD	ENVIRO SUSTAINABILITY IN SPAIN	79	UG		X	Interdisciplinary focus on the relationship between earth systems and human activities. Nature and distribution of natural resources, their uses and exploitation, environmental impacts associated with exploitation, and sustainable development initiatives, including the restoration and rehabilitation of the land affected by extraction activities. Water management: understanding of the resource and its location; the development of efficient tools; an associated regulatory apparatus; and economics.
OSPPARIS	MEASURE WELLBEING/SUSTAINABLTY	86	UG		X	Explore well-being and sustainability through the lens of the new indicators that are being developed in all corners of social sciences and at the frontier with natural and physical science. Lab to learn how to build an indicator of well-being or sustainability. Historical perspective on well-being and sustainability thinking since Aristotle; overview of standard economic indicators and their limits. Well-being indicators focusing on health, education, happiness, trust, inequality and governance. New research in sustainability indicators. How building new indicators changes policy at the global, national and local level.
OSPPARIS	IN INTRO TO MAKIN: WHAT IS EE	40M	GR	X		Is a hands-on class where students learn to make stuff. Through the process of building, you are introduced to the basic areas of EE. Students build a "useless box" and learn about circuits, feedback, and programming hardware, a light display for your desk and bike and learn about coding, transforms, and LEDs, a solar charger and an EKG machine and learn about power, noise, feedback, more circuits, and safety. And you get to keep the toys you build. Prerequisite: CS 106A.
OSPSANTG	SUSTAINABLE CITIES LATIN AM	29	UG		X	Energy and environmental challenges resulting from the growing size and complexity in Latin American cities. Key issues: way in which public authorities deal with the dynamics of urban growth and complexity; related environmental and energy issues, particularly related to different public transportation models. Systemic approach as seen in Curtiba, Bogota, Santiago, and Medellin. Analysis centering on different approaches used to tackle these related issues; different institutional strategies.
OSPSANTG	MARINE ECOLOGY OF CHILE	85	UG	X		Relationships among physical processes in the ocean, biological productivity, and the exploitation of resources by high-thropic-level predators including human beings. Characterization of ecological patterns; identification of processes operating on marine systems. Open ocean ecosystems, intertidal and benthic regions of the world's oceans, and ecological research developed along coastal regions, focusing on Chile's 4,000 km coastline.
OUTDOOR	OUTDOOR ED: ASST INSTRUCTOR	495	GR	X		Assist Instructor Outdoor Leadership Courses. Instructor Approval and Defined Student Goals/Benchmarks Required Prior to instructing.
OUTDOOR	OUTDOOR EDUCATOR APPRENTICESHI	416	GR	X		This course provides the student an opportunity to lead a multi-day outdoor experiences in an official capacity. Experience includes: outdoor living skills, planning and logistics, leadership, risk management, environmental integration, and education. Students will plan and co-lead field outings. Prerequisites: OUTDOOR 106 or OUTDOOR 406; OUTDOOR 415.
PEDS	HUMANITARIAN AID AND POLITICS	225	GR	X		Open to medical students, graduate students, and undergraduate students. Examines the moral dilemmas and political realities that complicate the delivery of humanitarian aid, especially when undertaken by the United Nations and non-governmental organizations (NGOs). Emphasis is on what humanitarians call "complex humanitarian emergencies": crises often characterized by famine and/or epidemic disease and typically the result of war and/or civil war. Provides background into the history of humanitarian aid, though focus is on the post-Cold War era, up to the recent crises in Libya and Syria.
PEDS	SOC & ENVIRN DETERMNTS OF HLTH	150	UG		X	How race/ethnicity and SES contribute to health disparities, how vulnerable populations are uniquely at health risk, and how the built environment relates to health and wellness. Topics include: gender, age, race/ethnicity, language, education, individual SES and neighborhood SES as related to health; individual and structural race bias; health needs of vulnerable populations (e.g., the homeless, the incarcerated, immigrant populations, children, and uninsured/underinsured); and environmental forces (e.g., urban design/planning, traffic/car culture, green space, housing, food access/culture, law enforcement, and media).
PEDS	HUMAN RIGHTS & GLOBAL HEALTH	223	GR	X		Open to medical students, graduate students, and advanced undergraduates. Examines the newly emerging field of human rights and global health, beginning with the essential background into the field of human rights, and the recent emergence of health as a human right. Emphasis is on the pioneering work of Dr. Paul Farmer and Partners in Health and the challenge he and his organization have posed to the conventional wisdom about approaches to combating poor health and disease worldwide. Topics include the "big three" infectious diseases -- tuberculosis, malaria, and HIV/AIDS -- as well as emerging infectious diseases, clean water and sanitation, and malnutrition and famine.

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PEDS	FAMINE IN THE MODERN WORLD	226	GR	X		Open to medical students, graduate students, and undergraduate students. Examines the major famines of modern history, the controversies surrounding them, and the reasons that famine persists in our increasingly globalized world. Focus is on the relative importance of natural, economic, and political factors as causes of famine in the modern world. Case studies include the Great Irish Famine of the 1840s; the Bengal famine of 1943-44; the Soviet famines of 1921-22 and 1932-33; China's Great Famine of 1959-61; the Ethiopian famines of the 1970s and 80s, and the Somalia famines of the 1990s and of 2011.
PEDS	SOC & ENVIRN DETERMNTS OF HLTH	250	GR	X		How race/ethnicity and SES contribute to health disparities, how vulnerable populations are uniquely at health risk, and how the built environment relates to health and wellness. Topics include: gender, age, race/ethnicity, language, education, individual SES and neighborhood SES as related to health; individual and structural race bias; health needs of vulnerable populations (e.g., the homeless, the incarcerated, immigrant populations, children, and uninsured/underinsured); and environmental forces (e.g., urban design/planning, traffic/car culture, green space, housing, food access/culture, law enforcement, and media).
PHIL	OWNING THE EARTH	378W	GR	X		(Why) do Americans have the right to control the land and resources of the United States? Or should we think that all humans have an equal right to the earth? Should we allocate responsibilities to act on climate change based on equal ownership of the atmosphere? Does a national people living on an island that will disappear because of climate change have a right to a new state elsewhere? Can an individual rightfully own a distant planet? Why are resource-rich states at higher risk for authoritarianism, civil conflict and corruption¿and can this `resource curse¿ be lifted? This course will draw on philosophy, political science and law to ask who has¿and should have¿control over the earth and its resources.
PHIL	ETHICS OF CLIMATE CHANGE	177C	GR		X	Climate change is an ethical failure. When we cause greenhouse gas to be emitted for our own benefit, the gas spreads around the world and does harm everywhere. Many of those who are harmed emit very little greenhouse gas themselves. When some people harm others for their own benefit, something is morally wrong. Specifically, there is an injustice. One of the ethical problems raised by climate change is how to rectify this injustice. Climate change also raises a different range of ethical questions, which may be classified as questions of value. For example, in making decisions, how should the distant future be valued in comparison with the present and how should we take account of the great loss of human life that climate change will cause? This course investigates the issues of justice and the issues of value. It considers the moral demands that climate change puts both on private individuals and on public institutions. Because the effects of climate change are so widespread and so complex, the methods of economics can be useful in putting ethical principles into effect. The course will therefore assess some of these methods.
PHIL	ETHICS OF CLIMATE CHANGE	277C	GR		X	Climate change is an ethical failure. When we cause greenhouse gas to be emitted for our own benefit, the gas spreads around the world and does harm everywhere. Many of those who are harmed emit very little greenhouse gas themselves. When some people harm others for their own benefit, something is morally wrong. Specifically, there is an injustice. One of the ethical problems raised by climate change is how to rectify this injustice. Climate change also raises a different range of ethical questions, which may be classified as questions of value. For example, in making decisions, how should the distant future be valued in comparison with the present and how should we take account of the great loss of human life that climate change will cause? This course investigates the issues of justice and the issues of value. It considers the moral demands that climate change puts both on private individuals and on public institutions. Because the effects of climate change are so widespread and so complex, the methods of economics can be useful in putting ethical principles into effect. The course will therefore assess some of these methods.
PHIL	ETHICS/POLITICS PUBLIC SERVICE	275A	GR	X		Ethical and political questions in public service work, including volunteering, service learning, humanitarian assistance, and public service professions such as medicine and teaching. Motives and outcomes in service work. Connections between service work and justice. Is mandatory service an oxymoron? History of public service in the U.S. Issues in crosscultural service work. Integration with the Haas Center for Public Service to connect service activities and public service aspirations with academic experiences at Stanford.

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PHIL	HUMAN RIGHTS	177W	GR	X		In this course we will think critically about human rights by evaluating complex moral situations and weighing powerful but op-posed arguments. In our discussions we will explore a variety of alleged human rights and ask: Which of these is really a human right? What could the justification of human rights be? If some right is a real human right, what exactly does it require of us and others? Are there really any human rights at all, or are human rights just another means for Western societies to impose their way of life on the rest of the world? What is a human right? Case studies will include the death penalty, democratic participation, gay rights and duties of corporations to respect human rights.
PHIL	INTRODUCTION TO GLOBAL JUSTICE	76	UG	X		This course provides an overview of core ethical problems in international politics, with special emphasis on the question of what demands justice imposes on institutions and agents acting in a global context. The course is divided into three sections. The first investigates the content of global justice, and comprises of readings from contemporary political theorists and philosophers who write within the liberal contractualist, utilitarian, cosmopolitan, and nationalist traditions. The second part of the course looks at the obligations which global justice generates in relation to five issues of international concern ¿ global poverty, climate change, immigration, warfare, and well-being of women. The final section of the course asks whether a democratic international order is necessary for global justice to be realized.
PHIL	CONTEMPORARY MORAL PROBLEMS	72	UG	X		This course addresses moral issues that play a major role in contemporary public discourse. The course aims to encourage students to consider moral problems in a reflective, systematic manner, and to equip students with skills that will enable them to do so. Questions to be addressed include: Do rich countries have an obligation to accept refugees from other parts of the world? Do such obligations conflict with the right of individuals to protect their culture? Is there anything principally wrong in the use of drones for purposes of warfare? Do we have obligations to the environment, and if so why? What is racism and what makes it wrong? And what are feminist ideals?
PHIL	COLLECTIVE ACTION	73	UG	X		Collective action problems arise when actions that are individually rational give rise to results that are collectively irrational. Scholars have used such a framework to shed light on various political phenomena such as revolutions, civil disobedience, voting, climate change, and the funding of social services. We examine their findings and probe the theoretical foundations of their approach. What does this way of thinking about politics bring into focus, and what does it leave out? What role do institutions play in resolving collective action problems? And what if the required institutions are absent? Can we, as individuals, be required to cooperate even if we expect that others may not play their part? Readings drawn from philosophy, political science, economics, and sociology.
PHOTON	ELECTRONIC STRUCTURE SURFACE	329	GR	X		Physical concepts and phenomena for surface science techniques probing the electronic and chemical structure of surfaces, interfaces and nanomaterials. Microscopic and atomic models of microstructures; applications including semiconductor device technology, catalysis and energy. Physical processes of UV and X-ray photoemission spectroscopy, Auger electron spectroscopy, surface EXAFS, low energy electron diffraction, electron/photon stimulated ion desorption, scanning tunneling spectroscopy, ion scattering, energy loss spectroscopy and related imaging methods; and experimental aspects of these surface science techniques. Prerequisites: PHYSICS 70 and MATSCI 199/209, or consent of instructor.
PHYSICS	BACK OF THE ENVELOPE PHYSICS	216	GR	X		Techniques such as scaling and dimensional analysis, useful to make order-of-magnitude estimates of physical effects in different settings. Goals are to promote a synthesis of physics through solving problems, including problems that are not usually thought of as physics. Applications include properties of materials, fluid mechanics, geophysics, astrophysics, and cosmology.
PHYSICS	INTRO TO PHYSICS OF ENERGY	240	GR	X		Energy as a consumable. Forms and interconvertability. World Joule budget. Equivalents in rivers, oil pipelines and nuclear weapons. Quantum mechanics of fire, batteries and fuel cells. Hydrocarbon and hydrogen synthesis. Fundamental limits to mechanical, electrical and magnetic strengths of materials. Flywheels, capacitors and high pressure tanks. Principles of AC and DC power transmission. Impossibility of pure electricity storage. Surge and peaking. Solar constant. Photovoltaic and thermal solar conversion. Physical limits on agriculture.
PHYSICS	INTRO TO NUCLEAR ENERGY	241	GR	X		Radioactivity. Elementary nuclear processes. Energetics of fission and fusion. Cross-sections and resonances. Fissionable and fertile isotopes. Neutron budgets. Light water, heavy water and graphite reactors. World nuclear energy production. World reserves of uranium and thorium. Plutonium, reprocessing and proliferation. Half lives of fission decay products and actinides made by neutron capture. Nuclear waste. Three Mile Island and Chernobyl. Molten sodium breeders. Generation-IV reactors. Inertial confinement and magnetic fusion. Laser compression. Fast neutron production and fission-fusion hybrids.

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PHYSICS	SCIENCE ON THE BACK OF THE ENV	81N	GR	X		Understanding the complex world around us quantitatively, using order of magnitude estimates and dimensional analysis. Starting from a handful of fundamental constants of Nature, one can estimate complex quantities such as cosmological length and time scales, size of the atom, height of Mount Everest, speed of tsunami, energy density of fuels and climate effects. Through these examples students learn the art of deductive thinking, fundamental principles of science and the beautiful unity of nature.
POLECON	STRATEGY BEYOND MARKETS	230	GR	X		This course develops techniques and tools to use in firms' strategic interactions beyond the market environment. We'll examine firms' interactions with stakeholders, constituents, and institutions, including interest groups, legislatures, regulatory agencies, courts, international organizations, and the public. Topics covered in the class include: environmental regulation, intellectual property, antitrust, bank bailouts, health care reform, carried interest in private equity, protectionist trade policies, strategic corporate social responsibility, and beyond market strategy for start-ups. The goal is to develop integrated strategies for optimal firm performance that combine strategies within and beyond markets.
POLECON	DEVELOPING ECONOMIES	231	GR	X		This course shares significant material with POLECON 230 and the goal of developing integrated strategies for optimal firm performance that combine elements within and beyond markets. POLECON 231 diverges from the base course to delve deeper into issues that are particularly salient for entrepreneurs in emerging and frontier markets. Using a combination of cases from developed and developing countries, we will expand the list of topics considered to include managing political risk and protecting the firm in the face of uncertain and discretionary regulatory environments. The objective is to provide a solid grounding in the techniques explored in 230, while refining skill sets and whetting appetites for investment in higher risk environments.
POLISCI	POLITICS & PUBLIC POLICY	102	UG	X		(Formerly PS 2) American political institutions (the Presidency, Congress, and the Court) and political processes (the formation of political attitudes and voting) have for some time now been criticized as inadequate to the task of making modern public policy. Against the backdrop of American culture and political history we examine how public policy has been and is being made. We use theories from Political Science and Economics to assess the state of the American system and the policy making process. We use case studies and lectures to analyze contemporary issues including environmental policy, taxes and spending , gun control , economic growth and inequality and mobility. In some of these issue areas we use comparative data from other countries to see how the U.S. is doing relative to other countries. In addition to class room lecture and discussion, student groups are formed to analyze policy issues of relevance to them. Undergraduate Public Policy students are required to enroll in this class for five units.
POLISCI	COLLECTIVE ACTION	131A	GR	X		Collective action problems arise when actions that are individually rational give rise to results that are collectively irrational. Scholars have used such a framework to shed light on various political phenomena such as revolutions, civil disobedience, voting, climate change, and the funding of social services. We examine their findings and probe the theoretical foundations of their approach. What does this way of thinking about politics bring into focus, and what does it leave out? What role do institutions play in resolving collective action problems? And what if the required institutions are absent? Can we, as individuals, be required to cooperate even if we expect that others may not play their part? Readings drawn from philosophy, political science, economics, and sociology.
POLISCI	ETHICS/POLITICS PUBLIC SERVICE	133	UG	X		Ethical and political questions in public service work, including volunteering, service learning, humanitarian assistance, and public service professions such as medicine and teaching. Motives and outcomes in service work. Connections between service work and justice. Is mandatory service an oxymoron? History of public service in the U.S. Issues in crosscultural service work. Integration with the Haas Center for Public Service to connect service activities and public service aspirations with academic experiences at Stanford.
POLISCI	THE AMERICAN WEST	124A	GR	X		The American West is characterized by frontier mythology, vast distances, marked aridity, and unique political and economic characteristics. This course integrates several disciplinary perspectives into a comprehensive examination of Western North America: its history, physical geography, climate, literature, art, film, institutions, politics, demography, economy, and continuing policy challenges. Students examine themes fundamental to understanding the region: time, space, water, peoples, and boom and bust cycles.

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POLISCI	INTRODUCTION TO GLOBAL JUSTICE	136R	GR	X		This course provides an overview of core ethical problems in international politics, with special emphasis on the question of what demands justice imposes on institutions and agents acting in a global context. The course is divided into three sections. The first investigates the content of global justice, and comprises of readings from contemporary political theorists and philosophers who write within the liberal contractualist, utilitarian, cosmopolitan, and nationalist traditions. The second part of the course looks at the obligations which global justice generates in relation to five issues of international concern ¿ global poverty, climate change, immigration, warfare, and well-being of women. The final section of the course asks whether a democratic international order is necessary for global justice to be realized.
POLISCI	POLITICS & PUBLIC POLICY	123	UG	X		(Formerly PS 2) American political institutions (the Presidency, Congress, and the Court) and political processes (the formation of political attitudes and voting) have for some time now been criticized as inadequate to the task of making modern public policy. Against the backdrop of American culture and political history we examine how public policy has been and is being made. We use theories from Political Science and Economics to assess the state of the American system and the policy making process. We use case studies and lectures to analyze contemporary issues including environmental policy, taxes and spending , gun control , economic growth and inequality and mobility. In some of these issue areas we use comparative data from other countries to see how the U.S. is doing relative to other countries. In addition to class room lecture and discussion, student groups are formed to analyze policy issues of relevance to them. Undergraduate Public Policy students are required to enroll in this class for five units.
POLISCI	CONTEMPORARY MORAL PROBLEMS	134P	GR	X		This course addresses moral issues that play a major role in contemporary public discourse. The course aims to encourage students to consider moral problems in a reflective, systematic manner, and to equip students with skills that will enable them to do so. Questions to be addressed include: Do rich countries have an obligation to accept refugees from other parts of the world? Do such obligations conflict with the right of individuals to protect their culture? Is there anything principally wrong in the use of drones for purposes of warfare? Do we have obligations to the environment, and if so why? What is racism and what makes it wrong? And what are feminist ideals?
PUBLPOL	POLITICS & PUBLIC POLICY	201	GR	X		(Formerly PS 2) American political institutions (the Presidency, Congress, and the Court) and political processes (the formation of political attitudes and voting) have for some time now been criticized as inadequate to the task of making modern public policy. Against the backdrop of American culture and political history we examine how public policy has been and is being made. We use theories from Political Science and Economics to assess the state of the American system and the policy making process. We use case studies and lectures to analyze contemporary issues including environmental policy, taxes and spending , gun control , economic growth and inequality and mobility. In some of these issue areas we use comparative data from other countries to see how the U.S. is doing relative to other countries. In addition to class room lecture and discussion, student groups are formed to analyze policy issues of relevance to them. Undergraduate Public Policy students are required to enroll in this class for five units.
PUBLPOL	PUBLIC SERVICE INTERNSHIP PREP	74	UG	X		Are you prepared for your internship this summer? This workshop series will help you make the most of your internship experience by setting learning goals in advance; negotiating and communicating clear roles and expectations; preparing for a professional role in a non-profit, government, or community setting; and reflecting with successful interns and community partners on how to prepare sufficiently ahead of time. You will read, discuss, and hear from guest speakers, as well as develop a learning plan specific to your summer or academic year internship placement. This course is primarily designed for students who have already identified an internship for summer or a later quarter. You are welcome to attend any and all workshops, but must attend the entire series and do the assignments for 1 unit of credit.
PUBLPOL	ETHICS/POLITICS PUBLIC SERVICE	103D	GR	X		Ethical and political questions in public service work, including volunteering, service learning, humanitarian assistance, and public service professions such as medicine and teaching. Motives and outcomes in service work. Connections between service work and justice. Is mandatory service an oxymoron? History of public service in the U.S. Issues in crosscultural service work. Integration with the Haas Center for Public Service to connect service activities and public service aspirations with academic experiences at Stanford.

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PUBLPOL	ETHICS ON THE EDGE	134	UG	X		The objective of the course is to explore the increasing ethical challenges in a world in which technology, global risks, and societal developments are accelerating faster than our understanding can keep pace. We will unravel the factors contributing to the seemingly pervasive failure of ethics today among organizations and leaders across all sectors: business, government and non-profit. A framework for ethical decision-making underpins the course. The relationship between ethics and culture, global risks (poverty, cyber-terrorism, climate change, etc.) leadership, and the law and policy will inform discussion. Prominent guest speakers will attend certain sessions interactively. A broad range of international case studies might include: Ebola; Facebook's mood manipulation research and teen suicides from social media bullying; Google's European "right to be forgotten" and driverless cars; Space X (Elon Musk's voyages to Mars); ISIS' interaction with international NGOs; sexual assault on U.S. university campuses and in the U.S. military; the ethics of corporate social responsibility (through companies such as L'Oreal, Whole Foods and Walmart); corporate and financial sector scandals; and non-profit sector ethics challenges. Final project in lieu of exam on a topic of student's choice. Attendance required. Class participation important (with multiple opportunities beyond speaking in class). Final project in lieu of exam. Strong emphasis on critical thinking and testing ideas in real-world contexts. There will be a limited numbers of openings above the set enrollment limit of 40 students. If the enrollment limit is reached, students wishing to take the course should contact Dr. Susan Liautaud at susan11@stanford.edu. The course offers credit toward Ethics in Society, Public Policy core requirements (if taken in combination with Public Policy 103E), and Science, Technology and Society and satisfies the Ways of Thinking requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. *Public Policy majors taking the course to complete the core requirements must obtain a letter grade. Other students may take the course for a letter grade or C/NC.
PUBLPOL	ETHICS ON THE EDGE	234	GR	X		The objective of the course is to explore the increasing ethical challenges in a world in which technology, global risks, and societal developments are accelerating faster than our understanding can keep pace. We will unravel the factors contributing to the seemingly pervasive failure of ethics today among organizations and leaders across all sectors: business, government and non-profit. A framework for ethical decision-making underpins the course. The relationship between ethics and culture, global risks (poverty, cyber-terrorism, climate change, etc.) leadership, and the law and policy will inform discussion. Prominent guest speakers will attend certain sessions interactively. A broad range of international case studies might include: Ebola; Facebook's mood manipulation research and teen suicides from social media bullying; Google's European "right to be forgotten" and driverless cars; Space X (Elon Musk's voyages to Mars); ISIS' interaction with international NGOs; sexual assault on U.S. university campuses and in the U.S. military; the ethics of corporate social responsibility (through companies such as L'Oreal, Whole Foods and Walmart); corporate and financial sector scandals; and non-profit sector ethics challenges. Final project in lieu of exam on a topic of student's choice. Attendance required. Class participation important (with multiple opportunities beyond speaking in class). Final project in lieu of exam. Strong emphasis on critical thinking and testing ideas in real-world contexts. There will be a limited numbers of openings above the set enrollment limit of 40 students. If the enrollment limit is reached, students wishing to take the course should contact Dr. Susan Liautaud at susan11@stanford.edu. The course offers credit toward Ethics in Society, Public Policy core requirements (if taken in combination with Public Policy 103E), and Science, Technology and Society and satisfies the Ways of Thinking requirement. The course is open to undergraduate and graduate students. Undergraduates will not be at a disadvantage. *Public Policy majors taking the course to complete the core requirements must obtain a letter grade. Other students may take the course for a letter grade or C/NC.

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PUBLPOL	CA COAST-SCIENCE POLICY LAW	175	UG		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
PUBLPOL	CA COAST-SCIENCE POLICY LAW	275	GR		X	This interdisciplinary course integrates the legal, scientific, and policy dimensions of how we characterize and manage resource use and allocation along the California coast. We will use this geographic setting as the vehicle for exploring more generally how agencies, legislatures, and courts resolve resource-use conflicts and the role that scientific information and uncertainty play in the process. Our focus will be on the land-sea interface as we explore contemporary coastal land-use and marine resource decision-making, including coastal pollution, public health, ecosystem management; public access; private development; local community and state infrastructure; natural systems and significant threats; resource extraction; and conservation, mitigation and restoration. Students will learn the fundamental physics, chemistry, and biology of the coastal zone, tools for exploring data collected in the coastal ocean, and the institutional framework that shapes public and private decisions affecting coastal resources. There will be 3 to 4 written assignments addressing policy and science issues during the quarter, as well as a take-home final assignment. Special Instructions: In-class work and discussion is often done in interdisciplinary teams of students from the School of Law, the School of Engineering, the School of Humanities and Sciences, and the School of Earth, Energy, and Environmental Sciences. Students are expected to participate in class discussion and field trips. Elements used in grading: Participation, including class session and field trip attendance, writing and quantitative assignments. Cross-listed with Civil & Environmental Engineering (CEE 175A/275A), Earth Systems (EARTHSYS 175/275), Law (LAW514), and Public Policy (PUBLPOL 175/275). Open to graduate students and to advanced undergraduates with instructor consent.
PUBLPOL	ENERGY POLICY IN CALIFORNIA	73	UG		X	This seminar will provide an in-depth analysis of the role of California state agencies in driving energy policy development, technology innovation, and market structures. The course will cover three areas: 1) roles and responsibilities of key state agencies; 2) current and evolving energy and climate policies; and 3) development of California's 21st century energy systems. Presentations will include experts from the California Energy Commission, the California Public Utilities Commission, the California Air Resources Board, the California Independent System Operator, the California Legislature, and the Governor's office. This class is required for all Stanford Energy Internships in California (SEIC) fellowship awardees and is open to other interested undergraduate and graduate students. Class dates are: April 2nd (10am-2pm), April 30th (10am-1pm), and May 21st (10am-1pm). Lunch will be provided. May be repeat for credit. If interested you can fill out this webform: http://web.stanford.edu/~sburbank/Energy.fb

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PUBLPOL	BIOSECURITY/BIOTERRISM RESPONS	122	UG	X		Overview of the most pressing biosecurity issues facing the world today. Guest lecturers have included former Secretary of State Condoleezza Rice, former Special Assistant on BioSecurity to Presidents Clinton and Bush Jr. Dr. Ken Bernard, Chief Medical Officer of the Homeland Security Department Dr. Alex Garza, eminent scientists, innovators and physicians in the field, and leaders of relevant technology companies. How well the US and global healthcare systems are prepared to withstand a pandemic or a bioterrorism attack, how the medical/healthcare field, government, and the technology sectors are involved in biosecurity and pandemic or bioterrorism response and how they interface, the rise of synthetic biology with its promises and threats, global bio-surveillance, making the medical diagnosis, isolation, containment, hospital surge capacity, stockpiling and distribution of countermeasures, food and agriculture biosecurity, new promising technologies for detection of bio-threats and countermeasures. Open to medical, graduate, and undergraduate students. No prior background in biology necessary. 4 units for twice weekly attendance (Mon. and Wed.); additional 1 unit for writing a research paper for 5 units total maximum. PLEASE NOTE: This class will meet for the first time on Wednesday, March 30.
PUBLPOL	REG POLITICS & DECISION MAKING	135	UG	X		Dynamics of regional leadership and decision making in Silicon Valley, a complex region composed of 40 cities and four counties without any overarching framework for governance. Formal and informal institutions shaping outcomes in the region. Case studies include transportation, workforce development, housing and land use, and climate change.
PUBLPOL	POLITICS&POLICY IN CALIFORNIA	154	UG	X		State politics and policy making, including the roles of the legislature, legislative leadership, governor, special interests, campaign finance, advocacy groups, ballot initiatives, state and federal laws, media, and research organizations. Case studies involving budgets, education, pensions, health care, political reform, environmental reforms, water, transportation and more. Evaluation of political actions, both inside and outside of government, that can affect California policy and social outcomes. Meetings with elected officials, policymakers, and advocates in class and during a day-long field trip to Sacramento.
PUBLPOL	COLLECTIVE ACTION	304A	GR	X		Collective action problems arise when actions that are individually rational give rise to results that are collectively irrational. Scholars have used such a framework to shed light on various political phenomena such as revolutions, civil disobedience, voting, climate change, and the funding of social services. We examine their findings and probe the theoretical foundations of their approach. What does this way of thinking about politics bring into focus, and what does it leave out? What role do institutions play in resolving collective action problems? And what if the required institutions are absent? Can we, as individuals, be required to cooperate even if we expect that others may not play their part? Readings drawn from philosophy, political science, economics, and sociology.
PWR	INT. WRITING: COMM CLIMATE CHA	91EP	GR		X	In the next two decades floods, droughts and famine caused by climate change will displace more than 250 million people around the world. In this course students will develop an increased understanding of how different stakeholders including scientists, aid organizations, locals, policy makers, activists, and media professionals communicate the climate change crisis. They will select a site experiencing the devastating effects and research the voices telling the stories of those sites and the audiences who are (or are not) listening. Students might want to investigate drought-ridden areas such as the Central Valley of California or Darfur, Sudan; Alpine glaciers melting in the Alps or in Alaska; the increasingly flooded Pacific islands; the hurricane ravaged Gulf Coast, among many others. Data from various stakeholders will be analyzed and synthesized for a magazine length article designed to bring attention to a region and/or issue that has previously been neglected. Students will write and submit their article for publication.nnFor students who have completed the first two levels of the writing requirement and want further work in developing writing abilities, especially within discipline-specific contexts and nonfiction genres. Individual conferences with instructor and peer workshops. Prerequisite: first two levels of the writing requirement or equivalent transfer credit. For more information, see https://undergrad.stanford.edu/programs/pwr/explore/notation-science-writing.
PWR	PWR 2: RHETORIC OF ACTIVISM	2SN	GR	X		Prerequisite: PWR 1. Further work in developing skills in argument and research-based writing, with emphasis on both written and oral/multimedia presentation of research. See http://www.stanford.edu/dept/undergrad/cgi-bin/drupal_ual/AP_univ_req_PWR_Courses.html.
PWR	PWR 1: RHETORIC OF GLOBAL DEV	1EP	GR	X		Rhetorical and contextual analysis of readings; research; and argument. Focus is on development of a substantive research-based argument using multiple sources. Individual conferences with instructor. Seehttps://undergrad.stanford.edu/programs/pwr/courses/pwr-1.

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PWR	PWR 1: POWER OF ENV VIS RHETOR	1MS	GR		X	Rhetorical and contextual analysis of readings; research; and argument. Focus is on development of a substantive research-based argument using multiple sources. Individual conferences with instructor. Seehttps://undergrad.stanford.edu/programs/pwr/courses/pwr-1.
PWR	PWR 1: RHET OF CLIMATE CHANGE	1SI	GR		X	Rhetorical and contextual analysis of readings; research; and argument. Focus is on development of a substantive research-based argument using multiple sources. Individual conferences with instructor. Seehttps://undergrad.stanford.edu/programs/pwr/courses/pwr-1.
PWR	PWR 2: RHET SUSTAINBL ENERGY	2KM	GR		X	Prerequisite: PWR 1. Further work in developing skills in argument and research-based writing, with emphasis on both written and oral/multimedia presentation of research. Focus on the rhetoric and ethics of sustainable energy, investigating both the alarmism and optimism which fuel this debate. See http://www.stanford.edu/dept/undergrad/cgi-bin/drupal_ual/AP_univ_req_PWR_Courses.html.
PWR	PWR 2: RHET OF NATURAL AND BEY	2RL	GR		X	Prerequisite: PWR 1. Further work in developing skills in argument and research-based writing, with emphasis on both written and oral/multimedia presentation of research. See http://www.stanford.edu/dept/undergrad/cgi-bin/drupal_ual/AP_univ_req_PWR_Courses.html.
RELIGST	RELIGION & COUNTERCULTURE	104	UG	X		Counterculture: A radical culture, esp. amongst the young, that rejects established social values and practices; a mode of life opposed to the conventional or dominant. Cf. alternative adj. ~ O.E.D.nnWe will critically examine contemporary and past countercultural religious movements in light of larger debates on such perennially important issues as race, politics, environmentalism, and gender. In particular, we will focus on how mysticism, myth, and the radical religious imagination are mobilized to affect real change in the sociocultural realm. We will engage primary materials such as text, film, and music: a multimedia approach that will foreground the complex strategies used to transform ideas into actions, propositions into performances. To this end, assignments will offer creative yet critical opportunities to think through the complexities of the construction of our own group and individual identities. Subject matter treated will include sex, drugs and rock & roll¿as well as polite conversations about other things normally avoided in polite conversation. No prior experience with religious studies or philosophy is necessary. All materials will be in English. Everyone is welcome.
SINY	URBANISM AND CHANGE	102	UG	X		Explore the range of scales, budgets and bureaucracies that have characterized urban planning, design and intervention. Looking at concrete examples in NYC, students will survey tactical urbanism, ¿guerrilla urbanism,¿ artistic urbanism, and the city as a canvas. Class concludes with a real urban intervention project.
SIW	ENRGY, ENVRN, CLMT & CONSRVTN	144	UG		X	no course description
SIW	INTERNATIONAL ENVIRON POLICY	116	UG		X	no course description
SOC	ALTERNATIVE SPRING BREAK	100ASB	GR	X		Limited to students participating in the Alternative Spring Break program. See http://asb.stanford.edu for more information.
SOC	ROOTS SOC PROTEST	22N	GR	X		Preference to freshmen. The conditions under which social protest occurs and the emergence, success, and viability of contemporary social movements. Examples include women's civil rights, ecology, and antiwar and anti-globilization movements in the U.S. and elsewhere. Sociological theories to explain the timing, location, and causes of mobilization; how researchers evaluate these theories. Comparison of tactics, trajectories, and outcomes.
SOC	SOCIAL MOVEMENTS & COLL ACTION	218	GR	X		Why social movements arise, who participates in them, the obstacles they face, the tactics they choose, and how to gauge movement success or failure. Theory and empirical research. Application of concepts and methods to social movements such as civil rights, environmental justice, antiglobalization, and anti-war.
SOC	SOCIAL MOVEMENTS & COLL ACTION	118	UG	X		Why social movements arise, who participates in them, the obstacles they face, the tactics they choose, and how to gauge movement success or failure. Theory and empirical research. Application of concepts and methods to social movements such as civil rights, environmental justice, antiglobalization, and anti-war.
SOC	INST THEORY WORLD SOCIETY	378	GR	X		Sociological analyses of the rise and impact of the expanded modern world order, with its internationalized organizations and globalized discourse. Consequences for national and local society: education, political organization, economic structure, the environment, and science. The centrality of the individual and the rationalized organization as legitimated actors.

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SOMGEN	PREPARING FOR SERVICE SRI LANK	260	GR		X	Preparation course for students attending the Bing Overseas Study Program in Sri Lanka. Focuses on specific topics relevant to Sri Lanka, including: water issues, effects of war and natural disaster on population health, maternal and child health, and etiquette and basic language skills for visitors. Explores the Sarvodaya model of development together with the World Health Organization's Sustainable Development Goals. Required for BOSP students; open to all students interested in Sri Lanka and global health.
STRAMGT	FOOD INNOVATION & ENTREPREN	306	GR	X		Americans spend nearly 7% of their income on food items and another 5% on food services annually (US Census). Food spend is at the intersection of two of the most important industries in the US: health care and agriculture. Food production today supports the food consumption causing our extraordinary burden of disease; 75 cents of every dollar of the $4.8 billion spent annually on health care is for diet-related disease. The health care system accounts for over 17% of U.S. gross domestic product (GDP). Agriculture and agriculture-related industries contributed 4.8% to the U.S. gross domestic product (GDP) in 2012.nThis course focuses on the opportunities across these industries for food, health, and nutrition entrepreneurship. The course is designed for students with a broad interest in the food or health systems and/or who are interested in careers in food-related fields.nnWe will examine the food system from three points of view: the consumer, nutritional science, and policy. The class will focus on problem-solving from the perspective of an entrepreneur. The class will involve lecture, discussion, and prominent guest speakers who are entrepreneurs themselves or industry leaders.
STRAMGT	GLOBAL ELECTRIC AUTO INDUSTRY	574	GR	X		This six-session 2-point Bass seminar will involve students (maximum 18) in analyzing the emerging global electric automotive industry by focusing on: (1) The electric automotive industry in the U.S. and Europe, (2) the electric automotive industry in Japan and Korea, and (3) the electric automotive industry in China. We will each time examine the strategies of the key automotive companies as well as that of the government and other key players such as infrastructure providers. The purpose of the seminar is to help students sharpen their skills in identifying facilitating and impeding forces of strategic change, and in assessing and estimating the direction and rate of strategic change. While the instructors will provide relevant pre- readings related to these topics, students will be expected to complement these materials with their own research of theoretical and empirical sources. They will also be expected to help structure the discussion and move it forward toward conclusions. Students will organize into three teams each focused on one of the regions and prepare a five-to-ten page group report of their most important findings and conclusions that extend current knowledge.
STRAMGT	CHALLENGES IN/WITH CHINA	583	GR	X		The general objective of the course is to develop a solid grasp of the changing socio-economic and political situation in China (with its challenges both for China and for the rest of the world). It should make then possible to define sustainable strategies for managing effectively in China and for handling the growing interdependence between China and the US and China with the rest of the world. From assessing critically the performance of China today, students will get an insight in the current complex dynamics of China renaissance/transformation and discuss alternative scenarios, with their business and socio-political consequences on the medium term. From this analysis and with a prospective perspective in mind, we will explore alternative strategic business approaches and propose responsible management practices required to build, overtime, a mutually rewarding growing inter-dependence.n nMore specifically, the course will initially identify the multi-causality behind China's achievements and discuss some of the dysfunctions associated, today, with such performance. The conditions of management effectiveness required to enter and succeed overtime in the Chinese market will be identified while the challenges faced by the global expansion of Chinese firms overseas will be illustrated. nThe course will rely upon different pedagogical methods; it will create conditions to share and leverage participants' experience and it will make use of a number of recent cases and research results. nnAuditors will be admitted, but they will have to be present (and prepared) in all the sessions.
STS	ADVANCED TOPICS IN AGNOTOLOGY	200J	GR	X		Advanced research into the history of ignorance. Our goal will be to explore how ignorance is created, maintained and destroyed, using case studies from topics such as tobacco denialism, global climate denialism, and other forms of resistance to knowledge making. Course culminates in a research paper on the theory and practice of agnotology, the science of ignorance.

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STS	ETHICS, SCIENCE, & TECHNOLOGY	200H	GR	X		Critical analysis of ethical issues raised by recent or emerging advances in science and engineering. Issues: privacy, intellectual property, design equity, the public interest, ethical responsibilities of technical practitioners, research ethics, and freedom of inquiry. Advances from fields such as IT, biotechnology, nanotechnology, neurotechnology, construction technology, and transport technology. Seminar limited to 25 senior STS majors. Prerequisite: a course in ethics or permission of the instructor.
STS	PUBLIC LIFE OF SCIENCE & TECH	1	UG	X		The course focuses on key social, cultural, and values issues raised by contemporary scientific and technological developments through the STS interdisciplinary lens by developing and applying skills in three areas: (a) The historical analysis of contemporary global matters (e.g., spread of technologies; climate change response); (b) The bioethical reasoning around health issues (e.g., disease management; privacy rights); and (c) The sociological study of knowledge (e.g., intellectual property, science publishing). A discussion section is required and will be assigned the first week of class.
STS	ISSUES IN TECH & THE ENVIRO	190	UG		X	Humans have long shaped and reshaped the natural world with technologies. Once a menacing presence to conquer or an infinite reserve for resources, nature is now understood to require constant protection from damage and loss. This course will examine humanity's varied relationship with the environment, with a focus on the role of technology. Topics include: industrialization, modernism, nuclear technology, and biotechnology. Students will explore theoretical and methodological approaches in STS and conduct original research that addresses this human-nature-technology nexus.
STS	FOOD AND SOCIETY	200A	GR	X		This course will examine how politics, culture, and technology intersect in our food practices. Through a survey of academic, journalistic, and artistic works on food and eating, the course will explore a set of key analytical frameworks and conceptual tools in STS, such as the politics of technology, classification and identity, and nature/culture boundaries. The topics covered include: the industrialization of agriculture; technology and the modes of eating (e.g., the rise of restaurants); food taboos; globalization and local foodways; food and environmentalism; and new technologies in production (e.g., genetically modified food). Through food as a window, the course intends to achieve two broad intellectual goals. First, students will explore various theoretical and methodological approaches in STS. In particular, they will pay particular attention to the ways in which politics, culture, and technology intersect in food practices. Second, student will develop a set of basic skills and tools for their own critical thinking and empirical research, and design and conduct independent research on a topic related to food. First class attendance mandatory. STS majors must have Senior status to enroll in this Senior Capstone course.
SURG	HEALTHCARE IN HAITI	231	GR	X		Originally developed to highlight healthcare in exreme poverty in Haiti, related lectures have been added covering healthcare in resource poor environments with the objective to introduce students to the complexity and unique problems of working in the Third World's healthcare morass.
THINK	THE SUSTAINABILITY CHALLENGE	40	UG		X	What are the most critical sustainability challenges facing us in this century? How can natural and social sciences, humanities, and technology fields interact to contribute to their solution? How do we balance the needs and desires of current generations with the needs of future generations? The term sustainability seems to be everywhere. Businesses, cities, non-governmental organizations, individuals, and universities such as Stanford use the term to characterize decisions that make sense for the well-being of people as well as the environment. Beyond the popular use of the term is an emerging field of study that focuses on the goals of sustainable development - improving human well-being while preserving Earth's life support systems (air, water, climate, ecosystems) over the long run - and explores how science and technology can contribute to the solution of some of the most critical problems of the 21st Century. The goal of this course is to engage you in critical thinking and analysis about complex sustainability challenges and to encourage you to consider the need for integrative solutions that draw on different disciplines. We will examine some of the major problems of sustainable development (including issues related to food, water, and energy resources, climate change, and protection of ecosystem services), grapple with the complexities of problem solving in complex human-environment systems, and participate in the design of effective strategies and policies for meeting sustainability goals. You will learn to develop policy briefs addressing sustainability issues in the university, local communities, state and the nation as well as work on team projects with decision makers that address real-life challenges in your local area.

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THINK	THINKING THROUGH AFRICA	42	UG	X		What is human well-being? How do we define it? How do we measure it? What do we mean when we talk about certain parts of the world as "developed" and others as "underdeveloped" or "developing"? How do improvements in human well-being come about? What happens when some people become much better off and others do not? In this course, we will use African experiences, past and present, to think critically and reflectively about concepts whose meaning we all too often take for granted: not only well-being and development, but also wealth and health, equality and inequality. Using the tools and techniques of four different disciplines -- history, anthropology, public health, and engineering -- we will tackle essential questions about the meaning of well-being and the indices by which we measure it, the role of politics in the development process, the importance of historical and cultural contexts, and the sometimes unanticipated challenges that individuals, institutions, and societies face when they seek to promote development and improve human well-being.
URBANST	THE URBAN ECONOMY	173	UG	X		Applies the principles of economic analysis to historical and contemporary urban and regional development issues and policies. Explores themes of urban economic geography, location decision-making by firms and individuals, urban land and housing markets, and local government finance. Critically evaluates historical and contemporary government policies regulating urban land use, housing, employment development, and transportation. Prerequisite: Econ 1A or permission of instructor.
URBANST	PUBLIC SERVICE INTERNSHIP PREP	101	UG	X		Are you prepared for your internship this summer? This workshop series will help you make the most of your internship experience by setting learning goals in advance; negotiating and communicating clear roles and expectations; preparing for a professional role in a non-profit, government, or community setting; and reflecting with successful interns and community partners on how to prepare sufficiently ahead of time. You will read, discuss, and hear from guest speakers, as well as develop a learning plan specific to your summer or academic year internship placement. This course is primarily designed for students who have already identified an internship for summer or a later quarter. You are welcome to attend any and all workshops, but must attend the entire series and do the assignments for 1 unit of credit.
URBANST	CHINA URBANIZATION SEMINAR	145	UG		X	Comparative approach to sustainable cities, with focus on international practices and applicability to China. Tradeoffs regarding land use, infrastructure, energy and water, and the need to balance economic vitality, environmental quality, cultural heritage, and social equity. Student teams collaborate with Chinese faculty and students partners to support urban sustainability projects. Limited enrollment via application; see internationalurbanization.org for details. Prerequisites: consent of the instructor(s).
URBANST	SUSTAINABLE URBAN TRANSPORT	165	UG		X	Environmental, economic, and equity aspects of urban transportation in 21st-century U.S. Expanded choices in urban and regional mobility that do not diminish resources for future generations. Implications for the global environment and the livability of communities.
URBANST	ETHICS/POLITICS PUBLIC SERVICE	122	UG	X		Ethical and political questions in public service work, including volunteering, service learning, humanitarian assistance, and public service professions such as medicine and teaching. Motives and outcomes in service work. Connections between service work and justice. Is mandatory service an oxymoron? History of public service in the U.S. Issues in crosscultural service work. Integration with the Haas Center for Public Service to connect service activities and public service aspirations with academic experiences at Stanford.
URBANST	ENVIRNMNTL JUSTICE IN BAY AREA	16SI	GR		X	Hands-on, discussion-based class that seeks to expose students to the intersectionality of social justice and environmental well being. Through student-led talks and field trips around the Bay, the course pushes participants to think about connections between issues of privilege, race, health, gender equality, and class in environmental issues. Students from all experiences and fields of study are encouraged to join to gain a sense of place, engage critically with complex challenges, and learn about environmental justice in and out of the classroom.
URBANST	DEFINING SMART CITIES	174	UG		X	In a rapidly urbanizing world, "the city" paves the way toward sustainability and social well-being. But what does it mean for a city to be smart? Does that also make it sustainable or resilient or livable? This seminar delves into current debates about urbanism through weekly talks by experts on topics such as big data, human-centered design, new urbanism, and natural capital. How urban spaces are shaped, for better or worse, by the complex interaction of cutting-edge technology, human societies, and the natural environment. The goal is to provoke vigorous discussion and to foster an understanding of cities that is at once technological, humanistic, and ecologically sound.

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URBANST	COMMUNITY ORGANIZING	108	UG	X		This course explores the theory, practice and history of grassroots community organizing as a method for developing community power to promoting social justice. We will develop skills for 1-on-1 relational meetings, media messaging, fundraising strategies, power structure analysis, and strategies organizing across racial/ethnic difference. And we will contextualize these through the theories and practices developed in the racial, gender, queer, environmental, immigrant, housing and economic justice movements to better understand how organizing has been used to engage communities in the process of social change. Through this class, students will gain the hard skills and analytical tools needed to successfully organize campaigns and movements that work to address complex systems of power, privilege, and oppression. As a Community-Engaged Learning course, students will work directly with community organizations on campaigns to address community needs, deepen their knowledge of theory and history through hands-on practice, and develop a critical analysis of inequality at the structural and interpersonal levels. Placements with community organizations are limited. Enrollment will be determined on the first day through a simple application process. Students will have the option to continue the course for a second quarter in the Winter, where they will execute a campaign either on campus or in collaboration with their community partner.
URBANST	INTRO TO URBAN STUDIES	110	UG	X		Designed for freshmen and sophomores. Introduction to the study of cities and urban civilization focusing on the utopias that have been produced over time to guide and inspire city-dwellers to improve and perfect their urban environments. History of urbanization and the urban planning theories inspired by Ebenezer Howard, Le Corbusier, Frank Lloyd Wright, the New Urbanists and Smart Growth advocates that address current issues such as urban community dynamics, suburbanization, sustainability, and globalization. Public policy approaches designed to address these issues and utopian visions of what cities could be, or should be, in the future. Topic of the final paper chosen by the student, with consent of instructor, and may be a historical research paper, a policy-advocacy paper, or a proposal for an urban utopia that addresses the challenges and possibilities of urban life today.
URBANST	INTRO TO URBAN DESIGN	113	UG	X		Comparative studies in neighborhood conservation, inner city regeneration, and growth policies for metropolitan regions. Lect-disc and research focusing on case studies from North America and abroad, team urban design projects. Two Saturday class workshops in San Francisco: 2nd and 4th Saturdays of the quarter.
URBANST	CONCEPTS & ANALYTIC SKILLS	132	UG	X		How to create and grow innovative not-for-profit organizations and for-profit enterprises which have the primary goal of solving social and environmental problems. Topics include organizational mission, strategy, communications/marketing, financing and impact evaluation. Opportunities and limits of methods from the for-profit sector to meet social goals. Perspectives from the field of social entrepreneurship, design thinking and social change. Focus is on integrating theory with practical applications. Enrollment limited to 20. Prerequisite:consent of instructor. Email lalitvak@stanford.edu
URBANST	SUSTAINABLE CITIES	164	UG		X	Service-learning course that exposes students to sustainability concepts and urban planning as a tool for determining sustainable outcomes in the Bay Area. Focus will be on the relationship of land use and transportation planning to housing and employment patterns, mobility, public health, and social equity. Topics will include government initiatives to counteract urban sprawl and promote smart growth and livability, political realities of organizing and building coalitions around sustainability goals, and increasing opportunities for low-income and communities of color to achieve sustainability outcomes. Students will participate in team-based projects in collaboration with local community partners and take part in significant off-site fieldwork.

Stanford University Sustainability Course Inventory

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URBANST	GREEN MOBILITIES FOR THE SUBUR	167	UG	X		Much of the recent academic discussion of the future of urban mobility has stressed the likelihood of a concentration of all urban functions in dense urban centers. The need for sustainability, so the argument goes, will make cities ¿more like Manhattan¿ with high-rise clustering, residences close to work, pedestrian and bicycle pathways, and a heavy emphasis on mass transit. But a recent US Census report indicates that center-city urban growth in America has begun to level off while suburbs continue to grow vigorously, and the suburban residential option remains highly attractive both to the established middle-class populations in the advanced industrial nations and to the emerging middle-classes in Asia and Latin America. As a result, the real urban sustainability challenge of the future will be the task of greening the suburbs with the use of mobility policies that are necessarily very different from those needed in dense urban centers. In addition, the automobile industry will face two very different design and marketing challenges ¿ one for center cities and quite another for more spatially diffuse suburbs.Working together, students in this undergraduate seminar will explore these issues, hear from suburban planners and developers concerned about sustainability challenges, and engage in the re-design of suburbs and suburban mobility options for the future.