

Energy and Climate Courses at Stanford

Course Number	Course Title	Cross-Listed Classes	Units	Quarter	GER	Class format/size	General Area	Level	Prereqs	Professor	Description	Web Link	Comments
CHEMENG 35N	Renewable Energy for a Sustainable World	--	3	Aut	--		Science/Engineering	Frosh preference, Soph	--	Swartz, J.	An overall energy assessment, projections, and technologies. How to assess good and bad potential impacts of leading renewable energy candidates: benefit versus impact ratio using quantitative cradle-to-grave approach. Technologies suitable for near-term application in developing economic systems. Governmental policies, governmental versus private sector investments, raw materials supply issues, and impact of cultural influences on technology choices and speed of implementation. Classes are ~20 in size. 1 hour lectures three times a week. Covers basics about renewable energies from an engineering assessment perspective.	--	
CHEMENG 60Q	Environmental Regulation and Policy	--	3	Aut	DB-EngrAppSci	Lecture/Discussion	Environmental Policy	Soph preference	--	Robertson, C.; Libicki, S.	How environmental policy is formulated in the US. 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 development, 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. Classes are ~20 in size and is co-taught by Shari Libicki, a partner at Environ, an environmental consultancy. The focus is how science can inform policy. Class session occurs once a week and is 2 hours, 50 minutes long; the format is part lecture part group work. There is a heavy emphasis on group presentation and a project at the end of the term. There are no midterms or a final. The average workload is 5-10 hours a week.	--	
CEE 64	Air Pollution: From Urban Smog to Global Change	CEE 263D	3	Win						Jacobson, M	Survey of urban- through global-scale air pollution. Topics: the evolution of the Earth's atmosphere, indoor air pollution, urban smog formation, history of discovery of atmosphere chemicals, visibility, acid rain, the greenhouse effect, historical climate, global warming, stratospheric ozone reduction, Antarctic ozone destruction, air pollution transport across political boundaries, the effects of air pollution on ultraviolet radiation, and impacts of energy systems on the atmosphere. GER: DB-NatSci		
CEE 100	Managing Sustainable Building Projects		4	Spr						Fischer, M	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. GER:DB-EngrAppSci		
CEE 115	Goals and Methods of Sustainable Building Projects	CEE 215	4	Aut						Haymaker, J	Goals related to sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and economic and social sustainability. Methods to integrate these goals and enhance the economic, ecological, and equitable value of building projects. Industry and academic rating systems, project case studies, guest lecturers, and group project.		
CEE 136	Green Architecture	CEE 236	4								Preference to Architectural Design and CEE majors; others by consent of instructor. An architectural design studio exploring the Stanford Green Dorm project. Initial sessions develop a working definition of sustainable design and strategies for greening the built environment in preparation for design studio work. Enrollment limited to 14. Prerequisites: 31 or 31Q, and 110 and 130. GER:DB-EngrAppSci		
CEE 142A	Creating Sustainable Development	CEE 242A	3	Win						Christensen, S	How the built environment influences the way people interact with each other in communities. Case studies. How tradeoffs among economic, ecological, and social benefits can be managed. Frameworks for managing stakeholder processes including negotiating multiparty processes. Group project. Enrollment limited to 50.		

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Course ID	Course Title	Prerequisites	Units	Term	Days	Format	Instructor	Level	Notes	Assessment	Other
CEE 248G-01	Measuring Sustainability		1	Spr 09		Lecture/Lab	Jiffy Vermeylen		Measuring Sustainability is open to students in all disciplines. The goal is to prepare students for the United States Green Building Council's professional accreditation exam. Basic metrics for project certification via USGBC's LEED rating system will be discussed, as well as comparisons to other systems. Sustainability at Stanford will also be addressed. It is recommended that students have familiarity with basic design and construction terminology. Application deadline: March 20th, 2009 @ 8:00am. The course is currently offered only spring 09. The LEED accreditation process is changing soon, and students will no longer be eligible to become LEED-APs without prior experience on a LEED certified project.	Coursework	Field trip, some group work
CEE 301	The Energy Seminar		1	Fall, Win, Spr		Lecture	Horne, R.	None	Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students. May be repeated for credit.		
EE 140	The Earth from Space: Introduction to Remote Sensing	GEOPHYS 140	3	Aut (Alternate years)		Lecture/Lab	Zebker, H.	Juniors, Seniors, Grad students	Global change science as viewed using space remote sensing technology. Global warming, ozone depletion, the hydrologic and carbon cycles, topographic mapping, and surface deformation. Physical concepts in remote sensing. EM waves and geophysical information. Sensors studied: optical, near and thermal IR, active and passive microwaves. The class is about 15-20 students in size and there is a team project instead of a final, and weekly homework. There is a laboratory component as well.	http://www.stanford.edu/class/ee140	
MS&E 92Q	International Environmental Policy		4	Win		Policy	Weyant, J.	Soph preference	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. Classes are ~20 in size and the course load is described as 1-5 hours a week. It meets twice a week for approximately 1.5 hours.		
MS&E 198	Applied Modeling of Energy and Environmental Markets		1	Aut		Lecture/Discussion	Huntington, H.	Advanced juniors and seniors, Grad	Economic principles in models of energy and environmental markets. Spreadsheet examples for developing insights and communicating with decision makers. Market-clearing conditions, controlling emissions through fees, diffusion of new technologies, resource depletion, cartel behavior, and model evaluation. Class meets once a week with about 25 people. The format is lecture with some discussion. There is no HW or projects (two years ago).		
MS&E 243	Energy and Environmental Policy Analysis		3	Spr		Lecture (45)	Sweeney, J.	IPER 241 or ECON 50, 51.	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. Class meets three times a week with about 45 people in each class. A group project comprises 40% of your grade. The project is centered around choosing your own policy to analyze. The final is 50% of the grade, and problem sets are 10%. More focused on policy. Intertemporal economic analysis of natural resource use, particularly energy, and including air, water, and other depletable mineral and biological resources. Emphasis is on an integrating theory for depletable and renewable resources. Stock-flow relationships; optimal choices over time; short- and long-run equilibrium conditions; depletion/extinction conditions; market failure mechanisms (common-property, public goods, discount rate distortions, rule-of-capture); policy options. Class meets three times a week with about 45 students. There is a group project that requires an in-class presentation at the end of the quarter, and written paper. 40%-50% of grade. The final exam is open notes, and open book. More quantitative.	None	
MS&E 248	Economics of Natural Resources	IPS 248	3 - 4	Aut		Lecture/Discussion	Sweeney, J.	Seniors, Grad students	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.		
MS&E 294	Climate Policy Analysis		3	Alternate years		Economics/Policy	Weyant, J.	Seniors, Grad students	Background in economics, optimization, and decision analysis.		

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MS&E 295	Energy Policy Analysis	--	3	Win	--		Economics/Policy	Seniors, Grad students	Background in economic optimization, and decision analysis	Weyant, J.	Design and application of formal analytical methods for policy and technology assessments of energy efficiency and renewable energy options. Emphasis is on integrated use of modeling tools from diverse methodologies and requirements for policy and corporate strategy development.	Group Project
MS&E 296	Sustainable Mobility - Improving Energy Efficiency in Transport		3	Spr 09			Economics/Policy	Seniors, Grad Students		Schipper, L.	Covers key issues of sustainable mobility, vehicles, fuels, air pollution, and CO2 emissions from transport. Primarily focused on the US passenger transport system, the course will offer insights on freight, with some attention to Europe and key developing countries. Tools of analysis primarily spreadsheets, but applications using econometrics encouraged for the class project. Problem sets, project, and a final focused on analytical issues and policies. Decision making models and methods to address complex, uncertain energy decisions. Experts present best practices and research on current topics such as traditional versus alternative energy supply, global demand forecasts, mathematical modeling of energy economics, energy policy and consumer behavior, and geopolitical energy considerations. Class meets once a week and is in seminar format and is a part of the annual series of seminars on decision making in the specific areas of medicine, energy, and environment. Speakers from different disciplines (both on and off campus) present their latest research, applications, and insights. Is a credit/no-credit class only and is dependent on the student's attendance and participation in discussions. Missed classes can be made up with a short writing assignment. Students are primarily from the MS&E and CEE departments, though there have also been graduate students from the school of humanities and sciences, education, law, business, and medicine, as well as upper div undergraduates with an interest in the topic.	
MS&E 453B	Energy Decision Making Seminar	--	1	Win	--	Seminar	Economics/Policy	Seniors, Grad students (any school)	--	Robinson, B.	Decision making models and methods to address complex, uncertain environmental decisions. Experts present best practices and research on current topics such as climate change science and policy, mathematical modeling of environmental strategy consequences, marine resource preservation, groundwater contamination, and international agricultural crop decisions. Class meets once a week and is in seminar format and is a part of the annual series of seminars on decision making in the specific areas of medicine, energy, and environment. Speakers from different disciplines (both on and off campus) present their latest research, applications, and insights. Is a credit/no-credit class only and is dependent on the student's attendance and participation in discussions. Missed classes can be made up with a short writing assignment. Students are primarily from the MS&E and CEE departments, though there have also been graduate students from the school of humanities and sciences, education, law, business, and medicine, as well as upper div undergraduates with an interest in the topic.	
MS&E 453C	Environmental Decision Making Seminar	--	1	Spr	--	Seminar	Economics/Policy	Seniors, Grad students (any school)	--	Robinson, B.	Overlap and synergies between business and environmental fields. Guest speakers from for-profit and nonprofit sectors. Past speakers have included business executives, alternative energy experts, environmental consultants, and professors. Group assignments build on concepts presented during the weekly 90-minute class discussions. The class is offered for the credit/no-credit option. Classes are seminar format with speakers from different clean tech businesses. Students must attend 9 of 10 classes in order to receive credit. There are two essay responses (prepared in groups) due once at the middle of the quarter and one at the end. Great class for anyone, from freshmen to grad students	
MS&E 474	Business and Environmental Issues	--	2	Spr	--	Seminar	Economics	Seniors, Grad students, though freshmen, sophomores, and juniors okay too	--	Plambeck, E.; Sweeney, J.		

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MS&E 491	Real-World Clean Energy Project Development	--	3	Alternate years	--	Economics	Grad	--		Student teams prepare and present a development plan for a clean energy project of their choice, specifying the resource, technology, market, end-use, and policy and regulatory factors. Management plan and financial and economic evaluation. readings and presentations on topics in clean energy. Guest speakers involved in project development. Heavy emphasis on team projects and presentations. Workload is approximately 1-5 hours a week.
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	--	4	Aut	DB-EngrAppSci	Engineering/Science	Juniors, Seniors	--	Clemens, B.	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. Theory of conventional p-n junction and excitonic solar cells. Design, fabrication, and characterization of crystalline silicon, amorphous silicon, CdTe, CIGS, and tandem and organic solar cells. Emerging solar cell concepts such as intermediate band gap and bioinspired solar cells. Emphasis is on the materials science aspects of solar cells research. Module design and economic hurdles that must be overcome for solar cell technology to generate a significant fraction of the world's electricity. Group project to explore one solar cell approach in depth. Class meets three times a week and the workload was about 1-5 hours a week.
MATSCI 302	Solar Cells	--	3	Spr	--	Engineering/Science	Grad	--	McGehee, M.	Sample application areas: renewable energy including nanoscaled photovoltaic cells, hydrogen storage, fuel cells, and nanoelectronics. Nanofabrication techniques including: self-assembly of amphiphilic molecules, block copolymers, organic-inorganic mesostructures, colloidal crystals, organic monolayers, proteins, DNA and abalone shells; biologically inspired growth of materials; photolithography, electron beam lithography, and scanning probe lithography; and synthesis of carbon nanotubes, nanowire, and nanocrystals. Other nanotechnology topics may be explored through a group project. Class meets twice a week and the workload was about 1-5 hours a week. There are about 80-90 people in the class, though lectures are available online through scpd.
MATSCI 316	Nanoscale Science, Engineering, and Technology	--	3	Win	--	Engineering/Science	Grad	Ideally knowledge of organic materials (MatSci 190/210 or ChemE 160), microfabrication (EE 212), and electronic materials (MatSci 152 and MatSci 209)	Cui, Y.	Class meets twice a week and the workload was about 1-5 hours a week. There are about 80-90 people in the class, though lectures are available online through scpd.
ME 25N	Global Warming and Climate Change: Fact or fiction	--	3	Win	--	Science	Frosh preference	High school physics, chemistry, and biology MATH 43, PHYSICS 55, and ENGR 30 or ME 140, or equivalents	Bowman, C.	Scientific arguments are not causing global warming versus the view that these activities are responsible for a global warming that results in significant climate change. Consequences of increased demand for energy.
ME 260	Fuel Cell Science and Technology	--	3	Spr	--	Engineering/Science	Juniors, Seniors, Grad students		Prinz, F.	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. Class meets twice a week for approximately 1 hour, and the courseload outside of class is about 5-10 hours a week.
ME 399	Fuel Cell Seminar	--	1	Alternate years	--	Science	Grad			Interdisciplinary research in engineering, chemistry, and physics. Talks on fundamentals of fuel cells by speakers from Stanford, other academic and research institutions, and industry. The potential to provide high efficiency and zero emissions energy conversion for transportation and electrical power generation. Class is a seminar style, credit/no-credit grading checked for attendance.

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EARTHSYS 10	Introduction to Earth Systems	--	4	Aut	DB-NatSci	Lecture, with sections (150)	Science	Primarily freshmen & sophomores	--	Ernst, G.	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. Guest lectures and field trips to local energy-efficient buildings. Stanford's current carbon profile and energy consumption. How to evaluate building envelope, lighting, heating, cooling, and energy efficiency economics. Students evaluate a campus building for submission to Facilities and Operations. Group project focused on reducing Stanford's carbon emissions.	None
EARTHSYS 15SI	Reducing Stanford's Carbon Footprint	--	2	Aut	--	Guest lectures, field trips, discussions, group project (10-12)	Science	Undergraduates	--	Taught by a different student each year. Faculty sponsor: Schneider, S.	None	
EARTHSYS 45N	Energy Issues Confronting the World	--	3	Win	DB-NatSci	Introsem (15)	Science	Freshmen	--	Howell, D.	Geologic, economic, and policy issues shaping energy use and contrasting human perceptions of energy security. Topics include discourse of resources, history and future of fossil fuels, curse of oil, global climate change, adaptation versus mitigation, relationship between wealth and energy, demand and strategies for efficiency and conservation, alternative energy prospects, geopolitics of energy trading, and energy flow among countries of the world. Game simulation, outside readings, class brainstorming, and student oral presentations on country energy profiles	None
EARTHSYS 101	Energy and the Environment	ENERGY 101	3	Win	DB-EngrAppSci		Engineering	Sophomores, Juniors, Seniors	Recommended: MATH 21 or 42, ENGR 30	Kovscek, A; Durlifsky, L	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 102	Renewable Energy Sources and Greener Energy Processes	ENERGY 102	3	Spr	DB-EngrAppSci		Engineering	Juniors, Seniors	Recommended: 101, MATH 21 or 42	Kovscek, A; Gerritsen, M; Horne, R	The energy sources that power society are rooted in fossil energy although energy from the core of the Earth and the sun is almost inexhaustible; but the rate at which energy can be drawn from them with today's technology is limited. The renewable energy resource base, its conversion to useful forms, and practical methods of energy storage. Geothermal, wind, solar, biomass, and tidal energies; resource extraction and its consequences.	
EARTHSYS 103	Energy Resources	CEE 173A, CEE 207A	4 or 5	Aut	DB-EngrAppSci	Lecture, with optional section (130)	Engineering	Undergraduates and Graduates	--	Woodward, J	Fossil and renewable energy resources: oil, natural gas, coal, nuclear, hydropower, solar, geothermal, biomass, wind, ocean energy, and energy efficiency. Topics for each resource: resource abundance, location, recovery, conversion, consumption, end-uses, environmental impacts, economics, policy, and technology. Buildings, transportation, the electricity industry, and energy in the developing world. Required field trips to local energy facilities. Optional discussion section for extra unit.	http://www.maproyalty.com/stanford/173A/
EARTHSYS 112	Environmental Economics and Policy	ECON 155	5	Win	DB-NatSci		Economics/Policy	Juniors, Seniors	ECON 50	Kotchen, M	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.	
EARTHSYS 123	From Local to Global: Collaborations for International Environmental Education	EDUC 122X	2	Alternate Years	--		Science/Education	Undergraduates	--	Hoagland, S; Emery, D; Goldman, S	A collaboration with three universities in Africa. Discourse and debate using Internet and mobile technology interactions. Topics include the global environment, climate change, sustainable development, and food security.	
EARTHSYS 124/224	Environmental Justice: Local, National, and International Dimensions	--	4	Alternate Years	--		Science/Social Science	Undergraduates	--	Burns, W	Focus is on whether minorities and low income citizens suffer disproportionate environmental and health impacts resulting from government and corporate decision making in contexts such as the siting of industrial facilities and waste dumps, toxic chemical use and distribution, and the enforcement of environmental mandates and policies. Implications of environmental justice issues at the international level, emphasizing climate change.	

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EARTHSYS 132/232	Energy Cooperation in the Western Hemisphere	IPS 263	4	Spr	--	Seminar with guest lectures (20)	Policy	Juniors, Seniors, Graduates	--	O'Keefe, T	Current political dynamics in major western hemisphere fossil fuel producers in N. America, the Andean region, the Southern Cone of S. America, and Trinidad and Tobago. The potential for developing sustainable alternative energy resources in the western hemisphere for export particularly biofuels, and its impact on agricultural policy, environmental protection, and food prices. The feasibility of creating regional energy security rings such as the proposed N. American Energy Security and Prosperity Partnership.	None
EARTHSYS 147/247	Controlling Climate Change in the 21st Century	BIO 147/247, HUMBIO 116	3	Win; Alternate Years	DB-NatSci	Lecture, with discussion section for 247 (100-150)	Science/Policy	Juniors, Seniors, Graduates	--	Schneider, S; Mastrandrea, M	Global climate change science, impacts, and response strategies. Topics: scientific understanding of the climate system; modeling future climate change; global and regional climate impacts and vulnerability; mitigation and adaptation approaches; the international climate policy challenge; and decarbonization of energy and transportation systems.	None
EARTHSYS 188/288	The Political Economy of Energy in India	--	2 or 3	Alternate Years	--	Seminar	Policy	Juniors, Seniors	Application	Victor, D	How central, state, and local governments in India balance the competing goals of alleviating poverty, protecting the environment, and assuring the financial viability of India's energy companies. Case studies. Two-week field trip to India in June 2007 to visit industrial sites and meet with stakeholders in industry, government, and consumer advocacy.	
EARTHSYS 205	Political Economy of Energy Policy	Law 227	4	Win	--		Policy	Juniors, Seniors, Graduates	Application	Victor, D	Theoretical frameworks used by political scientists, sociologists, economists, and other intellectuals to understand how societies make and implement public policies related to energy and how the energy industry responds. Topics include theories of the state, monopoly and regulation, public choice, organizational behavior, international agreements, and innovation. Applications of those theories to energy policy issues, such as ethanol, climate change, energy security, the role of national oil companies in the world oil market, the functioning of OPEC, and the California electricity crisis.	
EARTHSYS 215	Free Trade, NAFTA, and the Environment	--	4 or 5	Spr	--		Policy	Juniors, Seniors, Graduates	--	Simon, G	New forms of environmental governance stipulated within NAFTA policy. Topics include: theories of free trade, economic liberalization, and transnational environmental governance; green technology transfers; agricultural and industrial economies and implications for workers; transboundary conservation, water, and air quality issues in the N. American west.	
ENERGY 101	Energy and the Environment	EARTHSYS 101	3	Win	DB-EngrAppSci		Engineering	Sophomores, Juniors, Seniors	Recommended: MATH 21 or 42, ENGR 30	Kovscek, A; Durlofsky, L	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.	
ENERGY 102	Renewable Energy Sources and Greener Energy Processes	EARTHSYS 102	3	Spr	DB-EngrAppSci		Engineering	Juniors, Seniors	Recommended: ENERGY 101, MATH 21 or 42	Kovscek, A; Gerritsen, M; Horne, R	The energy sources that power society are rooted in fossil energy although energy from the core of the Earth and the sun is almost inexhaustible; but the rate at which energy can be drawn from them with today's technology is limited. The renewable energy resource base, its conversion to useful forms, and practical methods of energy storage. Geothermal, wind, solar, biomass, and tidal energies; resource extraction and its consequences.	
ENERGY 104	Technology in the Greenhouse	--	3	Spr	--	Lecture (12)	Engineering	Juniors, Seniors, Graduates	--	Benson, S	Technologies that might be employed to reduce emissions of greenhouse materials, such as carbon dioxide, methane, nitrous oxide, and black soot, produced by the generation and use of energy. Sources of greenhouse materials in the current energy mix and evidence for global geochemical and climate changes. Advantages and limitations of technologies to reduce emissions. Examples include renewable sources such as wind and solar energy, more efficient use of energy, hydrogen, capture and storage of carbon dioxide, and nuclear power.	None
ENERGY 120	Fundamentals of Petroleum Engineering	ENGR 120	3	Aut	DB-EngrAppSci	Lecture (25-30)	Engineering	Junior	--	Horne, R; Wilcox, J	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.	None

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ENERGY 130	Well Log Analysis I	--	3	Aut	--	Lecture, with field trip (12-18)	Engineering	Upper-level undergraduates and graduates	--	Lindblom, R	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.	None	
ENERGY 153/253	Carbon Capture and Sequestration	--	3	Aut	--	Lecture w/ brief weekly discussion section (18)	Engineering	Upper level undergraduate & graduate (~1/3 Undergrad, 2/3 Grad)	--	Benson, S; Wilcox, J	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.	None	(see attached document for course highlights)
ENERGY 155	Undergraduate Report on Energy Industry Training	--	1 to 3	Aut, Win, Spr, Sum	--	Independent work	Engineering	Undergraduate	Written consent of instructor	Staff	On-the-job practical training under the guidance of on-site supervisors. Required report detailing work activities, problems, assignments and key results.	None	
ENERGY 167/267	Engineering Valuation and Appraisal of Oil and Gas Wells, Facilities, and Properties	--	3	Win	DB-EngrAppSci	Lecture (25)	Engineering	Junior, Senior, Graduate	--	Kourt, W; Pande, K	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.	None	
ENERGY 175	Well Test Analysis	--	3	Spr	--	Lecture (25-30)	Engineering	Senior	--	Horne, R	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.	None	
ENERGY 180/280	Oil and Gas Production Engineering	--	3	Alternate Years	DB-EngrAppSci		Engineering		ENERGY 120. Recommended: ENERGY 130		Design and analysis of production systems for oil and gas reservoirs. Topics: well completion, single-phase and multiphase flow in wells and gathering systems, artificial lift and field processing, well stimulation, inflow performance.		
ENERGY 194	Special Topics in Energy and Mineral Fluids	--	1 to 3	Aut, Win, Spr, Sum	--		Engineering		--	Staff	None	May be repeated for credit.	
ENERGY 121/221	Fundamentals of Multiphase Flow	--	3	Win			Engineering	Undergraduate and Graduate		H, Tchelepi	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. 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 222	Advanced Reservoir Engineering	--	3	Spr	--	Lecture (20)	Engineering	Graduates	ENERGY 221	Durlofsky, L	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.	None	
ENERGY 223	Reservoir Simulation	--	3 or 4	Win	--		Engineering	Graduates	ENERGY 221 and 246, or consent of instructor. Recommended: CME 206	Durlofsky, L; Tchelepi, H; Gerritsen, M		Code black oil model simulator	

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ENERGY 224	Advanced Reservoir Simulation	--	3	Aut	--		Engineering	Graduates	ENERGY 223 or consent of instructor	Durlafsky, L; Tchelepi, H; Aziz, K	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. 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. 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.	None	May be repeated for credit.
ENERGY 225	Theory of Gas Injection Processes	--	3	Win	--	Lecture (10)	Engineering	Graduates	CME 200	Orr, F	None	May be repeated for credit.	
ENERGY 226	Thermal Recovery Methods	--	3	Spr, Alternate Years	--	Lecture (15)	Engineering	Graduates	--	Castanier, L	None		
ENERGY 227	Enhanced Oil Recovery	--	3	Alternate Years	--		Engineering	Graduates	--	Kovscek, A	None		
ENERGY 230	Advanced Topics in Well Logging	--	3	Spr	--	Lecture, with field trip (8-12)	Engineering	Upper-level undergraduates and graduates	ENERGY 130 or equivalent ; basic well logging; and standard practice and application of electric well logs	Lindblom, R	None		
ENERGY 246	Reservoir Characterization and Flow Modeling with Outcrop Data	GES 246	3	Aut	--	Lecture, with field and lab components (25)	Engineering	Graduate	--	Graham, S; Tchelepi, H; Boucher, A	None	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 255	Master's Report on Energy Industry Training	--	1 to 3	Sum	--	Independent work	Engineering	Graduates	Consent of adviser	Staff	None	May be repeated for credit.	
ENERGY 269	Geothermal Reservoir Engineering	--	3	Spr	--	Lecture; 2 field trips (25-30)	Engineering	Seniors and graduates	--	Home, R	None	Conceptual models of heat and mass flows within geothermal reservoirs. The fundamentals of fluid/heat flow in porous media; convective/conductive regimes, dispersion of solutes, reactions in porous media, stability of fluid interfaces, liquid and vapor flows. Interpretation of geochemical, geological, and well data to determine reservoir properties/characteristics. Geothermal plants and the integrated geothermal system.	
ENERGY 273	Special Topics in Petroleum Engineering	--	1 to 3	Aut, Win, Spr, Sum	--		Engineering	Graduates	--	Staff	None		
ENERGY 301	Energy Seminar	CEE 301	1	Aut, Win, Spr	--	Seminar (70 enrolled, 150 attendees)	Science/Engineering	Undergraduates and Graduates	--	Home, R	None	Interdisciplinary exploration of current energy challenges and opportunities, with talks by faculty, visitors, and students. http://woods.stanford.edu/cgi-bin/energyseminar.php	May be repeated for credit.
ENERGY 355	Doctoral Report on Energy Industry Training	--	1 to 3	Sum	--	Independent work	Engineering	PhD students	Consent of advisor	Staff	None	May be repeated for credit.	

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EES 37N	Energy and the Environment on the Back of an Envelope	--	3	Alternate Years	DB-NatSci	Introsem	Science	Freshmen	--		How quantitative understanding of the Earth helps inform decisions about energy supply. How can enough energy be provided to support future growth and development throughout the world without damaging the natural environment? Focus is on simple quantitative observations and calculations that facilitate evaluation of potential solutions to this problem; algebra only, no calculus.		
EES 39N	The Carbon Cycle: Reducing Your Impact	--	3	Spr	DB-NatSci	Introsem	Science	Freshmen	--	Chamberlain, P	Changes in the long- and short-term carbon cycle and global climate through the burning of fossil fuels since the Industrial Revolution. How people can shrink their carbon footprints. Long-term sources and sinks of carbon and how they are controlled by tectonics and short-term sources and sinks and the interaction between the biosphere and ocean. How people can shrink their carbon footprints. Held at the Stanford Community Farm.		
GEOPHYS 255	Report on Energy Industry Training	--	1 to 3	Au, Win, Spr, Sum	--	Independent work	Engineering	Graduates	Written consent of instructor	Staff	On-the-job-training for master's and doctoral degree students under the guidance of on-site supervisors. Students submit a report detailing work activities, problems, assignment, and key results.	None	May be repeated for credit.
GEOPHYS 300	Earth Sciences Seminar	EARTHSYS 300, EES 300, EESS 300, ENERGY 300, GES 300, IPER 300	1	Aut	--	Seminar	Science	Graduates	--	Harris, J.	Required for incoming graduate students except cotermers. 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 each other across departments and research groups. Two faculty members present work at each meeting. May be repeated for credit.		
GES 246	Reservoir Characterization and Flow Modeling with Outcrop Data	ENERGY 246	3	Aut	--	Lecture, with field and lab components (25)	Engineering	Graduate	--	Graham, S; Tchlepi, H; Boucher, A	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.		
GES 253	Petroleum Geology and Exploration	--	3	Spr	--	Lecture, with lab component (25)	Science	Graduate	Prerequisites: 110, 151.	Graham, S	The origin and occurrence of hydrocarbons. Topics: thermal maturation history in hydrocarbon generation, significance of sedimentary and tectonic structural setting, principles of accumulation, and exploration techniques.	None	
IPER 243	Energy and Environmental Policy Analysis	MS&E 243	3	Spr	--	Lecture (45)	Policy	Graduates	IPER 241 or ECON 50, 51.	Sweeney, J	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.	None	
CLASSGEN 123/223	Urban Sustainability: Long-Term Archaeological Perspectives	URBANST 115	3-5	Spr	--	Lecture	Social Sciences	Undergrad	--	Shanks, M	Comparative and archaeological view of urban design and sustainability. How fast changing cities challenge human relationships with nature. Innovation and change, growth, industrial development, the consumption of goods and materials. Five millennia of city life including Near Eastern city states, Graeco-Roman antiquity, the Indus Valley, and the Americas. Class meets twice a week and is in lecture format.	http://humanitieslab.stanford.edu/admin/directory.html	
ECON 17N	Energy, the Environment, and the Economy	--	2	Spr	--	Seminar	Economics	F, Sem	--	Wolak, F	The relationship between environmental quality and production and consumption of energy. Can environmentally-friendly energy production and consumption compete with conventional sources? How to estimate and compare environmental impact costs of nonrenewable sources such as fossil fuels and nuclear power versus renewable sources such as solar and wind power. Implicit subsidies in conventional energy sources and the environmental costs of these subsidies. Regulatory and legal barriers to more environmentally friendly energy sources. Class meets twice a week and is a small seminar format.		
ECON 251	Natural Resource and Energy Economics	--	2-5	Win	--	Lecture	Economics	Grad	202, 203, 204, 271, and 272	Wolak, F	Issues in provision and management of non-renewable and renewable natural resources, and energy products and services. Theory and empirical methods related to: market structure, pricing, and performance of important energy and resource industries; sources of market failure in these industries; and alternative regulatory approaches. Can be taken for 2 to 5 units with different assignment requirements depending on unit amount.		

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HISTORY 282C/382C	Environmental History of the Middle East	HISTORY 382C	4-5	Spr	--	Seminar/Discussion	Policy	Juniors, Seniors, Grad students	--	Mikhail, A	What can Middle East environmental history learn from a consideration of other regions? Major problems of the field, available sources, and directions for future research. Topics include Islam and the environment, animals, environmentalism, gardens, colonialism, disease, water and irrigation, and science and technology. Meets two hours once a week. Has a 4 or 5 unit option. There is one presentation required for the readings and a final paper. No final exam.
IPS 262	Contemporary Issues in Nuclear Energy Policy	--	5	Win	--	Lecture	Policy	Grad	--	Staff	Current nuclear energy trends related to economic growth and carbon-free energy production to reduce global warming. Topics include: trends, promise, and perils; environment; proliferation; and international security. Policy considerations for nuclear safety and safeguards, environmentally responsible management from raw uranium to spent fuel, international security and nonproliferation, economic competition with other energy sources, domestic and foreign politics, and international law and treaties. International guest expert lecturers. Relationships among dependence on oil export, democratization and authoritarian rule, and rising conflict. Case studies including Venezuela, Nigeria, Iran, Iraq, Chad, and Indonesia. The resource curse: the impact of oil on a country's political economy. The relationship between such economic dependence and regime type. Why oil exporting countries are more prone to conflict and civil war than other countries. Class meets twice a week. Application required and preference is given to sophomores. The total class size is 15-20 students. Each student is asked to become an "expert" in an oil producing country and is responsible for required readings, at least one short oral presentation, regular class participation, three short papers, and a policy memorandum at the end of the course in lieu of a final examination. Readings provide extensive coverage of energy policy topics throughout the course.
POLISCI 43N	Oil, Regime Change, and Conflict	--	5	Aut	--	Seminar	Policy	S, Sem	--	Karl, T	Political and economic determinants of oil and resource policies in developing countries, and their impact on world markets. Interaction between states and extractive industries, challenges of resource wealth management, and causal links between resource dependency and institutions. Is there a resource curse? Do mineral rents hinder democracy and development? Why is resource nationalism on the rise again? Why are there such high rents in oil extraction? Meets once a week for three hours; class sizes are about 20-25 students. Students complete readings assigned before each lecture and are expected to actively contribute to the class discussion. There is a requisite short presentation about a resource-producing country or region. There is a short midterm exam and a final long paper on one of the topics covered during the course. Enrollment is limited and requires the permission of the instructor.
POLISCI 242	Political Economy of Oil and Other Resources	--	5	Spr	--	Lecture/Discussion	Policy	Grad	Senior standing, or masters student; familiarity with basic economic and political economy is highly desired	Monaldi Marturet, F	Why is resource nationalism on the rise again? Why are there such high rents in oil extraction? Meets once a week for three hours; class sizes are about 20-25 students. Students complete readings assigned before each lecture and are expected to actively contribute to the class discussion. There is a requisite short presentation about a resource-producing country or region. There is a short midterm exam and a final long paper on one of the topics covered during the course. Enrollment is limited and requires the permission of the instructor.
PUBLPOL 121	Policy and Climate Change	--	5	Aut	--	Seminar (22)	Policy	Undergrad	--	Nation, J	Science and economics, including recent findings. History and evolution of local, state, regional, national, and international policy. California's recent landmark climate change bill. Future policy prospects, emphasizing national and international levels. Meets once a week for two hours. Minimal coverage of energy policy.
URBANST 165	Sustainable Urban and Regional Transportation Planning	--	4-5	NGTY	DB-SocSci		Policy				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.
ANTRHO 90C	Theory of Ecological and Environmental Anthropology	HUMBIO 118	3-5	Win	DB-SocSci, WIM		Social Science			Bird, R	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.

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ANTHRO 115A	Environmental Crises and State Collapse: Lessons from the Past	HUMBIO 115	3	Spr	Seminar (10-15)	Social Science	Juniors, Seniors	HUMBIO Core	Truncer, J	The effects and consequences of long-term human interaction with the environment. How and why past societies adapted, or failed to adapt, to changing environmental conditions and relevance to current environmental problems. Demographic, archaeological, and environmental data assessed using case studies from around the world since the late Pleistocene. Development of agriculture, societal collapse, sustainability, and policy response.	
ANTHRO 161A/261A	Ecology, Nature, and Society: Principle in Human Ecology		4	Aut	Lecture w/Discussion Section (40)	Social Science			Glover, S	Interdisciplinary. The study of diversity and change in human societies, using frameworks including anthropology, evolutionary ecology, history, archaeology, and economics. Focus is on population dynamics, family organization, disease, economics, warfare, politics, and resource conservation.	
ANTHRO 162/262	Indigenous Peoples and Environmental Problems		3-5	Spr	DB-Hum, EC-GlobalCom	Social Science			Durham, W	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 177/277	Environmental Change and Emerging Infectious Diseases	HUMBIO 114	3-5	NGTY	DB-SocSci	Social Science				The changing epidemiological environment. How human-induced environmental changes, such as global warming, deforestation and land-use conversion, urbanization, international commerce, and human migration, are altering the ecology of infectious disease transmission, and promoting their re-emergence as a global public health threat. Case studies of malaria, cholera, hantavirus, plaque, and HIV. (HEF III; DA-C)	
ME 25N	Global Warming and Climate Change: Fact or Fiction		3	Win	Seminar		F, Sem		Bowman, C	Scientific arguments concerning debates between the view that anthropogenic activities are not causing global warming versus the view that these activities are responsible for a global warming that results in significant climate change. Consequences of increased demand for energy. Prerequisites: high school physics, chemistry, and biology.	
APPPHYS 219	Solid State Physics and the Energy Challenge		3	Win					Shen, Z	Technology issues for a secure energy future: role of solid state physics in energy technologies. Topics include the physics principles behind future technologies related to solar energy and solar cells, solid state lighting, superconductivity, solid state fuel cells and batteries, electrical energy storage, materials under extreme condition, nanomaterials.	Alternate Years
APPPHYS 79N	Energy Choices for the 21st Century		3	Aut	By application, Seminar, 19 people	Science, Engineering	Freshmen, Sophomores	None	Fox, John and Geballe, Theodore	We will look at choices which can be envisioned for meeting the future energy needs of the United States and the rest of our planet, and evaluate their strengths and weaknesses. It takes a long time before any new technology can be implemented so that choices made today will affect your children and grandchildren. This seminar will explore the basic physics of energy sources, the technologies we might employ, and will highlight some of the intertwined public policy issues. The first half of the course will survey possible energy technologies, and develop an appreciation of the underlying physics to provide some quantitative estimates of the trade-offs. In the second half of the course the seminar members (as individuals or in groups) will be asked to prepare a discussion and paper on a selected technology, or on a related public policy choice. We are enthusiastic about having an enrollment of students with diverse interests and backgrounds because we think that the opportunity for those with technology interests to work with those with policy interests will provide unpredictable insights. An inquiring mind but no previous expertise or course prerequisites are required. We hope that attendees will learn to appreciate the need to bring quantitative estimates to the policy options in order to make rational choices for a sustainable world energy economy. We will use both lecture and discussion formats. We are arranging local field trips to see some of the energy technologies and learn from local experts.	
BIO 13N	Environmental Problems and Solutions		3	Spr	Seminar	Science	F, Sem	--	Ehrlich, P	Stanford Introductory Seminar. Preference to freshmen. Students do independent investigations of current environmental problems, analyzing differing views of them and discussing possible solutions. Each student gives two seminar presentations and leads two seminar discussions. Short, documented position papers are written for policy makers.	http://www.stanford.edu/group/CB/Staff/Ehrlich.html Professor biography provided in Web Link

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BIO 15N	Environmental Literacy		3	Win	Seminar	Science	F, Sem	--	Schneider, S	Stanford Introductory Seminar. Preference to freshmen. Lack of public understanding of the details of most environmental problems is cited as a cause of environmental deterioration. Good citizenship requires literacy about the elements of the scientific and decision making processes that accompany most environmental issues: what can happen, what are the odds, how can the credibility of sources of expertise be assessed, which components of environmental debates deal with factual and theoretical issues, and which are political value judgments? GFR:DB-NatSci	http://stephenscneider.stanford.edu/Mediaology/ameset.html	Professor website on "Environmental Literacy" provided in Web Link
CHEM 237	Electrochemistry		3	Win		Science	Juniors, Seniors, Grad	CHEM 171	Chidsey, C	Principles of electrochemistry and their application to redox systems, electron transfer, electroanalysis, electrodeposition, electrocatalysis, batteries, and fuel cells. Prerequisite: 171 or equivalent.	http://www.stanford.edu/dept/chemistry/academic/under/reqs.html	Department website in Web Link
GES 171	Geochemical Thermodynamics		3	Aut		Science, Engineering		GES 80	Bird, D	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: 80. GER:DB-NatSci		
GEOPHYS 222 (formerly 182)	Reflection Seismology		3	Aut, Given Alt. Years		Engineering		Graduate	Klemperer, S	The principles of seismic reflection profiling, focusing on methods of seismic data acquisition and seismic data processing for hydrocarbon exploration.		
GEOPHYS 223 (formerly 183)	Reflection Seismology Interpretation		1 to 4	Win, Given Alt. Years		Engineering		Graduate	Klemperer, S	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 224 (formerly 184)	Seismic Reflection Processing		3	Spr, Given Alt. Years		Engineering		Graduate	Klemperer, S	Workshop in computer processing of seismic reflection data. Students individually process a commercial seismic reflection profile from field tapes to migrated stack, using interactive software on a workstation. Prerequisite: consent of instructor.		
PHYSICS 220	Classical Electrodynamics			Win		Science	Advanced undergraduates/Graduate	Physics 121, 210, Math 106 and 132	Tantawi, S	Electrostatics and magnetostatics: conductors and dielectrics, magnetic media, electric and magnetic forces, and energy. Maxwell's equations: electromagnetic waves, Poynting's theorem, electromagnetic properties of matter, dispersion relations, wave guides and cavities, magnetohydrodynamics. Special relativity: Lorentz transformations, covariant, equations of electrodynamics and mechanics, Lagrangian formulation, Noether's theorem and conservation laws. Radiation: dipole and quadrupole radiation.		
PHYSICS 221	Classical Electrodynamics			Spr		Science	Juniors, Seniors, Grad	Physics 121, 210, 220; Math 106 and 132	Tantawi, S	Electrostatics and magnetostatics: conductors and dielectrics, magnetic media, electric and magnetic forces, and energy. Maxwell's equations: electromagnetic waves, Poynting's theorem, electromagnetic properties of matter, dispersion relations, wave guides and cavities, magnetohydrodynamics. Special relativity: Lorentz transformations, covariant, equations of electrodynamics and mechanics, Lagrangian formulation, Noether's theorem and conservation laws. Radiation: dipole and quadrupole radiation, electromagnetic scattering and diffraction, the optical theorem, Liénard-Wiechert potentials, relativistic Larmor's formula, frequency and angular distribution of radiation, synchrotron radiation. Energy losses in matter: Bohr's formula, Cherenkov radiation, bremsstrahlung and screening effects, transition radiation.		
PHYSICS 152A	Introduction to Particle Physics I	PHYSICS 252A	4	Win	Lecture, 15 students	Science	Juniors, Seniors, Grad	Physics 130, Co -- Physics 131	Dixon, L	Electromagnetic scattering and diffraction, the optical theorem, Liénard-Wiechert potentials, relativistic Larmor's formula, frequency and angular distribution of radiation, synchrotron radiation. Energy losses in matter: Bohr's formula, Cherenkov radiation, bremsstrahlung and screening effects, transition radiation. Prerequisites: 121, 210, or equivalents; MATH 106 and 132.	http://www.slac.stanford.edu/~lance/phys152A/index.html	

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Course ID	Course Title	Prerequisites	Units	Term	Format	Department	Level	Physics Course	Instructor	Description	Notes	
PHYSICS 152B	Introduction to Particle Physics II	PHYSICS 252B	4	Spr	Lecture, 15 students	Science	Juniors, Seniors, Grad	Physics 130, Physics 152 Co -- Physics 131	Quinn, H	(Same as PHYSICS 252B.) Discoveries and observations in experimental particle physics and relation to theoretical developments. Asymptotic freedom. Charged and neutral weak interactions. Electroweak unification. Weak isospin. Gauge theories, spontaneous symmetry breaking and the Higgs mechanism. Quark and lepton mixing. CP violation. neutrino oscillations. Prerequisites: 152 or 152A. 130, 131.		
PHYSICS 172	Solid State Physics		3	Spr		Science	Advanced undergraduates	Physics 170, 171	Manoharan, H	Crystal structures and bonding in solids. X-ray diffraction. Lattice dynamics and thermal properties. Electronic structure of solids; transport properties of metals; quantum oscillations; charge density waves. Properties and applications of semiconductors. Phenomenology and microscopic theory of superconductivity.		
PHYSICS 450	Particle Physics		3	Aut	Lecture, 14 students	Science	Graduate	Physics 262, 330, 331, 332	Peskin, R	General properties of proton-proton collisions at 14 TeV. Capabilities of the LHC experiments. QCD predictions for hard-scattering reactions: parton distributions, radiative corrections, jets, parton shower. Methods for computing multijet cross sections. Properties of W, Z, top quarks, and Higgs bosons at the LHC. Methods for discovering new heavy particles. May be repeated for credit. Prerequisites: 262, 330, 331, and 332.	http://www.slac.stanford.edu/~mpeskin/Physics450/	No net energy yet via particle physics
PHYSICS 25	Modern Physics		3	Spr	Lecture and discussion, 120 students	Science	All undergraduate	PHYSICS 23 or consent of instructor	Burchat, P	Introduction to modern physics. Relativity, quantum mechanics, atomic theory, radioactivity, nuclear reactions, nuclear structure, high energy physics, elementary particles, astrophysics, stellar evolution, and the big bang. Prerequisite: 23 or consent of instructor. How do incandescent light bulbs work and why are they so inefficient?		
										<p>Topics include:</p> <p>How do fluorescent bulbs work and why are they more efficient? Why do they contain mercury? How do LEDs (light emitting diodes) work and why are they even more efficient? How do solar cells turn light into electricity? How is mass turned into energy in the sun and in a nuclear reactor? What is the difference between fusion and fission?</p> <p>Other topics we discuss:</p> <p>How does Einstein's theory of special relativity lead to the conclusion that time "slows down" and objects are shorter when viewed in a moving frame of reference? How does quantum mechanics explain the form of the periodic table? How do we explain which isotopes are stable and which aren't? How does a laser work? What is radiation? How is it used for cancer therapy? What is dark matter and dark energy? How was the cosmic microwave background radiation produced and what does it tell us about the Universe?</p>		
PHYSICS 41	Mechanics		4	Win	Lecture, 100 students	Science	Freshmen, Sophomores	--	Church, S	Vectors, particle kinematics and dynamics, work, energy, momentum, angular momentum; conservation laws; rigid bodies; mechanical oscillations and waves. Discussions based on use of calculus. Corequisite: MATH 19 or 41, or consent of instructor. GER:DB-NatSci		
PHYSICS 43	Electricity and Magnetism		4	Spr	Lecture, 100 students	Science	Freshmen, Sophomores	--	Fisher, I	Electrostatics, Coulomb's law, electric fields and fluxes, electric potential, properties of conductors, Gauss's law, capacitors and resistors, DC circuits; magnetic forces and fields, Biot-Savart law, Faraday's law, Ampere's law, inductors, transformers, AC circuits, motors and generators, electric power, Galilean transformation of electric and magnetic fields, Maxwell's equations; limited coverage of electromagnetic fields and special relativity. Prerequisites: 41 or equivalent, and MATH 19 or 41. Corequisite: MATH 20 or 42, or consent of instructor. GER:DB-NatSci		
PHYSICS 45	Light and Heat		4	Aut, Sum	Lecture, 100 students	Science	Freshmen, Sophomores	--	Gratta, G / Staff	Reflection and refraction, lenses and lens systems; polarization, interference, and diffraction; temperature, properties of matter and thermodynamics, introduction to kinetic theory of matter. Prerequisites: 41 or equivalent, and MATH 19 or 41, or consent of instructor. GER:DB-NatSci		

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PHYSICS 61	Mechanics and Special Relativity	4	Aut	Lecture, 60	Science	Freshmen	Strong math and physics background	Blandford, R	For students with a strong high school mathematics and physics background. Contemplating a major in Physics or interested in a rigorous treatment of physics. The fundamental structure of classical physics including Newtonian mechanics, electricity and magnetism, waves, optics, thermodynamics. Foundations of modern physics including special relativity, atomic structure, quantization of light, matter waves and the Schrodinger equation. Diagnostic quiz in calculus and conceptual Newtonian mechanics at first meeting to decide if course is appropriate; some students may benefit more from the 40 series. Prerequisites: high school physics and familiarity with calculus (differentiation and integration in one variable); pre- or corequisite MATH 42. GER:DB-NatSci Recommended for prospective Physics majors or those interested in a rigorous treatment of physics. The fundamental structure of classical physics including Newtonian mechanics, Lagrangian mechanics, special relativity, and electricity and magnetism. Diagnostic quiz in calculus and conceptual Newtonian mechanics at first meeting of 61 to help students decide if course is appropriate; some students may benefit more from the 40 series. Prerequisites: high school physics and familiarity with calculus (differentiation and integration in one variable); pre- or corequisite: MATH 42. GER:DB-NatSci	Coursework
PHYSICS 63	Electricity, Magnetism, and Waves	4	Win	Lecture, 30 students	Science	Freshmen, Sophomores	Strong math and physics background	Allen, S	Recommended for students contemplating a major in Physics or interested in a more rigorous treatment of physics. The structure of classical physics including Newtonian mechanics, Lagrangian mechanics, special relativity, and electricity and magnetism. Diagnostic quiz in calculus and conceptual Newtonian mechanics at first meeting of 61 to help students decide if course is appropriate; some students may benefit more from the 40 series. Prerequisites: high school physics and familiarity with calculus (differentiation and integration in one variable); pre- or corequisite: MATH 42. GER:DB-NatSci	NA
PHYSICS 65	Thermodynamics and Foundations of Modern Physics	4	Spr	Lecture, 30 students	Science	Freshmen	Strong math and physics background	Fetter, A	Vector analysis, electrostatic fields, including multipole expansion; dielectrics. Special relativity and transformation between electric and magnetic fields. Maxwell's equations. Static magnetic fields, magnetic materials. Electromagnetic radiation, plane wave problems (free space, conductors and dielectric materials, boundaries). Dipole and quadrupole radiation. Wave guides and cavities. Prerequisites: 43 or 63; concurrent or prior registration in MATH 52 and 53. Recommended: concurrent or prior registration in 112	NA
PHYSICS 120	Intermediate Electricity and Magnetism	4	Win	Lecture	Science	Sophomores, Juniors	Pre -- Physics 43/63, Pre/Co -- Math 52 and 53, Co: Physics 112	Cabrera, B	Vector analysis, electrostatic fields, including multipole expansion. Dielectrics, static magnetic fields, magnetic materials. Maxwell's equation. Electromagnetic radiation. Special relativity and transformation between electric and magnetic fields. Plane wave problems (free space, conductors and dielectric materials, boundaries). Dipole and quadrupole radiation and their frequency and angular distributions. Scattering synchrotron and bremsstrahlung processes. Energy loss in water. Wave guides and cavities. Prerequisites: 120; concurrent or prior registration in MATH 131	NA
PHYSICS 121	Intermediate Electricity and Magnetism	4	Spr	Lecture and Class discussion (25-30 students)	Science	Mainly sophomore	Physics 120, Math 131, Physics 112	Petrosian, V	Transformative Design examines the implications of design decisions: the ways in which your designs change the world, and also the ways in which the world changes your designs. In this project-based course you will learn how to employ interactive technologies to create designs to expressly encourage behavioral transformation. Class sessions will be structured around project work and interdisciplinary discussion of topics such as self-efficacy, social support, and mechanism of cultural change; accompanying lab sessions will familiarize students with basic hardware and software tools for interaction prototyping. To announce please attend the first class.	http://www.stanford.edu/class/engr231/
ENGR 231	Transformative Design	3-5	Win	Seminar (40)	Design	All	Application	Sarah S. Lochlann Jain, Cultural and Social Anthropology; Wendy Ju, d.school; Bill Moggridge, IDEO; Bernard Roth, Mechanical Engineering and d.school		http://www.stanford.edu/class/engr231/

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OIT 333/334	Design for Extreme Affordability	ME206A/ME206B	4	Win/Spr	Seminar (40)	Interdisciplinary	Grad only	Application	James Patell; David Beach	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 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.	http://extreme.stanford.edu/index.html	
MS&E 288	Creating Infectious Action		4	Spr	Seminar (24)	Design	Grad only	Application	Perry Klebahn, Timbuk2, d.school; Bob Sutton, Management Science & Engineering; Diego Rodriguez, IDEO, d.school; Michael Dearing, d.school	This class will immerse Stanford masters students in the practice and theory of creating large-scale persistent behavioral changes. Student teams will complete hands-on projects coached by design process experts and evaluated by members of partner organizations and other business leaders, along with members of the teaching team. In addition, brief "thought bombs" will be presented in most classes on pertinent topics including developing ideas that stick, leading social movements, behavioral decision theory, network theory, interpersonal persuasion, examples of ideas that have spread, and seemingly unsuccessful ideas. We invite all Stanford graduate students to apply for the class. We select students for both their individual background and skills and, especially, to round out our multi-disciplinary teams. This is a high commitment class and will require intensive teamwork	http://www.stanford.edu/group/dschool/particpate/classes.html	> - Class format (lecture? seminar? sections?)
TBD	Designing for Sustainable Abundance		3-4	Spr	Seminar (12)	Design	Grad only	Application	Debra Dunn, d.school; Nitzan Waisberg, d.school	Can we use the design process to achieve material "abundance" while reducing raw material extraction and waste to sustainable levels? In this small, team-based, multidisciplinary class we will explore several key aspects of this challenge. How can households be motivated to recycle more of their waste? What are the opportunities to design useful solutions using material that many would view as trash? Can we design products and solutions to achieve a more durable emotional connection with their owners so that they are not discarded when they are no longer shiny and new? The course will provide hands-on experience in collaboration across disciplines as student teams use the design process to tackle these challenges in complex organizations. Students will wrestle with product and systems considerations involved in sustainable design.	http://www.stanford.edu/group/dschool/particpate/classes.html	2 lectures + two discussion sections
IPER 243	Energy and Environmental Policy Analysis	MS&E 243	3	Spr	Lecture (45)	Policy		241 or ECON 50, 51	Sweeney, J	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.		> - Level (frosh, sophomore, junior, senior, graduate)
IPER 335	Environmental Science for Managers and Policy Makers	Same as LAW 608, OIT 338	4	Win	Seminar (40)	Interdisciplinary	MBA, Law, MD with IPER MS		Plambeck, E; Daily, G; Field, C; Masters, G; Palumbi, S	recommended for those who plan to apply to the joint degree program. Fundamentals of earth and environmental science, spreadsheet modeling, optimization, and Monte Carlo simulation. Applications in resource management and environmental policy.		> - Course website (if applicable)
IPER 339	Environmental Entrepreneurship	GSBGEN 339	4	Aut (next available 2010)	Seminar (40)	Interdisciplinary	MBA		Plambeck, E	The potential of markets for solving environmental problems, and for environmental entrepreneurs to invent those solutions. How to apply business principles of finance, marketing, economics, operations, and accounting to the provision of environmental goods and services. Case studies include innovation in materials and energy, conservation of land and wildlife, environmental product differentiation and supply chain management, investing under regulatory risk, and partnership between nonprofit and for-profit organizations. Guest speakers include environmental entrepreneurs, venture capitalists, corporate executives, and nonprofit leaders. Students develop their own business plans in environmental entrepreneurship.		Not open yet

Energy and Climate Courses at Stanford

LAW 513	California Climate Change Law and Policy		1.7	Aut		Policy	Law		Grenfell, K	The California Global Warming Solutions Act of 2006, the clean cars and trucks bill, and the greenhouse gas emissions performance standard. Complementary and subsidiary regulations such as the renewable portfolio standard, the low Carbon fuel standard, land use law, and energy efficiency and decoupling. Focus is on the draft scoping plan to outline California's policies for economy-wide reductions in greenhouse gas emissions. The Western Climate Initiative. History, details, and current status of California's efforts.	http://www.law.stanford.edu/program/courses/#2nd-3rd_year_program	
LAW 514	The California Coast: Science, Policy, and Law	EARTHSYS 175, EARTHSYS 275, CEE 175A, CEE275A	5.1	Win		Interdisciplinary			Boehm, A; Sivas, D; Caldwell, M	The legal, science, and policy dimensions of managing California's coastal resources. Coastal land use and marine resource decision making. The physics, chemistry, and biology of the coastal zone, tools for exploring data from the coastal ocean, and the institutional framework that shapes public and private decision making. Field work: how experts from different disciplines work to resolve coastal policy questions. Students prepare papers to be used as technical support for problems that arise in the negotiations for the new global climate change agreement. Examples of paper subjects include analyzing the performance of proposed financial mechanisms in support of climate favoring technologies, the roles of intellectual property in facilitating or impeding technology diffusion, and the effectiveness of existing or past efforts to influence technology innovation at national or international levels. Focus is on output to those questions framed by the negotiation issues where bottlenecks may be avoided through improved technical support.	http://www.law.stanford.edu/program/courses/#2nd-3rd_year_program	> - Syllabus-please email me a copy if possible
LAW 599	Climate Change Workshop		4.5	Aut / Win (Semester)		Policy	Law		Heller, T		http://www.law.stanford.edu/program/courses/#2nd-3rd_year_program	Will go on courseworks later
LAW 604	Environmental Law Workshop: Clean Technology		3.75	Win	Seminar (30)	Interdisciplinary	Law		Caldwell, M; Thompson, B	Current research and work in environmental and natural resources field focused on clean technologies. Academics, policy makers, and business leaders from various disciplines present current research or work.	http://www.law.stanford.edu/program/courses/#2nd-3rd_year_program	
LAW 227	The Political Economy of Energy Policy	Earth Systems 205	4	Win		Policy		Juniors, Seniors, Graduates	Victor, D	Theories of political economy that explain policy choices and behavior in energy markets in the U.S. and overseas. Topics include: collective action and public choice; state behavior and sovereignty; international political economy; behavior of complex organizations; monopoly and regulation. Case study applications, such as U.S. policy on ethanol, safety regulation at nuclear power plants, and international collective efforts to manage global warming.	http://pesd.stanford.edu/courses/list/0/0/0/	
LAW 605	International Environmental Law		3.75	Not this year		Policy	Law			This seminar examines the legal, scientific, political, economic, and organizational issues associated with the creation of international environmental regimes. The principal focus is on the issue of climate change, with a focus on the current regime(s) and the post-Kyoto negotiations, now underway. The course also addresses the Montreal Protocol for Ozone Depleting Substances, the International Convention for Regulation of Whaling, and the U.N. Convention on Straddling Fish Stocks and Highly Migratory Fish Stocks. It examines the interaction between law, science, and economics in shaping the choice of treaty instrument and the implementation and evolution of environmental regimes. The course also looks closely at the structure and performance of environmental markets as solutions to global commons problems. Finally, it considers the evolving meanings in an international context of concepts such as sustainable development, common heritage of mankind, and common but differentiated responsibilities of nations.	http://www.law.stanford.edu/program/courses/#2nd-3rd_year_program	

Energy and Climate Courses at Stanford

LAW 455	Energy Law and Policy	4.5	Spr (last offered 2007)	Seminar (30)	Policy	Law	David Victor	<p>This course will cover the major types of regulation and market oversight that apply to energy systems. Topics covered will include extraction of oil and gas; contracting and regulation of large infrastructure; siting and control of hazardous energy infrastructures such as refineries; operation and control of the international market for crude oil and products; regulation of electric power franchises; regulatory reform in electricity and gas; major environmental regulations that apply to the energy sector. Most of the course will be empirical, but attention will be given to major theories of market failure as well as theories from political economy that explain when, why and how governments regulate energy systems. Most case material will be drawn from the experience in the United States, but the course will also include comparisons with other countries--notably in Western Europe and also in the major developing countries including Brazil, China and India. Case material will concentrate on national regulation, but topics of regulatory federalism will be addressed, as will attempts to coordinate regulatory actions across international borders such as through international treaties.</p> <p>Public regulators exert a pervasive influence over large swaths of industrial activity. Even where government has sought to rely more heavily on market forces, regulation is nonetheless often omnipresent. This course will introduce major theories and cases on the role of regulation in modern economies, with emphasis on competition, environmental protection, and product safety. Examples will be drawn mainly from electricity and utilities, oil & gas, telecommunications, chemicals, and food. The course will provide a comprehensive introduction to regulatory oversight of these industries in the U.S. and will address common themes and challenges, such as the limited ability of regulators to elicit accurate information from their subjects, rent-seeking, and the impact of regulation on technological innovation. Some attention will be given to comparisons with other countries and to the increasingly role of international institutions, such as the World Trade Organization, that constrain the scope and style of national regulation.</p>	http://pesd.stanford.edu/courses/list/0/0/0/
LAW 220	Regulated Industries	3.75	Win (Last offered 2008)	Seminar (30)	Policy	Law	David Victor	<p>Public regulators exert a pervasive influence over large swaths of industrial activity. Even where government has sought to rely more heavily on market forces, regulation is nonetheless often omnipresent. This course will introduce major theories and cases on the role of regulation in modern economies, with emphasis on competition, environmental protection, and product safety. Examples will be drawn mainly from electricity and utilities, oil & gas, telecommunications, chemicals, and food. The course will provide a comprehensive introduction to regulatory oversight of these industries in the U.S. and will address common themes and challenges, such as the limited ability of regulators to elicit accurate information from their subjects, rent-seeking, and the impact of regulation on technological innovation. Some attention will be given to comparisons with other countries and to the increasingly role of international institutions, such as the World Trade Organization, that constrain the scope and style of national regulation.</p>	http://pesd.stanford.edu/courses/list/0/0/0/