EARTH SYSTEMS

Courses offered by the Earth Systems Program are listed under the subject code EARTHSYS (https://explorecourses.stanford.edu/search/?q=EARTHSYS&view=catalog&page=0&academicYear=&filter-term-Autumn=on&filter-term-Winter=on&filter-term-Spring=on&filter-term-Summer=on&collapse=&filter-departmentcode-EARTHSYS=on&filter-coursestatus-Active=on&filter-catalognumber-EARTHSYS=on&filter-catalognumber-EARTHSYS=on) on the Stanford Bulletin's ExploreCourses web site (http://explorecourses.stanford.edu/CourseSearch/search/?view=catalog&catalog=&page=0&q=EARTHSYS&filter-catalognumber-EARTHSYS=on).

Mission of the Undergraduate Program in Earth Systems

The Earth Systems Program is an interdisciplinary environmental science major. Students learn about and independently investigate complex environmental problems caused by human activities in conjunction with natural changes in the Earth system. Earth Systems majors become skilled in those areas of science, economics, and policy needed to tackle the world's most pressing social-environmental problems, becoming part of a generation of scientists, professionals, and citizens who approach and solve problems in a systematic, interdisciplinary way.

For students to be effective contributors to solutions for such problems, their training and understanding must be both broad and deep. To this end, Earth Systems students take fundamental courses in ecology, calculus, chemistry, geology, and physics, as well as economics, policy, and statistics. After completing breadth training, they concentrate on advanced work in one of six focus areas: biology, energy, environmental economics and policy, land systems, sustainable food and agriculture, or oceanography and climate. Tracks are designed to support focus and rigor but include flexibility for specialization. Examples of specialized foci have included but are not limited to environment and human health, sustainable agriculture, energy economics, sustainable development, business and the environment, and marine policy. Along with formal course requirements, Earth Systems students complete a 1-unit (270-hour) internship. The internship provides a hands-on academic experience working on a supervised field, laboratory, government, or private sector project.

The Earth Systems Program provides an advising network that includes faculty, staff, and student peer advisers.

The following is an outline of the sequential topics covered and skills developed in this major.

1. *Fundamentals:* The Earth Systems Program includes courses that describe the natural functioning of the physical and biological components of the Earth and human activities that interact with these components. Training in fundamentals includes introductory course work in geology, biology, chemistry, physics, and economics. Additional training in course work in single and multivariable calculus, linear algebra, and statistics provides students with skills needed for quantifying environmental problems. Training in statistics is specific to the area of focus: geostatistics, biostatistics, econometrics.
2. *System Interactions:* Focus in these courses is on the fundamental interactions among the physical, biological, and human components of the Earth system. Understanding the dynamics between natural variation in and human-imposed influences on the Earth system informs the development of effective solutions to social-environmental challenges.
   a. Earth Systems courses that introduce students to the dynamic and multiple interactions that characterize social-environmental challenges include:

		Units
EARTHSYS 10	Introduction to Earth Systems	4
EARTHSYS 111	Biology and Global Change	4
EARTHSYS 112	Human Society and Environmental Change	4

   b. Competence in understanding system-level interactions is critical to development as an Earth Systems thinker, so additional classes that meet this objective are excellent choices as electives.
3. *Track-Specific Requirements:* After completing a core designed to introduce students to different functional components of the Earth system, undergraduate students focus their studies through one of six tracks: Human Environmental Systems (formerly Anthrosphere); Biosphere; Energy, Science and Technology; Oceans and Climate (formerly Oceans); Land Systems; or Sustainable Food and Agriculture.
4. *Skills Development:* Students take skills courses that help them to recognize, quantify, describe, communicate, and help solve complex problems that face society. For example, field and laboratory methods can help students to recognize the scope and nature of environmental change. Training in satellite remote sensing and geographic information systems allows students to monitor and analyze large-scale spatial patterns of change. This training is either required or recommended for all tracks.
5. *Communication:* Success in building workable solutions to environmental problems is linked to the ability to effectively communicate ideas, data, and results. Writing intensive courses (WIM) help students to communicate complex concepts to expert and non-expert audiences. Other Earth Systems courses also focus on effective written and oral communication and are recommended. All Stanford students must complete one WIM course in their major. Earth Systems students can fulfill the WIM requirement by successfully completing one of the following courses:

		Units
EARTHSYS 191	Concepts in Environmental Communication	3
EARTHSYS 177C	Specialized Writing and Reporting: Health and Science Journalism	4-5
EARTHSYS 149	Wild Writing	3
BIOHOPK 47	Introduction to Research in Ecology and Ecological Physiology	5

6. *Finding solutions:* Effective solutions to environmental problems take into consideration natural processes as well as human needs. Earth Systems emphasizes the importance of interdisciplinary analysis and implementation of workable solutions through:

		Units
EARTHSYS 210A	Senior Capstone and Reflection	3
or EARTHSYS 210B	Senior Capstone and Reflection	
EARTHSYS 210P	Earth Systems Capstone Project (or Honors Thesis)	2
EARTHSYS 260	Internship	1

A comprehensive list of environmental courses (p. 15) is available on the "Related Courses" tab. This list as well as advice on courses that focus on problem solving are available in the program office.

Learning Outcomes (Undergraduate)

The program expects majors to be able to demonstrate the following learning outcomes. These learning outcomes serve as benchmarks for evaluating students and the program's undergraduate degree. Students are expected to:

1. demonstrate knowledge of foundational skills and concepts in order to advance the interdisciplinary study of the environment.
2. demonstrate the ability to analyze, integrate and apply relevant science and policy perspectives to social-environmental problems.
3. demonstrate the ability to communicate complex concepts and data relevant to social-environmental problems and questions to expert and non-expert audiences.

Learning Outcomes (Graduate)

The coterminal master's degree in Earth Systems provides the student with enhanced analytical tools to evaluate the disciplines most closely associated with the student's focus area. Specialization is gained through course work and independent research work supervised by the master's faculty adviser.

Bachelor of Science in Earth Systems

The B.S. in Earth Systems (EARTHSYS) requires the completion of courses divided into three categories:

1. Core
2. Foundation and Breadth
3. Track-specific Requirements.

The student must fulfill the internship requirement, participate in the Senior Capstone and Reflection course (EARTHSYS 210A or EARTHSYS 210B), complete the Earth Systems Capstone Project (EARTHSYS 210P)/(or Honors Thesis), and complete the Writing in the Major (WIM) requirement.

Core courses, track courses, and electives must be taken for a letter grade. The WIM course may not also count towards the track or electives, if counted as a WIM.

Required Core Courses

		Units
EARTHSYS 10	Introduction to Earth Systems	4
EARTHSYS 111	Biology and Global Change	4
EARTHSYS 112	Human Society and Environmental Change	4
Select one of the following:		3
EARTHSYS 210A	Senior Capstone and Reflection	3
or EARTHSYS 210B	Senior Capstone and Reflection	
EARTHSYS 210P	Earth Systems Capstone Project (or HONORS THESIS)	2
EARTHSYS 260	Internship	1
Select one of the following (WIM):		
EARTHSYS 191	Concepts in Environmental Communication	3
EARTHSYS 177C	Specialized Writing and Reporting: Health and Science Journalism	4-5
EARTHSYS 149	Wild Writing	3
BIOHOPK 47	Introduction to Research in Ecology and Ecological Physiology	5

Tracks

See each track's tab for the required Foundation and Breadth and Track-Specific Courses. All Earth Systems majors must select a track from one of the following:

Biosphere Track (p. 3)

Explores biological systems and how human activities affect biological, ecological, and biogeochemical cycles. Coursework investigates ecosystems and society, conservation biology, ecology, and biogeochemistry.

Energy, Science and Technology (p. 4)

Investigates renewable and depletable energy resources, technology options for improved efficiency, and policy solutions to energy challenges.

Environmental Geoscience (p. 5)

Understand and articulate the ways in which Earth's interior and surface operate, and how these systems are connected to one another and inextricably bound to the evolution of life and current human activities. Apply understanding of earth and human systems to develop workable, scientifically based, human-centered solutions to building resilience to natural hazards, and our planet's most pressing environmental challenges.

Human Environmental Systems (p. 6)

Focuses on human interaction with and impact on the environment. Coursework in environmental policy and economics, sustainable development, natural and human-driven change, and social entrepreneurship.

Land Systems (p. 6)

Examines terrestrial ecology, land use, and land change driven by human activities and addressed by governmental policy. Students develop expertise in a focus area of land, water, or urban planning.

Oceans, Atmosphere, and Climate (p. 8)

Builds understanding of ocean systems through a focus on ocean physics, marine biology and chemistry, and remote sensing. A required and seminal track experience is a quarter away at Hopkins Marine Station, Stanford in Australia, or Stanford@SEA.

Sustainable Food and Agriculture Track (p. 9)

Focuses on local and global food and agricultural systems. Students gain a breadth of knowledge on these issues through study in food and society, climate and agriculture, the science of soils, world food economy, and principles and practices of sustainable agriculture.

Honors Program

The Earth Systems honors program provides students with an opportunity to pursue interdisciplinary research. It consists of a year-long research project that is mentored by one or more Earth Systems-affiliated faculty members, and culminates in a written thesis.

To qualify for the honors program, students must have and maintain a minimum overall GPA of 3.4. Potential honors students should complete the EARTHSYS 111 Biology and Global Change and EARTHSYS 112 Human Society and Environmental Change sequence by the end of the junior year. Qualified students can apply in Spring Quarter of the junior year, or the fourth quarter before graduation (check with program for specific application deadlines) by submitting a detailed research proposal and a brief statement of support from a faculty research advisor. Students who elect to do an honors thesis should begin planning no later than Winter Quarter of the junior year.

A maximum of 9 units is awarded for thesis research through EARTHSYS 199 Honors Program in Earth Systems. Those 9 units may not substitute for any other required parts of the Earth Systems curriculum. All theses are evaluated for acceptance by the thesis faculty advisor, one additional faculty member (who is the second reader), and the Director of Earth Systems. Both the advisor and second reader must be members of the Academic Council. Acceptance into the Honors program is not a guarantee of graduating with the honors designation.

Honors students are required to present their research publicly, preferably through the School of Earth, Energy, and Environmental Sciences' Annual Thesis Symposium which highlights undergraduate and graduate research in the school. Faculty advisors are encouraged to sponsor presentation of student research results at professional society meetings.

More extensive work in mathematics and physics may be valuable for those planning graduate study. Graduate study in ecology and evolutionary biology and in economics requires familiarity with differential equations, linear algebra, and stochastic processes. Graduate study in geology, oceanography, and geophysics may require more physics and chemistry. Students should consult their advisor for recommendations beyond the requirements specified above.

1 The Geological Sciences requirement can be fulfilled by completing GEOLSCI 1, GEOLSCI 4, or EARTHSYS 117. GEOLSCI 1A, 1B, and 1C are no longer offered. If taken in previous years, these still fulfill the Earth Systems' Geological Sciences requirement.

Biosphere

Learning Objectives:

1. Articulate the interplay of ecology, evolution, and biogeochemistry and understand their connections to the functioning of ecosystems on multiple spatial and temporal scales.
2. Recognize how human activity alters ecological processes, and how ecological changes can interact with human societies at multiple scales.
3. Apply knowledge of natural sciences and human-mediated environmental change to conservation challenges, while considering implications for environmental justice.

Requirements

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" tab in addition to the required courses listed below.

		Units
Additional foundation and breadth courses		
BIO 81	Introduction to Ecology	4
or BIOHOPK 81	Introduction to Ecology	
BIO 82	Genetics	4
BIOHOPK 175H	Marine Science and Conservation in a Changing World (This course alone replaces both course options above)	16
ECON 1	Principles of Economics	5
GEOLSCI 1	Introduction to Geology	4-5
or GEOLSCI 4	Coevolution of Earth and Life	
or EARTHSYS 117	Earth Sciences of the Hawaiian Islands	
or EARTHSYS 128	Evolution of Terrestrial Ecosystems	
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. *See Math Placement website for more information.		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
or CME 100	Vector Calculus for Engineers	
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	3-10
or CHEM 31M	Chemical Principles: From Molecules to Solids	
or GEOLSCI 2	Chemistry of the Earth and Planets	
*CHEM 31A, CHEM 31B, CHEM 31M, GEOLSCI 2 may be fulfilled by CHEM AP Exam score of 5		
CHEM 33	Structure and Reactivity of Organic Molecules	5
Physics (select one of the following):		4
GEOPHYS 110	Introduction to the Foundations of Contemporary Geophysics	3
or PHYSICS 41	Mechanics	
or PHYSICS 45	Light and Heat	
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3
or ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
or STATS 101	Data Science 101	
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or STATS 141	Biostatistics	
or CME 106	Introduction to Probability and Statistics for Engineers	
Choose two courses from Ecology and Conservation Biology, and one course from each of the remaining sub-categories below, total six required:		
Ecology and Conservation Biology		**3-12**
BIO 115	The Hidden Kingdom - Evolution, Ecology and Diversity of Fungi	4
BIO 130	Ecosystems of California	4
BIO 144	Conservation Biology: A Latin American Perspective	3
BIOHOPK 173H	Marine Conservation Biology	4
BIOHOPK 175H	Marine Science and Conservation in a Changing World	16
BIOHOPK 177H	Dynamics and Management of Marine Populations	4
BIOHOPK 185H	Ecology and Conservation of Kelp Forest Communities	5
EARTHSYS 116	Ecology of the Hawaiian Islands	4
EARTHSYS 105A & EARTHSYS 105B	Ecology and Natural History of Jasper Ridge Biological Preserve and Ecology and Natural History of Jasper Ridge Biological Preserve	8
EARTHSYS 128	Evolution of Terrestrial Ecosystems	4
EARTHSYS 123	Asian Americans and Environmental Justice	3-5
EARTHSYS 128	Evolution of Terrestrial Ecosystems	4
EARTHSYS 147	Ecosystem Ecology and Biogeochemistry	3
ESS 223	Biosphere-Atmosphere Interactions (EARTHSYS 123A)	4
GEOLSCI 123	Evolution of Marine Ecosystems (not given this year)	3-4
OSPAUSTL 10	Coral Reef Ecosystems	3
OSPAUSTL 30	(no longer offered)	
OSPSANTG 58	Global Change in Chile	5
OSPSANTG 85	Marine Ecology of Chile and the South Pacific (OSPSANTG 85)	5
Ecosystems and Society [2]		**3-5**
ANTHRO 166	Political Ecology of Tropical Land Use: Conservation, Natural Resource Extraction, and Agribusiness	3-5
EARTHSYS 107	Control of Nature	3
EARTHSYS 114	Global Change and Emerging Infectious Disease	4-5
EARTHSYS 118	Heritage, Environment, and Sovereignty in Hawaii	4

EARTHSYS 139	Ecosystem Services: Frontiers in the Science of Valuing Nature (last offered Autumn 2019)	3
EARTHSYS 159	Economic, Legal, and Political Analysis of Climate-Change Policy	5
EARTHSYS 185	Feeding Nine Billion	4-5
SIW 144		
LAW 2515	Environmental Justice	3
Biogeochemistry		
CEE 177	Aquatic Chemistry and Biology	4
CEE 274A	Environmental Microbiology I	3
EARTHSYS 132	Evolution of Earth Systems	4
EARTHSYS 143	Molecular Geomicrobiology Laboratory	3-4
EARTHSYS 151	Biological Oceanography	3-4
EARTHSYS 152	Marine Chemistry	3-4
EARTHSYS 155	Science of Soils	3-4
EARTHSYS 158	Geomicrobiology	3
ESS 256	Soil and Water Chemistry	3
Methods		
EARTHSYS 144	Fundamentals of Geographic Information Science (GIS) (REQUIRED)	3-4
Optional		
EARTHSYS 124	Measurements in Earth Systems	3-4
EARTHSYS 142	Remote Sensing of Land	4
EARTHSYS 211	Fundamentals of Modeling	3-5
ESS 165	Advanced Geographic Information Systems	4
ESS 224	Remote Sensing of Hydrology	3
ESS 220	Physical Hydrogeology	4
GEOLSCI 240	Data science for geoscience	3
Elective Requirement		**6-10**
Two additional courses at the 100-level or above are required. Each must be a minimum of 3 units.		

Energy, Science, and Technology

Learning Objectives:

1. Apply fundamental engineering principles to assess how transformation of systems of energy production, distribution, and consumption can contribute to achieving greater energy sustainability.
2. Use fundamental engineering principles—together with knowledge of economics, human behavior, energy infrastructure, and earth systems science—to assess and critique policy- and market-based solutions proposed to achieve greater energy sustainability.
3. Apply written, visual, and oral presentation skills to communicate scientific, technological, and policy knowledge to expert and non-expert audiences.

Requirements

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" tab in addition to the required courses listed below.

		Units
Additional Foundation and Breadth Courses		
BIO 81	Introduction to Ecology	4
or BIOHOPK 81	Introduction to Ecology	
or BIO 83	Biochemistry & Molecular Biology	
or HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
or EARTHSYS 116	Ecology of the Hawaiian Islands	
or BIOHOPK 175H	Marine Science and Conservation in a Changing World	
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	5
or CHEM 31M	Chemical Principles: From Molecules to Solids	
or GEOLSCI 2	Chemistry of the Earth and Planets	
*CHEM 31A, CHEM 31B, CHEM 31M, GEOLSCI 2may be fulfilled by CHEM AP Exam score of 5		
ECON 1	Principles of Economics	5
GEOLSCI 1	Introduction to Geology	4-5
or GEOLSCI 4	Coevolution of Earth and Life	
or EARTHSYS 117	Earth Sciences of the Hawaiian Islands	
or EARTHSYS 128	Evolution of Terrestrial Ecosystems	
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. See Math Placement website for more information.		
CME 100	Vector Calculus for Engineers (preferred)	5
or MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
PHYSICS 43	Electricity and Magnetism	4
PHYSICS 45	Light and Heat	4
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3
or ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
or STATS 101	Data Science 101	
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or STATS 141	Biostatistics	
or CME 106	Introduction to Probability and Statistics for Engineers	
Energy Fundamentals (required for all)		**3**
ME 30	Engineering Thermodynamics	3
CEE 272R	Modern Power Systems Engineering	3
or ENERGY 120	Fundamentals of Petroleum Engineering	
or MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	
EARTHSYS 101	Energy and the Environment (*Courses taken to fulfill 'Energy Fundamentals' may not double-count for the subcategories below.)	3
or EARTHSYS 102	Fundamentals of Renewable Power	
or EARTHSYS 103	Understanding Energy	
Choose at least one course in each of the three sub-categories, total five required. Note that many of these have prerequisite work:		
Energy Resources & Technology		**3-5**
EARTHSYS 101	Energy and the Environment	3
EARTHSYS 103	Understanding Energy	3-5
CEE 156	Building Systems Design & Analysis	4
CEE 176A	Energy Efficient Buildings	3-4
ENERGY 120	Fundamentals of Petroleum Engineering	3
ENERGY 269	Geothermal Reservoir Engineering	3
ENERGY 293B	Fundamentals of Energy Processes	3

MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	3-4
ENERGY 293C	Energy from Wind and Water Currents	3
Sustainable Energy & Development		**3-4**
CEE 176B	100% Clean, Renewable Energy and Storage for Everything	3-4
CEE 226	Life Cycle Assessment for Complex Systems	3-4
EARTHSYS 102	Fundamentals of Renewable Power	3
EARTHSYS 146A	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation	3
ENERGY 153	Carbon Capture and Sequestration	3-4
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution	3-4
Energy Policy, Economics & Entrepreneurship		**2-4**
ENERGY 104	Sustainable Energy for 9 Billion	3
ENERGY 110	Engineering Economics	3
ENERGY 171	Energy Infrastructure, Technology and Economics	3
ENERGY 191	Optimization of Energy Systems	3-4
GSBGEN 336	Energy Markets and Policy	3
MS&E 243	Energy and Environmental Policy Analysis	3
LAW 2503	Energy Law	3
Elective Requirement		**3-5**
One additional course at the 100-level or above is required. This course must be a minimum of 3 units. 3 units of approved energy seminars may count as one elective. See Earth Systems staff for the approved seminar list.		

Environmental Geoscience

Learning Objectives:

1. Understand and articulate the ways in which Earth's interior and surface operate, and how these systems are connected to one another and inextricably bound to the evolution of life and current human activities.
2. Understand and view the current state of, and expected changes within, the earth system in the context of past changes experienced by our planet.
3. Apply understanding of earth and human systems to develop workable, scientifically based, human-centered solutions to building resilience to natural hazards, and our planet's most pressing environmental challenges.

Requirements

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" tab in addition to the required courses listed below.

		Units
Additional Foundation and Breadth Courses		
BIO 81	Introduction to Ecology	4
or BIOHOPK 81	Introduction to Ecology	
or BIOHOPK 175H	Marine Science and Conservation in a Changing World	
or HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
or EARTHSYS 116	Ecology of the Hawaiian Islands	
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	3-10
or CHEM 31M	Chemical Principles: From Molecules to Solids	
or GEOLSCI 2	Chemistry of the Earth and Planets	
*CHEM 31A, CHEM 31B, CHEM 31M, GEOLSCI 2 may be fulfilled by CHEM AP Exam score of 5		
ECON 1	Principles of Economics	5
GEOLSCI 1	Introduction to Geology	4-5
or GEOLSCI 4	Coevolution of Earth and Life	
or EARTHSYS 117	Earth Sciences of the Hawaiian Islands	
or EARTHSYS 128	Evolution of Terrestrial Ecosystems	
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. *See Math Placement website for more information.		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
or CME 100	Vector Calculus for Engineers	
MATH 52	Integral Calculus of Several Variables	5
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3-5
or ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
or STATS 101	Data Science 101	
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or STATS 141	Biostatistics	
or CME 106	Introduction to Probability and Statistics for Engineers	
GEOPHYS 110	Introduction to the Foundations of Contemporary Geophysics	3
or PHYSICS 41 & PHYSICS 45	Mechanics and Light and Heat	
ESS 164	Fundamentals of Geographic Information Science (GIS)	3-4
A total of 6 courses are required from the Environmental Geoscience Focus Areas below. In addition, two electives are required for this track. All track courses and electives must be taken for a letter grade (nine courses total).		
The Solid Earth (must take 2):		
GEOLSCI 180	Igneous Processes	3-4
EARTHSYS 113	Earthquakes and Volcanoes	3
GEOPHYS 150	Geodynamics: Our Dynamic Earth	3-5
Earth's Surface (must take 2):		
GEOLSCI 106	Sediments: The Book of Earth's History	3
GEOLSCI 112	Geomorphology	3
EARTHSYS 104	The Water Course (not offered this year)	4
ESS 148	Introduction to Physical Oceanography	4
ESS 224	Remote Sensing of Hydrology	3
ESS 155	Science of Soils	3-4
ESS 220	Physical Hydrogeology	4
Evolution of Life on Earth (must take 1):		
GEOLSCI 128	Evolution of Terrestrial Ecosystems	4
GEOLSCI 135	Sedimentary Geochemistry and Analysis	1-4
Resilient Earth (must take 1):		
GEOLSCI 118X	Shaping the Future of the Bay Area	3-5
Two additional courses at the 100-level or above are required. Each must be a minimum of 3 units. See Earth Systems staff for a list of possible electives		

Human Environmental Systems

Learning Objectives:

1. Apply knowledge of fundamental physical and biological Earth system processes to analyze how human decisions shape environmental outcomes.
2. Apply fundamental principles and frameworks from the social sciences to analyze and understand (a) how humans make environmentally relevant decisions, and (b) how environmental changes shape human outcomes.

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" Tab in addition to the required courses listed below.

		Units
Additional Foundation and Breadth Courses		
Biology		**4-10**
BIO 81	Introduction to Ecology	4
or BIOHOPK 81	Introduction to Ecology	
or BIOHOPK 175H	Marine Science and Conservation in a Changing World	
or HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
or EARTHSYS 116	Ecology of the Hawaiian Islands	
Economics		
ECON 1	Principles of Economics	5
ECON 50	Economic Analysis I	5
ECON 155	Environmental Economics and Policy	5
Geological Sciences [1]		**4-5**
Select one of the following:		
EARTHSYS 117	Earth Sciences of the Hawaiian Islands	4
GEOLSCI 1	Introduction to Geology	5
GEOLSCI 4	Coevolution of Earth and Life	4
EARTHSYS 128	Evolution of Terrestrial Ecosystems	4
Mathematics		**5-15**
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. *See Math Placement website for more information.		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
or CME 100	Vector Calculus for Engineers	
CS 106A	Programming Methodology	3-5
Probability and Statistics		**3-5**
Select one of the following:		
BIO 141	Biostatistics	5
ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	5
STATS 101	Data Science 101	5
STATS 110	Statistical Methods in Engineering and the Physical Sciences	5
STATS 116	Theory of Probability	4
CME 106	Introduction to Probability and Statistics for Engineers	4
Select one of the following		
CS 106B	Programming Abstractions	3-5
ECON 102B	Applied Econometrics	5
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3

		Units
Choose one course in each of the three following sub-categories, with a total of six required. At least one of the six must be a skills/methods course marked with an asterisk (*):		
Economics, Policy, and Sustainable Development		**3-5**
CEE 175A	California Coast: Science, Policy, and Law	3-4
EARTH 2	Climate and Society	3
ECON 51	Economic Analysis II	5
ECON 52	Economic Analysis III	5
ECON 102B	Applied Econometrics (*)	5
ECON 106	World Food Economy (*)	5
CEE 175A	California Coast: Science, Policy, and Law	3-4
ECON 118	Development Economics	5
ECON 121	((Last offered Spring 2018))	
ECON 150	Economic Policy Analysis	4-5
ECON 159	Economic, Legal, and Political Analysis of Climate-Change Policy	5
ESS 268	Empirical Methods in Sustainable Development (*)	3-5
ECON 159	Economic, Legal, and Political Analysis of Climate-Change Policy	5
INTNLREL 135A	International Environmental Law and Policy: Oceans and Climate Change	4-5
IPS 270		3-5
LAW 2504	Environmental Law and Policy	3
MS&E 243	Energy and Environmental Policy Analysis	3
GSBGEN 336	Energy Markets and Policy	3
Human Behavior and Adaption		**2-5**
CEE 151	Negotiation	3
ANTHRO 116B	Anthropology of the Environment	5
ANTHRO 166	Political Ecology of Tropical Land Use: Conservation, Natural Resource Extraction, and Agribusiness	3-5
CEE 124	Sustainable Development Studio	1-5
CEE 226	Life Cycle Assessment for Complex Systems	3-4
EARTHSYS 114/214	Global Change and Emerging Infectious Disease	3
EARTHSYS 123A/223	Biosphere-Atmosphere Interactions	3-4
EARTHSYS 185	Feeding Nine Billion	4-5
ESS 360	Social Structure and Social Networks	5
ECON 106	World Food Economy (*)	5
ECON 118	Development Economics (*)	5
ESS 224	Remote Sensing of Hydrology	3
ESS 185	Adaptation	3
OSPSANTG 29	Sustainable Cities: Comparative Transportation Systems in Latin America	5
POLISCI 124A	The American West	5
URBANST 164	Sustainable Cities	4-5
URBANST 183	Team Urban Design Studio	5
Data Science and Analysis		**3-5**
CS 102		3-4
CS 106B	Programming Abstractions	3-5
CS 124	From Languages to Information	3-4
ECON 102B	Applied Econometrics (*)	5

EARTHSYS 141	Remote Sensing of the Oceans (*)	3-4
EARTHSYS 142	Remote Sensing of Land (*)	4
EARTHSYS 144	Fundamentals of Geographic Information Science (GIS) (*)	3-4
EARTHSYS 162	Data for Sustainable Development	3-5
ENERGY 240	Data science for geoscience	3
ESS 165	Advanced Geographic Information Systems (*)	4
ESS 214	Introduction to geostatistics and modeling of spatial uncertainty (* last offered Spring 2017)	3-4
ESS 268	Empirical Methods in Sustainable Development (*)	3-5
MS&E 231	Introduction to Computational Social Science	3
STATS 216	Introduction to Statistical Learning	3
Elective Requirement		**6-10**
Two additional courses at the 100-level or above are required. Each must be a minimum of 3 units.		

Land Systems

Learning Objectives:

1. Design strategies for using multi-source and multi-scale observations of land surface processes that integrate field, geospatial, and human survey data to describe biophysical and socio-economic impacts of land systems changes.
2. Integrate biophysical and socioeconomic data related to land use and land cover change using geospatial tools to analyze and model complex, multi-scalar human-environmental interactions that determine land use dynamics.
3. Determine remedies to address negative impacts of land changes on human-environmental systems using land-use management tools and interventions.

Requirements

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" tab in addition to the required courses listed below.

		Units
Additional Foundation and Breadth Courses		
BIO 81	Introduction to Ecology	4
or BIOHOPK 81	Introduction to Ecology	
or BIOHOPK 175H	Marine Science and Conservation in a Changing World	
or HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
or EARTHSYS 116	Ecology of the Hawaiian Islands	
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	3-10
or CHEM 31M	Chemical Principles: From Molecules to Solids	
or GEOLSCI 2	Chemistry of the Earth and Planets	
*CHEM 31A, CHEM 31B, CHEM 31M , GEOLSCI 2may be fulfilled by CHEM AP Exam score of 5		
ECON 1	Principles of Economics	5
GEOLSCI 1	Introduction to Geology	4-5
or GEOLSCI 4	Coevolution of Earth and Life	
or EARTHSYS 117	Earth Sciences of the Hawaiian Islands	
or EARTHSYS 128	Evolution of Terrestrial Ecosystems	
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. See Math Placement website for more information.		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
or CME 100	Vector Calculus for Engineers	
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3-5
or BIO 202	Ecological Statistics	
or ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
or STATS 101	Data Science 101	
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or STATS 141	Biostatistics	
or CME 106	Introduction to Probability and Statistics for Engineers	
GEOPHYS 110	Introduction to the Foundations of Contemporary Geophysics	3
or PHYSICS 41	Mechanics	
or PHYSICS 45	Light and Heat	
A total of 7 courses are required from the 4 Land Systems Focus Areas. Concentrating courses in a single focus area below will allow students to deepen their understanding of the chosen system. For breadth considerations, students are required to take a minimum of 1 course from each focus area. In addition, two electives are required for this track. All track courses and electives must be taken for a letter grade (9 courses total).		
Land Ecosystems:		
EARTHSYS 155	Science of Soils (recommended)	3-4
EARTHSYS 180	Principles and Practices of Sustainable Agriculture (recommended)	3-4
EARTHSYS 181	Urban Agroecology	3
EARTHSYS 182A	Ecological Farm Systems	1-2
BIO 144	Conservation Biology: A Latin American Perspective	3
EARTHSYS 105A & EARTHSYS 105B	Ecology and Natural History of Jasper Ridge Biological Preserve and Ecology and Natural History of Jasper Ridge Biological Preserve	8
EARTHSYS 116	Ecology of the Hawaiian Islands	4
EARTHSYS 128	Evolution of Terrestrial Ecosystems	4
ESS 256	Soil and Water Chemistry	3
ESS 223/ EARTHSYS 123A	Biosphere-Atmosphere Interactions	4
OSPSANTG 58	Global Change in Chile	5
Water:		
CEE 166A	Watershed Hydrologic Processes and Models (recommended)	3
CEE 101B	Mechanics of Fluids	4
CEE 162E	Rivers, Streams, and Canals	3
CEE 165C	Water Resources Management	3
CEE 166B	Water Resources and Hazards	3
CEE 177	Aquatic Chemistry and Biology	4
EARTHSYS 104	The Water Course	4
EARTHSYS 106B	Sustainable and Equitable Water Management	4

ESS 224	Remote Sensing of Hydrology	3
GEOPHYS 190	Near-Surface Geophysics: Imaging Groundwater Systems	3
OSPAUSTL 25	(not given this year)	
OSPMADRD 79	(not given this year)	
Land Use:		
ESS 270	Analyzing land use in a globalized world (recommended)	3
ANTHRO 166	Political Ecology of Tropical Land Use: Conservation, Natural Resource Extraction, and Agribusiness	3-5
CEE 124	Sustainable Development Studio	1-5
CEE 175A	California Coast: Science, Policy, and Law	3-4
CEE 176A	Energy Efficient Buildings	3
EARTHSYS 118	Heritage, Environment, and Sovereignty in Hawaii	4
EARTHSYS 185	Feeding Nine Billion	4-5
EARTHSYS 238	Land Use Law	3
ECON 106	World Food Economy	5
ENERGY 101	Energy and the Environment	3
ENERGY 102	Fundamentals of Renewable Power	3
ENERGY 104	Sustainable Energy for 9 Billion	3
ENVRES 250	Environmental Governance	3
OSPSANTG 29	Sustainable Cities: Comparative Transportation Systems in Latin America	5
SIW 144		
URBANST 110	Introduction to Urban Studies	4
URBANST 113	Introduction to Urban Design: Contemporary Urban Design in Theory and Practice	5
URBANST 164	Sustainable Cities	4-5
Methods:		
EARTHSYS 144	Fundamentals of Geographic Information Science (GIS) (required)	1-4
Optional		
EARTHSYS 124	Measurements in Earth Systems	3-4
EARTHSYS 142	Remote Sensing of Land	4
ESS 165	Advanced Geographic Information Systems	4
ESS 224	Remote Sensing of Hydrology	3
ESS 220	Physical Hydrogeology	4
GEOLSCI 240	Data science for geoscience	3
Two additional courses at the 100-level or above are required. Each must be a minimum of 3 units. See Earth Systems staff for a list of possible electives.		

Oceans, Atmosphere, and Climate

Learning Objectives:

1. Apply fundamental physical, chemical, and biological principles toward understanding the behavior of the oceans, atmosphere, and climate and the interrelationships of these systems with human society.
2. Apply fundamental principles of ocean, atmospheric, and climate science through field, laboratory, and computer-based research experiences.

Requirements

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" tab in addition to the required courses listed below.

		Units
Additional Foundation and Breadth Courses		
BIO 81	Introduction to Ecology	4-16
or BIOHOPK 81	Introduction to Ecology	
or BIOHOPK 175H	Marine Science and Conservation in a Changing World	
or HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
or EARTHSYS 116	Ecology of the Hawaiian Islands	
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	5
or CHEM 31M	Chemical Principles: From Molecules to Solids	
or GEOLSCI 2	Chemistry of the Earth and Planets	
*CHEM 31A, CHEM 31B, CHEM 31M, GEOLSCI 2 may be fulfilled by CHEM AP Exam score of 5		
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. See Math Placement website for more information.		
MATH 51 & MATH 52	Linear Algebra, Multivariable Calculus, and Modern Applications and Integral Calculus of Several Variables (CME 100 preferred over MATH 51 and MATH 52)	5-10
or CME 100	Vector Calculus for Engineers	
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3
or ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
or STATS 101	Data Science 101	
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or STATS 141	Biostatistics	
or CME 106	Introduction to Probability and Statistics for Engineers	
ECON 1	Principles of Economics	5
GEOLSCI 1	Introduction to Geology	5
or GEOLSCI 4	Coevolution of Earth and Life	
or EARTHSYS 117	Earth Sciences of the Hawaiian Islands	
or EARTHSYS 128	Evolution of Terrestrial Ecosystems	
PHYSICS 41	Mechanics	4
PHYSICS 45	Light and Heat	3-4
or GEOPHYS 110	Introduction to the Foundations of Contemporary Geophysics	
The Fundamentals (all courses required):		**3**
EARTHSYS 146A	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation	3
EARTHSYS 146B	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation	3
or EARTHSYS 164	Introduction to Physical Oceanography	
EARTHSYS 141	Remote Sensing of the Oceans	3-4
EARTHSYS 151	Biological Oceanography	3-4
EARTHSYS 152	Marine Chemistry	3-4
Human Dimensions		**3-4**
Select one of the following:		
BIOHOPK 173H	Marine Conservation Biology	4
BIOHOPK 280	Short Course on Ocean Policy	3
CEE 175A	California Coast: Science, Policy, and Law	3-4

LAW 2506	Natural Resources Law and Policy	3
Field Experience [1]		**12-20**
Select at least one of the following:		
One quarter abroad at the Stanford in Australia Program		
One quarter at Stanford @ SEA		
One quarter (or more) at the Hopkins Marine Station		
Elective Requirement		**6-10**
Two additional courses at the 100-level or above are required. Each must be a minimum of 3 units. See Earth Systems staff for a list of possible electives.		

Sustainable Food and Agriculture

Learning Objectives:

1. Describe the main biophysical and socioeconomic constraints in food systems at global and local scales.
2. Apply knowledge of agricultural soils and plant growth to solve problems related to crop production, soil conservation, and natural resource management.
3. Identify the links between food systems and other aspects of the Earth system, including water, energy, and climate systems.
4. Assess and critique proposed policy or technological solutions that claim to make food systems more sustainable.

Requirements

All students must complete the Required Core Courses (p. 2) listed under the "Bachelor's (p. 2)" tab in addition to the required courses listed below.

		Units
Additional Foundation and Breadth Courses		
BIO 81	Introduction to Ecology	4
or BIOHOPK 81	Introduction to Ecology	
or BIOHOPK 175H	Marine Science and Conservation in a Changing World	
or HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
or EARTHSYS 116	Ecology of the Hawaiian Islands	
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	3-10
or CHEM 31M	Chemical Principles: From Molecules to Solids	
or GEOLSCI 2	Chemistry of the Earth and Planets	
*CHEM 31A, CHEM 31B, CHEM 31M, GEOLSCI 2 may be fulfilled by CHEM AP Exam score of 5		
ECON 1	Principles of Economics	5
GEOLSCI 1	Introduction to Geology	4-5
or GEOLSCI 4	Coevolution of Earth and Life	
or EARTHSYS 117	Earth Sciences of the Hawaiian Islands	
or EARTHSYS 128	Evolution of Terrestrial Ecosystems	
MATH 19 & MATH 20 & MATH 21	Calculus and Calculus and Calculus	10
MATH 19, 20, 21 may be fulfilled by specific AP Exam Scores. See Math Placement website for more information.		
MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	5
or CME 100	Vector Calculus for Engineers	
BIOHOPK 174H	Experimental Design and Probability	3
PHYSICS 41	Mechanics	4
or PHYSICS 45	Light and Heat	
or GEOPHYS 110	Introduction to the Foundations of Contemporary Geophysics	
BIOHOPK 174H	Experimental Design and Probability (no longer offered)	3-5
or BIO 202	Ecological Statistics	
or ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
or STATS 101	Data Science 101	
or STATS 110	Statistical Methods in Engineering and the Physical Sciences	
or STATS 116	Theory of Probability	
or STATS 141	Biostatistics	
or CME 106	Introduction to Probability and Statistics for Engineers	
A total of 7 courses are required from the Food and Agriculture Focus Areas. In addition, two electives are required for this track. All track courses and electives must be taken for a letter grade (nine courses total).		
Fundamentals of Agriculture Production and Economics (both required):		
ECON 106	World Food Economy	5
EARTHSYS 185	Feeding Nine Billion	4-5
Biogeophysical Dimensions		
Required:		
EARTHSYS 155	Science of Soils	3-4
2 of the following:		
BIO 115	The Hidden Kingdom - Evolution, Ecology and Diversity of Fungi	4
EARTHSYS 142	Remote Sensing of Land	4
EARTHSYS 256	Soil and Water Chemistry	3
BIO 137	Plant Genetics (Not given this year)	3-4
HUMBIO 113	The Human-Plant Connection	3
HUMBIO 130	Human Nutrition	4
Social Dimensions (choose 1):		
ARCHLGY 124	Archaeology of Food: production, consumption and ritual	3-5
BIO 144	Conservation Biology: A Latin American Perspective	3
EARTHSYS 187	FEED the Change: Redesigning Food Systems	2-3
ECON 118	Development Economics	5
HUMBIO 113S	Healthy/Sustainable Food Systems: Maximum Sustainability across Health, Economics, and Environment	4
HUMBIO 166	Food and Society: Exploring Eating Behaviors in Social, Environmental, and Policy Context	4
OSPMADRD 79		
Applied Study in the Field (Choose 1)		
EARTHSYS 180	Principles and Practices of Sustainable Agriculture	1-4
or EARTHSYS 181	Urban Agroecology	
or EARTHSYS 182A	Ecological Farm Systems	
Two additional courses at the 100-level or above are required. Each must be a minimum of 3 units. See Earth Systems staff for a list of possible electives		

Minor in Earth Systems, Sustainability Subplan

The minor in Earth Systems, Sustainability subplan, provides students with foundational knowledge, skills, and frameworks needed to understand social-environmental systems and address intergenerational sustainability challenges. Students declaring the minor in Earth Systems must also declare the Sustainability subplan.

To minor in Earth Systems, students must take the core courses listed below and approved electives for a minimum of 35 units. Courses that count toward the fulfillment of major requirements may not be counted toward the minor, and all courses must be taken for a letter grade.

Students declaring a minor in Earth Systems must do so no later than two quarters prior to their intended quarter of degree conferral; for example, a student must declare a minor before the end of Autumn Quarter to graduate the following Spring Quarter. The Sustainability subplan must also be declared in Axess when declaring the minor. In addition, students pursuing the minor must complete the Multiple Major/Minor Form (https://stanford.box.com/v/change-UG-program/) and have it reviewed by all applicable departments/programs. This form must be submitted to the Student Services Center (https://studentservicescenter.stanford.edu/%22%20%5Ct%20%22_blank/) by the application to graduate deadline for the term in which the student intends to graduate.

Required Course Work

Core

		Units
EARTHSYS 10	Introduction to Earth Systems	4
EARTHSYS 111	Biology and Global Change	4
EARTHSYS 112	Human Society and Environmental Change	4
(ECON 1 recommended as a pre- or corequisite to EARTHSYS 112)		
EARTHSYS 131	Pathways in Sustainability Careers	1
SUST 210	Pursuing Sustainability: Managing Complex Social Environmental Systems (prerequisites: EARTHSYS 111, EARTHSYS 112)	3

Electives

Students must take a minimum of 19 units of electives at the 100-level or above that address dimensions of environmental systems and social-environmental systems in theory or practice, with at least one course taken in each of the following four categories: Earth Systems Science/Engineering; Environmental Justice; Applied Problem Solving; and Skills. Students may double-count courses in these categories (i.e., if a course fulfills both the Environmental Justice and Applied Problem Solving requirements, it can be applied to both categories).

To declare, please complete the Earth Systems Minor Course Plan Proposal (https://earth.stanford.edu/sites/default/files/inline-files/Earth%20Systems%20Minor%20Course%20Plan%20Proposal%20_%202018.xlsx) found under the Minor Forms section here: https://earth.stanford.edu/esys/resources/program-forms-guides (https://earth.stanford.edu/esys/resources/program-forms-guides/). A list of approved electives is also available on the Earth Systems website (https://earth.stanford.edu/sites/default/files/inline-files/Minor%20in%20Earth%20Systems%202018%20Track%20Sheet.pdf) and in the Earth Systems Program office (Y2E2 131). Students may petition to count one relevant freshman or sophomore seminar toward the minor. Please submit your completed Minor Course Plan Proposal to Deana Fabbro-Johnston (Deana@stanford.edu) for an approval signature and acceptance into the Earth Systems Minor Program.

Coterminal Master's Degrees in Earth Systems

The Earth Systems Program offers current Stanford University undergraduates the opportunity to apply to a one-year coterminal master's program. Earth Systems offers a coterminal Master of Science (M.S.) degree in Earth Systems (p. 13) and a coterminal Master of Arts (M.A.) degree in Earth Systems, Environmental Communication (p. 11); the Environmental Communication subplan prints on both the transcript and the diploma.

Application and Admission

The Earth Systems Program has quarterly coterminal degree application deadlines: October 27, 2020; February 16, 2021; and May 11, 2021. Seniors must apply by Winter Quarter deadline. To apply, students should submit an online application. The application includes the following:

- The Stanford coterminal application (https://www.applyweb.com/stanterm/)
- A statement of purpose
- A resume
- A current Stanford unofficial transcript
- Two letters of recommendation, one of which must be from the master's advisor (who must be an Academic Council member; each coterminal M.A. student has two advisors: Thomas Hayden and another approved faculty advisor who is an Academic Council member). These letters are due by the coterm application deadline for the given quarter.
- Master's Program Proposal (https://earth.stanford.edu/esys/program-forms/): A list of courses that fulfill degree requirements signed by the master's advisor

Note:

1. Applications must be submitted no later than the quarter prior to the expected completion of the B.S. degree (and within quarterly application deadlines). An application fee is assessed by the Registrar's Office for coterminal applications, once students are matriculated into the program.
2. Students applying to the coterminal master's program must have completed a minimum of 120 units toward graduation with a minimum overall Stanford GPA of 3.4.
3. All applicants must devise a program of study that shows a level of specialization appropriate to the master's level, as determined in consultation with the master's advisor and the Director of Earth Systems. (See also following sections, Master of Science and Master of Arts in Earth Systems Degree Requirements).
4. Students applying from an undergraduate major other than Earth Systems should review their undergraduate course list with Deana Fabbro-Johnston, Richard Nevle, or Thomas Hayden (M.A. only).
5. Students have the option of receiving the B.S. degree after completing that degree's requirements or receiving the B.S. and M.A./M.S. degrees concurrently at the completion of the master's program.
6. If you would like to change from the M.S. to the M.A. in Earth Systems, or from the M.A. to the M.S. in Earth Systems, you must submit a new application. If accepted, the student must submit a Graduate Authorization Petition through Axess; a $125 fee applies to a successful Graduate Authorization Petition.

University Coterminal Requirements

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/cotermdegrees/)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://

exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first graduate quarter is not a factor. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate advisor be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

Coterminal Master of Arts Program

Admission

Applications in 2020-21 are due:

- October 27, 2020 to apply for Winter 2020 matriculation.
- February 16, 2021 to apply for Spring 2021 matriculation.
- May 11, 2021 to apply for Autumn 2020-21 matriculation.
- Coterminal application (https://www.applyweb.com/stanterm/)
- A statement of purpose
- A resume
- A current Stanford unofficial transcript
- Two letters of recommendation, one from the M.A. Director (Thomas Hayden) and another approved faculty advisor who is an Academic Council member.
- Master's Program Proposal (M.A.) (https://pangea.stanford.edu/sites/default/files/Earth%20Systems%20MA%20Coterm%20Course%20Proposal.xlsx): A list of courses that fulfill degree requirements signed by both the M.A. director (Thomas Hayden) and the proposed faculty co-advisor.

Applications must be submitted no later than the quarter prior to the expected completion of the undergraduate degree. The specific application deadline for each quarter is listed above, or can be obtained from the Earth Systems Program office. An application fee is assessed by the Registrar's Office for coterminal applications once students are matriculated into the program.

- Students applying to the coterminal master's program must have completed a minimum of 120 units toward graduation with a minimum overall Stanford GPA of 3.4.
- All applicants must devise a program of study that shows a level of specialization appropriate to the master's level, as determined in consultation with the M.A. director and the Director of Earth Systems.
- Students applying from an undergraduate major other than Earth Systems should also review their undergraduate course list with the M.A. director. a
- Coterminal master's students have the option of receiving their undergraduate degree after completing that degree's requirements or receiving their undergraduate and M.A. degrees concurrently at the completion of the master's program.
- Students must submit a new application to change from the M.S. to the M.A., or from the M.A. to the M.S. in Earth Systems. If accepted, the student must submit a Graduate Authorization Petition through Axess; a $125 fee applies to a successful Graduate Authorization Petition.
- Applicants will be notified of the admission decision in writing, typically 3-4 weeks after the application deadline.
- A $125 application fee will be assessed by the Registrar's office for those accepted and matriculated into the program. To apply, students should submit an online application.

Students interested in applying to the Earth Systems Master of Arts, Environmental Communication should contact the M.A. director, Thomas Hayden (thayden@stanford.edu).

Students may apply to the Earth Systems Master of Arts, Environmental Communication degree from any undergraduate major. However, all admitted students are also required to complete the Earth Systems Core, i.e., EARTHSYS 10 Introduction to Earth Systems, EARTHSYS 111 Biology and Global Change, and EARTHSYS 112 Human Society and Environmental Change. These courses may be taken concurrently with the M.A. degree but may not be counted toward the 45 units required for the M.A. degree. In consultation with the M.A. Director, these courses may be actively audited rather than taken for credit. Rarely, additional prerequisites or foundational courses may be required depending on the academic background and intended focus of each student, to be determined in consultation with the M.A. director, faculty co-advisor, and the Director of Earth Systems

Learning Outcomes (Graduate)

The coterminal master's degree in Earth Systems, Environmental Communication provides the student with enhanced theoretical frameworks, analytical tools, and applied skills in various domains of environmental communication. Specialization is gained through courses, independent project work, and a professional practicum placement, supervised by the Earth Systems M.A. director and the faculty co-advisor

University Coterminal Requirements

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/cotermdegrees/)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first graduate quarter is not a factor. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate advisor be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

Degree Requirements

These degree requirements are the same for both the Master of Arts degree and the Master of Science degree in Earth Systems, and must be fulfilled to receive an M.A. degree in Earth Systems:

- A minimum of 45 units of course work and/or research credit (upon approval).
- At least 34 units of the student's course work for the M.A./M.S. must be at the 200-level or above.
- All remaining course work must be at the 100-level or above, with the exception of ENGLISH 91 and ENGLISH 191.
- All courses for the M.A. degree must be taken for a letter grade when that option exists; courses not taken for a letter grade must be approved by the M.A. Director and Director of Earth Systems.
- Transfer courses from other institutions are not permitted to count towards the master's degree.
- A minimum overall GPA of 3.4 must be maintained.
- All Earth Systems coterminal master's students are required to take the Master's Seminar, EARTHSYS 290 Master's Seminar. All Earth Systems M.A. students are required to take EARTHSYS 295 Environmental Communication Seminar.

This Earth Systems Master of Arts degree provides an overview of the theory, techniques, and challenges of communicating about environmental science, policy, and ethics with diverse audiences. Students have the opportunity to gain hands-on experience with a range of communication modalities including writing and journalism, multimedia production, policy and strategic communications, and environmental and informal education.

The degree program is built on a set of seven required core courses, which include a weekly seminar, a practicum placement, and an independent capstone project. These Core requirements are enhanced with individual selections from a range of Focus and Elective courses chosen either to emphasize a particular topic or modality or to provide greater breadth and diversity of study topics within environmental communication.

Each student in the Earth Systems Master of Arts, Environmental Communication, program has two academic advisors: the Director of the M.A. program and a faculty co-advisor. The faculty co-advisor is an Academic Council member selected by the student in consultation with the M.A. director.

Earth Systems M.A. students complete a minimum of 45 units for the degree, including 22 units of required core courses, a minimum of 10 units of approved focus courses, and up to 13 units of elective courses, to be selected in close consultation with the M.A. director and the faculty co-advisor. At least 34 units of the student's coursework must be at the 200-level or above. Students may include up to 9 units total of directed research or independent study, including the required EARTHSYS 294 Environmental Communication Capstone units.

Core Courses

Core courses are intended to give students a solid foundation in environmental communication theory and practice and exposure to the broad range of research and the variety of disciplines, approaches, genres, and expressions in environmental communication.

Environmental Communication Core Courses

		Units
Autumn Quarter		
EARTHSYS 290	Master's Seminar	2
EARTHSYS 291	Concepts in Environmental Communication	3
EARTHSYS 292	Multimedia Environmental Communication	3
EARTHSYS 293	Environmental Communication Practicum	1-5
EARTHSYS 294	Environmental Communication Capstone	1-5
EARTHSYS 295	Environmental Communication Seminar (must be taken twice for credit)	1
Winter Quarter		
EARTHSYS 290	Master's Seminar	2
EARTHSYS 277C	Specialized Writing and Reporting: Health and Science Journalism	4
EARTHSYS 293	Environmental Communication Practicum	1-5
EARTHSYS 294	Environmental Communication Capstone	1-3
Spring Quarter		
EARTHSYS 293	Environmental Communication Practicum	1-5
EARTHSYS 294	Environmental Communication Capstone	1-5
EARTHSYS 295	Environmental Communication Seminar (must be taken twice for credit)	1

Focus Courses

Focus courses are communication-specific courses that contribute to students' intended focus for the M.A. degree. Each student should select 10 units or more of focus courses. The following list includes pre-approved focus courses across a number of disciplines. Many other courses will also qualify as Focus courses, depending on the individual student's goals and with the approval of the M.A. director. These include many courses offered by the Graduate School of Education (EDUC), the Department of Communication (COMM), and the Sustainability Science and Practice Program (SUST).

Environmental Communication Focus Courses

		Units
Autumn Quarter		
COMM 208	Media Processes and Effects	4-5
COMM 225	Perspectives on American Journalism	4-5
EARTHSYS 194	Topics in Writing & Rhetoric: Introduction to Environmental Justice: Race, Class, Gender and Place	4
EARTHSYS 227	Decision Science for Environmental Threats	3-5
ENVRES 240	Environmental Decision-Making and Risk Perception	1-3
GSBGEN 515	Essentials of Strategic Communication	2
Winter Quarter		
EARTHSYS 105A	Ecology and Natural History of Jasper Ridge Biological Preserve	4
COMM 264	The Psychology of Communication About Politics in America	4-5
EDUC 357	Science and Environmental Education in Informal Contexts	3-4
GSBGEN 315	Strategic Communication	2-4
or GSBGEN 515	Essentials of Strategic Communication	
Spring Quarter		
EARTHSYS 249	Wild Writing	3
COMM 276	Advanced Digital Journalism Production	4-5
ESS 282	Designing Educational Gardens	2
EDUC 379	Moral, Civic, and Environmental Education	3
EARTHSYS 105B	Ecology and Natural History of Jasper Ridge Biological Preserve	4
EARTH 251	Negotiation	3
GSBGEN 315	Strategic Communication	2-4
or GSBGEN 515	Essentials of Strategic Communication	

Elective Courses

Some Earth Systems M.A. students build a course plan exclusively out of core and focus courses. However, environmental communication is a broad and inherently interdisciplinary field and students come to the M.A. with a wide diversity of backgrounds and goals. Students may select other courses from across campus to fill out their 45-unit degree requirement. These elective courses may be chosen to deepen knowledge about specific environmental topics, for example environmental science, policy, ethics, or history courses; to increase breadth or specialization in areas of communication practice or theory; or to add diversity to the student's overall graduate experience.

Some examples of potential elective courses include the English Department's Creative Nonfiction series (ENGLISH 91 and ENGLISH 191 Intermediate Creative Nonfiction), courses in Art Practice (ARTSTUDI) or Theater and Performance Studies (TAPS), courses associated with the Stanford Storytelling Project and the d.school, and a wide variety of the courses offered by Earth Systems (EARTHSYS), the Emmett Interdisciplinary Program in Environment and Resources (ENVRES), Earth System Science (ESS), Stanford Earth (EARTH), Human Biology (HUMBIO), and other associated departments and programs.

Elective courses can be selected from virtually any Stanford department or program, pending permission to enroll and a strong case for including the course in an individual student's cohesive degree plan. All electives must be approved by the M.A. director.

Coterminal Master of Science in Earth Systems

Admission

Applications in 2020-21 are due:

- October 27, 2020 to apply for Winter 2020 matriculation.
- February 16, 2021 to apply for Spring 2021 matriculation.
- May 11, 2021 to apply for Autumn 2020-21 matriculation.
- Coterminal application (https://www.applyweb.com/stanterm/)
- A statement of purpose
- A resume
- A current Stanford unofficial transcript

Applications must be submitted no later than the quarter prior to the expected completion of the undergraduate degree. The specific application deadline for each quarter is listed above, or can be obtained from the Earth Systems Program office. An application fee is assessed by the Registrar's Office for coterminal applications once students are matriculated into the program.

- Students applying to the coterminal master's program must have completed a minimum of 120 units toward graduation with a minimum overall Stanford GPA of 3.4.
- All applicants must devise a program of study that shows a level of specialization appropriate to the master's level, as determined in consultation with the M.A. director and the Director of Earth Systems.
- Students applying from an undergraduate major other than Earth Systems should also review their undergraduate course list with the M.A. director. a
- Coterminal master's students have the option of receiving their undergraduate degree after completing that degree's requirements or receiving their undergraduate and M.A. degrees concurrently at the completion of the master's program.
- Students must submit a new application to change from the M.S. to the M.A., or from the M.A. to the M.S. in Earth Systems. If accepted, the student must submit a Graduate Authorization Petition through Axess; a $125 fee applies to a successful Graduate Authorization Petition.
- Applicants will be notified of the admission decision in writing, typically 3-4 weeks after the application deadline.
- A $125 application fee will be assessed by the Registrar's office for those accepted and matriculated into the program. To apply, students should submit an online application.

University Coterminal Requirements

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/cotermdegrees/)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first graduate quarter is not a factor. No courses taken prior to the first quarter of the sophomore year may be used to meet master's degree requirements.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate advisor be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

Undergraduate Preparation for the Program

For the Master of Science degree in Earth Systems, the following courses must be taken if not completed in the undergraduate degree program. These courses do not have to be completed before applying to the coterm program. These may not be counted as part of the 45-unit master's degree:

		Units
Core (both required):		8
EARTHSYS 111	Biology and Global Change	
EARTHSYS 112	Human Society and Environmental Change	
Biology: One Biology Foundations/Core course pre-approved by Master's advisor, OR select from the following:		**4-10**
HUMBIO 2A & HUMBIO 2B	Genetics, Evolution, and Ecology and Culture, Evolution, and Society	
BIOHOPK 47	Introduction to Research in Ecology and Ecological Physiology	
EARTHSYS 116	Ecology of the Hawaiian Islands	
Chemistry (select one of the following):		**5-10**
CHEM 31A & CHEM 31B	Chemical Principles I and Chemical Principles II	
or CHEM 31M	Chemical Principles: From Molecules to Solids	
Physics (select one of the following):		**3-4**
One physics class from the PHYSICS 20 or 40 series or GEOPHYS 110		
Mathematics (select one of the following):		**5**

MATH 51	Linear Algebra, Multivariable Calculus, and Modern Applications	
CME 100	Vector Calculus for Engineers	
Statistics (select one of the following):		**3-5**
BIOHOPK 174H	Experimental Design and Probability	
BIO 141	Biostatistics	
ECON 102A	Introduction to Statistical Methods (Postcalculus) for Social Scientists	
STATS 101	Data Science 101	
STATS 110	Statistical Methods in Engineering and the Physical Sciences	
STATS 116	Theory of Probability	
CME 106	Introduction to Probability and Statistics for Engineers	

Degree Requirements

The master of science degree in Earth Systems allows specialization through graduate-level course work that may include up to 9 units of research with the master's advisor. This may culminate in the preparation of a M.S. thesis; however, a thesis is not required for the degree. The process of building mastery in the field is enriched through steady communication with a faculty advisor.

The following are required of all M.S. students:

- A minimum of 45 units of course work and/or research credit (upon approval).
- At least 34 units of the student's course work for the master's program must be at the 200-level or above.
- All remaining course work must be at the 100-level or above.
- All courses for the master's program must be taken for a letter grade; courses not taken for a letter grade must be approved by the master's advisor and Director of Earth Systems.
- A minimum overall GPA of 3.4 must be maintained.
- All coterminal master's students are required to take the capstone course, EARTHSYS 290 Master's Seminar.

COVID-19 Policies

On July 30, the Academic Senate adopted grading policies effective for all undergraduate and graduate programs, excepting the professional Graduate School of Business, School of Law, and the School of Medicine M.D. Program. For a complete list of those and other academic policies relating to the pandemic, see the "COVID-19 and Academic Continuity (http://exploredegrees.stanford.edu/covid-19-policy-changes/#tempdepttemplatetabtext)" section of this bulletin.

The Senate decided that all undergraduate and graduate courses offered for a letter grade must also offer students the option of taking the course for a "credit" or "no credit" grade and recommended that deans, departments, and programs consider adopting local policies to count courses taken for a "credit" or "satisfactory" grade toward the fulfillment of degree-program requirements and/or alter program requirements as appropriate.

Undergraduate Degree Requirements

Grading

For all courses taken during the 2020-21 academic year, the Earth System Program will allow grades of 'CR' (credit) or 'S' (satisfactory) grades in classes retaining the S/NC basis, in addition to letter grades, to count towards fulfillment of requirements for the Earth Systems Undergraduate Major and Minor.

Graduate Degree Requirements

Grading

For all courses taken during the 2020-21 academic year, the Earth System Program will allow grades of 'CR' (credit) or 'S' (satisfactory) grades in classes retaining the S/NC basis, in addition to letter grades, to count towards fulfillment of requirements for the Coterminal M.S. and M.A. Degrees.

Graduate Advising Expectations

Purpose of Advising

The primary purpose of the faculty adviser in the Earth Systems coterminal M.S. and M.A. programs is to help guide the academic development of their advisees. Faculty advisers help advisees design comprehensive, rigorous, interdisciplinary curricula that enable each student to acquire mastery of their chosen field(s). A small number of coterm students may also choose to conduct research and write a master's thesis under the guidance of their adviser. Earth Systems staff members can provide additional guidance on the selection of courses, navigating policies and degree requirements, and preparation for future employment and exploration of professional pathways.

Expectations

All candidates for coterminal master's programs in Earth Systems (M.S. and M.A.) are required to secure an academic adviser prior to applying to the coterm program. Coterm advisers must be members of the Academic Council. Each student is expected to meet with their adviser at least once per quarter to discuss degree progress and new course selections. Students must obtain their adviser's signed approval on their course plan each quarter as courses taken may differ from the original course plan submitted with the coterm application. The final curriculum must stay true to the scope and rigor of the originally approved curriculum even if some of the individual courses change.

Because Earth Systems is an interdisciplinary program, and does not have its own faculty, the program relies upon faculty in related departments to advise its students. This is particularly important for coterm students who are embarking on advanced studies and need the expertise of their advisers for curriculum planning and academic development. The program greatly appreciates this advising support, and the Earth Systems staff is available for any questions and to help in whatever way we can.

For a statement of University policy on graduate advising, see the "Graduate Advising (http://exploredegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext)" section of this bulletin.

Director: Karen Casciotti

Deputy Director: Richard Nevle

Associate Director: Deana Fabbro-Johnston

Director of Graduate Studies: Karen Casciotti

Director of Undergraduate Studies: Richard Nevle

Affiliated Faculty and Lecturers: Michelle Anderson (Law), Patrick Archie (Earth Systems, Earth System Science), Nicole Ardoin (School of Education, Woods Institute for the Environment), Kevin Arrigo (Earth System Science), Gregory Asner (Department of Global Ecology, Carnegie Institution), Greg Beroza (Geophysics), Barbara Block (Biology, Hopkins Marine Station, Woods Institute for the Environment), Alexandria Boehm (Civil and Environmental Engineering), Gordon Brown (Geological Sciences, emeritus), Marshall Burke (Earth System Science), Ken Caldeira (Earth System Science), Liz Carlisle (Earth Systems), Karen Casciotti (Earth System Science), Page Chamberlain (Geological Sciences), Larry Crowder (Biology, Woods Institute for the Environment), Danny

Cullenward (Earth Systems), Lisa Curran (Anthropology, Woods Institute for the Environment), Gretchen Daily (Biology, Woods Institute for the Environment), Jenna Davis (Civil and Environmental Engineering, Woods Institute for the Environment), Anne Dekas (Earth System Science), Mark Denny (Biology, Hopkins Marine Station), Noah Diffenbaugh (Earth System Science, Woods Institute for the Environment), Rodolfo Dirzo (Biology, Woods Institute for the Environment), Robert Dunbar (Earth System Science, Woods Institute for the Environment), Debra Dunn (Earth Systems, Hasso Plattner Institute of Design), William Durham (Anthropology, Woods Institute for the Environment), Louis Durlofsky (Energy Resources Engineering), Stefano Ermon (Computer Science), Gary Ernst (Geological Sciences, emeritus), Walter Falcon (Freeman Spogli Institute for International Studies, emeritus, Woods Institute for the Environment), Scott Fendorf (Earth System Science, Woods Institute for the Environment, Precourt Institute for Energy), Christopher Field (Woods Institute for the Environment), Christopher Francis (Earth System Science, Woods Institute for the Environment), Zephyr Frank (History, Woods Institute for the Environment), David Freyberg (Civil and Environmental Engineering, Woods Institute for the Environment), Tad Fukami (Biology), Margot Gerritsen (Energy Resources Engineering), Elizabeth Hadly (Biology, Woods Institute for the Environment), Thomas Hayden (Earth Systems), George Hilley (Geological Sciences), Suki Hoagland (Earth Systems), Robert Jackson (Earth System Science, Woods Institute for the Environment), Michael Kahan (Urban Studies), David Kennedy (History, emeritus, Woods Institute for the Environment), Alexandra Konings (Earth System Science), Karl Knapp (Atmosphere and Energy Operations), Rosemary Knight (Geophysics, Woods Institute for the Environment), Jeffrey Koseff (Civil and Environmental Engineering), Anthony Kovscek (Energy Resources Engineering), Eric Lambin (Earth System Science, Woods Institute for the Environment), Jim Leape (Center for Ocean Solutions), David Lobell (Earth System Science, Woods Institute for the Environment), Evan Lyons (Earth System Science), Gilbert Masters (Civil and Environmental Engineering), Pamela Matson (Earth System Science, Freeman Spogli Institute for International Studies, Woods Institute for the Environment), Anna Michalak (Earth System Science), Fiorenza Micheli (Hopkins Marine Station, Center for Ocean Solutions), Stephen Monismith (Civil and Environmental Engineering, Woods Institute for the Environment), Harold Mooney (Biology, emeritus, Woods Institute for the Environment), Rosamond Naylor (Earth System Science, Freeman Spogli Institute for International Studies, Woods Institute for the Environment), Richard Nevle (Earth Systems), Julia Novy-Hildesley (Sustainability Science and Practice), Stephen Palumbi (Biology, Hopkins Marine Station, Woods Institute for the Environment), Jonathan Payne (Geological Sciences), Kabir Peay (Biology), Emily Polk (Program in Writing and Rhetoric), Thomas Robinson (Medicine), Matt Rothe (Earth Systems, Hasso Plattner Institute of Design, Graduate School of Business), Jennifer Saltzman (Geological Sciences), Dustin Schroeder (Geophysics), Paul Segall (Geophysics), Deborah Sivas (Law), George Somero (Biology, Hopkins Marine Station), Jenny Suckale (Geophysics), James Sweeney (Management Science and Engineering, Woods Institute for the Environment), Leif Thomas (Earth System Science), Barton Thompson, Junior (Law, Woods Institute for the Environment), Tiziana Vanorio (Geophysics), Peter Vitousek (Biology, Woods Institute for the Environment), Virginia Walbot (Biology), Paula Welander (Earth System Science), Cindy Wilber (Jasper Ridge), Michael Wilcox (Anthropology), Mikael Wolfe (History), Jane Woodward (Atmosphere and Energy Operations), Mark Zoback (Geophysics)

Overseas Studies Courses in Earth Systems

The Bing Overseas Studies Program (http://bosp.stanford.edu) (BOSP) manages Stanford international and domestic study away programs for Stanford undergraduates. Students should consult their department or program's student services office for applicability of Overseas Studies courses to a major or minor program.

The BOSP course search site (https://undergrad.stanford.edu/programs/bosp/explore/search-courses/) displays courses, locations, and quarters relevant to specific majors.

For course descriptions and additional offerings, see the listings in the Stanford Bulletin's ExploreCourses (http://explorecourses.stanford.edu) or Bing Overseas Studies (http://bosp.stanford.edu).

Due to COVID-19, all BOSP programs have been suspended for Autumn Quarter 2020-21. All courses and quarters of operation are subject to change.

		Units
OSPAUSTL 10	Coral Reef Ecosystems	3
OSPAUSTL 28	Terrestrial Ecology and Conservation	3
OSPAUSTL 32	Coastal Ecosystems	3
OSPCPTWN 10	Climate Change and Political Violence	4
OSPSANTG 58	Global Change in Chile	5
OSPSANTG 85	Marine Ecology of Chile and the South Pacific	5

Environmental Courses List

		Units
AA 116Q	Electric Automobiles and Aircraft	
AA 251	Introduction to the Space Environment	
AA 260	Sustainable Aviation	
AA 280	Smart Structures	
AFRICAAM 47	History of South Africa	
AFRICAAM 50B	Nineteenth Century America	
AFRICAAM 51A	Race in Science	
AFRICAAM 58Q	American Landscapes of Segregation	
AFRICAAM 95	Liberation Through Land: Organic Gardening and Racial Justice	
AFRICAAM 100	Grassroots Community Organizing: Building Power for Collective Liberation	
AFRICAAM 111	AIDS, Literacy, and Land: Foreign Aid and Development in Africa	
AFRICAAM 144	Living Free: Embodying Healing and Creativity in The Era of Racial Justice Movements	
AFRICAAM 147	History of South Africa	
AFRICAAM 150B	Nineteenth Century America	
AFRICAAM 189	Black Life and Death in the Neoliberal Era	
AFRICAAM 204	Race, Colonialism, and Climate Justice in the Caribbean	
AFRICAST 112	AIDS, Literacy, and Land: Foreign Aid and Development in Africa	
AFRICAST 114N	Desert Biogeography of Namibia Prefield Seminar	
AMSTUD 1B	Media, Culture, and Society	
AMSTUD 10Q	Dystopian California: Imagining the Golden State in Disaster and Science Fiction Film	
AMSTUD 94	Topics in Food Studies	
AMSTUD 124A	The American West	
AMSTUD 136X	Indigenous Peoples and Environmental Change in the North American Wes	
AMSTUD 150X	From Gold Rush to Google Bus: History of San Francisco	
ANTHRO 18	Peopling of the Globe: Changing Patterns of Land Use and Consumption Over the Last 50,000 Years	
ANTHRO 34	Animals and Us	

ANTHRO 39	Sense of Place
ANTHRO 42	Megacities
ANTHRO 78A	Disruption and Diffusion: The Archaeology of Innovation
ANTHRO 103	The Archaeology of Climate
ANTHRO 106	Incas and their Ancestors: Peruvian Archaeology
ANTHRO 110	Environmental Archaeology
ANTHRO 112A	Archaeology of Human Rights
ANTHRO 113	Culture and Epigenetics: Towards A Non-Darwinian Synthesis
ANTHRO 116B	Anthropology of the Environment
ANTHRO 119	Zooarchaeology: An Introduction to Faunal Remains
ANTHRO 123B	Government of Water and Crisis: Corporations, States and the Environment
ANTHRO 123C	"Third World Problems?" Environmental Justice Around the World
ANTHRO 135B	Waste Politics: Contesting Toxicity, Value, and Power
ANTHRO 136	The Anthropology of Global Supply Chains
ANTHRO 137	The Politics of Humanitarianism
ANTHRO 140C	Mobilizing Nature
ANTHRO 150B	Fire: Social and Ecological Contexts of Conflagration
ANTHRO 154C	Animism, Gaia, and Alternative Approaches to the Environment
ANTHRO 159C	Ecological Humanities
ANTHRO 162	Indigenous Peoples and Environmental Problems
ANTHRO 166	Political Ecology of Tropical Land Use: Conservation, Natural Resource Extraction, and Agribusiness
ANTHRO 184A	Vital Curse: Oil As Culture
ANTHRO 219	Zooarchaeology: An Introduction to Faunal Remains
ANTHRO 235B	Waste Politics: Contesting Toxicity, Value, and Power
ANTHRO 237	The Politics of Humanitarianism
ANTHRO 262	Indigenous Peoples and Environmental Problems
ANTHRO 266	Political Ecology of Tropical Land Use: Conservation, Natural Resource Extraction, and Agribusiness
ANTHRO 364A	EcoGroup: Problems in Ecological and Evolutionary Anthropology
ANTHRO 372	Urban Ecologies
ANTHRO 378	Dynamics of Coupled Human-Natural Systems
ANTHRO 445	Anthropology Brown Bag Series
APPPHYS 79N	Energy Options for the 21st Century
APPPHYS 205	Introduction to Biophysics
APPPHYS 219	Solid State Physics Problems in Energy Technology
APPPHYS 294	Cellular Biophysics
ARCHLGY 12	Peopling of the Globe: Changing Patterns of Land Use and Consumption Over the Last 50,000 Years
ARCHLGY 102B	Incas and their Ancestors: Peruvian Archaeology
ARCHLGY 106	The Archaeology of Climate
ARCHLGY 111	Emergence of Chinese Civilization from Caves to Palaces
ARCHLGY 119	Zooarchaeology: An Introduction to Faunal Remains
ARCHLGY 124	Archaeology of Food: production, consumption and ritual
ARCHLGY 126	Archaeobotany
ARCHLGY 154	Animism, Gaia, and Alternative Approaches to the Environment
ARCHLGY 156	Design of Cities
ARCHLGY 224	Archaeology of Food: production, consumption and ritual
ARCHLGY 226	Archaeobotany
ARTHIST 152	The American West
ARTHIST 450	Art in the Age of Precarity
ARTSTUDI 141S	Drawing Outdoors
ARTSTUDI 153	Ecology of Materials
ARTSTUDI 184	Art and Environmental Engagement
ASNAMST 123	Asian Americans and Environmental Justice
BIO 2N	Ecology and Evolution of Infectious Disease in a Changing World
BIO 3	Frontiers in Marine Biology
BIO 3N	Views of a Changing Sea: Literature & Science
BIO 6N	Ocean Conservation: Pathways to Solutions
BIO 7N	Conservation Photography
BIO 8N	Human Origins
BIO 12N	Sensory Ecology of Marine Animals
BIO 16	Conservation Storytelling: Pre-course for BOSP South Africa
BIO 16N	Island Ecology
BIO 30	Ecology for Everyone
BIO 35N	Climate change ecology: Is it too late?
BIO 46	Introduction to Research in Ecology and Evolutionary Biology
BIO 47	Introduction to Research in Ecology and Evolutionary Biology
BIO 53	Conservation Photography
BIO 81	Introduction to Ecology
BIO 102	Ecosystem Ecology and Biogeochemistry
BIO 105A	Ecology and Natural History of Jasper Ridge Biological Preserve
BIO 105B	Ecology and Natural History of Jasper Ridge Biological Preserve
BIO 115	The Hidden Kingdom - Evolution, Ecology and Diversity of Fungi
BIO 116	Ecology of the Hawaiian Islands
BIO 117	Biology and Global Change
BIO 121	ORNITHOLOGY
BIO 130	Ecosystems of California
BIO 136	Macroevolution
BIO 137	Plant Genetics
BIO 138	Ecosystem Services: Frontiers in the Science of Valuing Nature
BIO 140	The Science of Extreme Life of the Sea
BIO 141	Biostatistics

BIO 142	Molecular Geomicrobiology Laboratory
BIO 144	Conservation Biology: A Latin American Perspective
BIO 145	Ecology and Evolution of Animal Behavior
BIO 147	Ecosystem Ecology and Biogeochemistry
BIO 156	California Wildfires: Forest Fire Ecology, Management, and Policy
BIO 172	Ecological Dynamics: Theory and Applications
BIO 179	Integrated Valuation of Ecosystem Services and Tradeoffs
BIO 182	Modeling Cultural Evolution
BIO 196A	Biology Senior Reflection
BIO 196B	Biology Senior Reflection
BIO 196C	Biology Senior Reflection
BIO 202	Ecological Statistics
BIO 208	Spanish in Science/Science in Spanish
BIO 227	Foundations of Community Ecology
BIO 234	Conservation Biology: A Latin American Perspective
BIO 238	Ecosystem Services: Frontiers in the Science of Valuing Nature
BIO 245	Ecology and Evolution of Animal Behavior
BIO 273A	Environmental Microbiology I
BIO 274S	Hopkins Microbiology Course
BIO 279	Integrated Valuation of Ecosystem Services and Tradeoffs
BIO 302	Current Topics and Concepts in Population Biology, Ecology, and Evolution
BIO 303	Current Topics and Concepts in Population Biology, Ecology, and Evolution
BIO 304	Current Topics and Concepts in Population Biology, Ecology, and Evolution
BIO 313	Ethics in the Anthropocene
BIO 384	Theoretical Ecology
BIO 386	Conservation and Population Genomics
BIO 459	Frontiers in Interdisciplinary Biosciences
BIOC 459	Frontiers in Interdisciplinary Biosciences
BIOE 44	Fundamentals for Engineering Biology Lab
BIOE 80	Introduction to Bioengineering (Engineering Living Matter)
BIOE 191	Bioengineering Problems and Experimental Investigation
BIOE 240	The Biology Revolution
BIOE 242	LAW, TECHNOLOGY, AND LIBERTY
BIOE 271	Frugal Science
BIOE 390	Introduction to Bioengineering Research
BIOE 459	Frontiers in Interdisciplinary Biosciences
BIOHOPK 14	Bio-logging and Bio-telemetry
BIOHOPK 43	Plant Biology, Evolution, and Ecology
BIOHOPK 47	Introduction to Research in Ecology and Ecological Physiology
BIOHOPK 81	Introduction to Ecology
BIOHOPK 85	Evolution
BIOHOPK 150H	Ecological Mechanics
BIOHOPK 152H	Physiology of Global Change
BIOHOPK 153H	Current Topics and Concepts in Quantitative Fish Dynamics and Fisheries Management
BIOHOPK 155H	Developmental Biology and Evolution
BIOHOPK 157H	Creative Writing & Science: The Artful Interpreter
BIOHOPK 158H	Science Meets Literature on the Monterey Peninsula
BIOHOPK 159H	Molecular Ecology Lab
BIOHOPK 160H	Developmental Biology in the Ocean: Diverse Embryonic & Larval Strategies of marine invertebrates
BIOHOPK 161H	Invertebrate Zoology
BIOHOPK 162H	Comparative Animal Physiology
BIOHOPK 163H	Oceanic Biology
BIOHOPK 165H	The Extreme Life of the Sea
BIOHOPK 166H	Molecular Ecology
BIOHOPK 167H	Nerve, Muscle, and Synapse
BIOHOPK 168H	Disease Ecology: from parasites evolution to the socio-economic impacts of pathogens on nations
BIOHOPK 173H	Marine Conservation Biology
BIOHOPK 173HA	Marine Conservation Biology - Seminar and Discussion Only
BIOHOPK 174H	Experimental Design and Probability
BIOHOPK 175H	Marine Science and Conservation in a Changing World
BIOHOPK 177H	Dynamics and Management of Marine Populations
BIOHOPK 179H	Physiological Ecology of Marine Megafauna
BIOHOPK 181H	Physiology of Global Change
BIOHOPK 182H	Stanford at Sea
BIOHOPK 183H	Introduction to Ecology
BIOHOPK 184H	Holistic Biology
BIOHOPK 185H	Ecology and Conservation of Kelp Forest Communities
BIOHOPK 187H	Sensory Ecology
BIOHOPK 198H	Directed Instruction or Reading
BIOHOPK 199H	Undergraduate Research
BIOHOPK 242H	Historical Ecology of Marine Invertebrates
BIOHOPK 250H	Ecological Mechanics
BIOHOPK 252H	Physiology of Global Change
BIOHOPK 253H	Current Topics and Concepts in Quantitative Fish Dynamics and Fisheries Management
BIOHOPK 255H	Developmental Biology and Evolution
BIOHOPK 257H	Creative Writing & Science: The Artful Interpreter
BIOHOPK 260H	Developmental Biology in the Ocean: Diverse Embryonic & Larval Strategies of marine invertebrates
BIOHOPK 261H	Invertebrate Zoology
BIOHOPK 262H	Comparative Animal Physiology
BIOHOPK 263H	Oceanic Biology
BIOHOPK 266H	Molecular Ecology
BIOHOPK 267H	Nerve, Muscle, and Synapse
BIOHOPK 268H	Disease Ecology: from parasites evolution to the socio-economic impacts of pathogens on nations
BIOHOPK 273H	Marine Conservation Biology
BIOHOPK 273HA	Marine Conservation Biology - Seminar and Discussion Only

BIOHOPK 274	Hopkins Microbiology Course
BIOHOPK 274H	Experimental Design and Probability
BIOHOPK 275H	Marine Science and Conservation in a Changing World
BIOHOPK 276H	Estimates and Errors: The Theory of Scientific Measurement
BIOHOPK 277H	Dynamics and Management of Marine Populations
BIOHOPK 279H	Physiological Ecology of Marine Megafauna
BIOHOPK 280	Short Course on Ocean Policy
BIOHOPK 285H	Ecology and Conservation of Kelp Forest Communities
BIOHOPK 287H	Sensory Ecology
BIOHOPK 299H	Advanced Topics in Marine Conservation
BIOHOPK 300H	Research
BIOHOPK 320H	Physical Biology
BIOHOPK 323H	Stanford at Sea
BIOHOPK 330H	Scientific Writing
BIOMEDIN 156	Economics of Health and Medical Care
BIOMEDIN 256	Economics of Health and Medical Care
BIOS 205	Stem Cells, Immunology and Regenerative Medicine
BIOS 221	Modern Statistics for Modern Biology
BIOS 233	Experimental Metagenomics: Nectar Microbes as a Model System
BIOS 235	Metabolism and Metabolic Ecology: Microbes, Gut and Cancer
BIOS 248	Scientific Computing for Ecologists, Biologists and Environmental Scientists
BIOS 252	Experimental strategies for understanding plant-environmental responses
BIOS 253	Discovery and Innovation in Emerging Viral Infections
BIOS 265	Introduction to Quantitative Reasoning in Biology
BIOS 270	Planetary Health: Socioeconomic & Ecological Links Between Human Health & Earth's Natural Ecosystems
BIOS 288	Quantitative Methods in Marine Conservation and Ocean Science
BIOS 292	Preparation & Practice: Science Communication & Media
CBIO 243	Principles of Cancer Systems Biology
CEE 1	Introduction to Environmental Systems Engineering
CEE 32A	Psychology of Architecture
CEE 33C	Housing Visions
CEE 63	Weather and Storms
CEE 64	Air Pollution and Global Warming: History, Science, and Solutions
CEE 70	Environmental Science and Technology
CEE 70N	Water, Public Health, and Engineering
CEE 73	Water: An Introduction
CEE 74N	Grand Challenges in Environmental Engineering
CEE 80N	Engineering the Built Environment: An Introduction to Structural Engineering
CEE 83	Seismic Design Workshop
CEE 100	Managing Sustainable Building Projects
CEE 101B	Mechanics of Fluids
CEE 101D	Computations in Civil and Environmental Engineering
CEE 107A	Understanding Energy
CEE 107H	Applied Hope: Whole-Systems Thinking on Energy Solutions
CEE 107R	E^3: Extreme Energy Efficiency
CEE 107S	Understanding Energy - Essentials
CEE 112A	Industry Applications of Virtual Design & Construction
CEE 112B	Industry Applications of Virtual Design & Construction
CEE 112C	Industry Applications of Virtual Design & Construction
CEE 113	Patterns of Sustainability
CEE 118X	Shaping the Future of the Bay Area
CEE 124	Sustainable Development Studio
CEE 124E	Ethics in Urban Systems
CEE 124S	Sustainable Urban Systems Seminar
CEE 125	Defining Smart Cities: Visions of Urbanism for the 21st Century
CEE 126	International Urbanization Seminar: Cross-Cultural Collaboration for Sustainable Urban Development
CEE 126X	Hard Earth: Environmental Justice
CEE 126Y	Hard Earth: Stanford Graduate-Student Talks Exploring Tough Environmental Dilemmas
CEE 126Z	Hard Earth: The Interconnected Impacts of Global Climate Change
CEE 130R	Racial Equity in Energy
CEE 131B	Financial Management of Sustainable Urban Systems
CEE 141A	Infrastructure Project Development
CEE 141B	Infrastructure Project Delivery
CEE 141C	Global Infrastructure Projects Seminar
CEE 144	Design and Innovation for the Circular Economy
CEE 146S	Engineering Economics and Sustainability
CEE 151	Negotiation
CEE 151A	Race in Science
CEE 155	Introduction to Sensing Networks for CEE
CEE 156	Building Systems Design & Analysis
CEE 157	Sustainable Finance and Investment Seminar
CEE 161I	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation
CEE 162D	Introduction to Physical Oceanography
CEE 162E	Rivers, Streams, and Canals
CEE 162F	Coastal Processes
CEE 162I	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation
CEE 165C	Water Resources Management
CEE 166A	Watershed Hydrologic Processes and Models
CEE 166B	Water Resources and Hazards
CEE 171F	New Indicators of Well-Being and Sustainability
CEE 171G	Environmental & Ecological Economics
CEE 172	Air Quality Management

CEE 173	Urban Water
CEE 173S	Electricity Economics
CEE 174A	Providing Safe Water for the Developing and Developed World
CEE 174B	Wastewater Treatment: From Disposal to Resource Recovery
CEE 175A	California Coast: Science, Policy, and Law
CEE 175Q	Changing Human Behavior: Drivers and Barriers in Environmental Action
CEE 175S	Environmental Entrepreneurship and Innovation
CEE 176A	Energy Efficient Buildings
CEE 176B	100% Clean, Renewable Energy and Storage for Everything
CEE 176C	Energy Storage Integration - Vehicles, Renewables, and the Grid
CEE 176G	Sustainability Design Thinking
CEE 177	Aquatic Chemistry and Biology
CEE 177L	Smart Cities & Communities
CEE 177S	Engineering and Sustainable Development
CEE 177X	Engineering and Sustainable Development: Toolkit
CEE 178	Introduction to Human Exposure Analysis
CEE 178S	Air Pollution Science & Engineering
CEE 179A	Water Chemistry Laboratory
CEE 179C	Environmental Engineering Design
CEE 179S	Seminar: Issues in Environmental Science, Technology and Sustainability
CEE 183	Integrated Civil Engineering Design Project
CEE 199	Undergraduate Research in Civil and Environmental Engineering
CEE 199L	Independent Project in Civil and Environmental Engineering
CEE 199S	Undergraduate Summer Research in Civil and Environmental Engineering
CEE 200A	Teaching of Civil and Environmental Engineering
CEE 200B	Teaching of Civil and Environmental Engineering
CEE 200C	Teaching of Civil and Environmental Engineering
CEE 201D	Computations in Civil and Environmental Engineering
CEE 206	Decision Analysis for Civil and Environmental Engineers
CEE 207A	Understanding Energy
CEE 207H	Applied Hope: Whole-Systems Thinking on Energy Solutions
CEE 207S	Understanding Energy - Essentials
CEE 212A	Industry Applications of Virtual Design & Construction
CEE 213	Patterns of Sustainability
CEE 217	Renewable Energy Infrastructure
CEE 218X	Shaping the Future of the Bay Area
CEE 221A	Planning Tools and Methods in the Power Sector
CEE 223	Materials for Sustainable Built Environments
CEE 224A	Design and Operation of Integrated Infrastructure Systems
CEE 224X	Shaping the Future of the Bay Area
CEE 225	Defining Smart Cities: Visions of Urbanism for the 21st Century
CEE 226	Life Cycle Assessment for Complex Systems
CEE 226E	Techniques and Methods for Decarbonized and Energy Efficient Building Design
CEE 227	Global Project Finance
CEE 229S	Climate Change Adaptation in the Coastal Built Environment
CEE 242P	Designing Project Organizations
CEE 243	Intro to Urban Sys Engrg
CEE 246	Venture Creation for the Real Economy
CEE 251	Negotiation
CEE 252Q	Construction Engineering Fundamentals
CEE 255	Introduction to Sensing Networks for CEE
CEE 256	Building Systems Design & Analysis
CEE 257	Sustainable Finance and Investment Seminar
CEE 260A	Physical Hydrogeology
CEE 260C	Contaminant Hydrogeology and Reactive Transport
CEE 260D	Remote Sensing of Hydrology
CEE 261B	Physics of Wind Energy
CEE 261I	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation
CEE 262A	Hydrodynamics
CEE 262B	Transport and Mixing in Surface Water Flows
CEE 262C	Coastal Ocean Modeling
CEE 262D	Introduction to Physical Oceanography
CEE 262F	Ocean Waves
CEE 262H	Observational Methods in Coastal Oceanography
CEE 262I	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation
CEE 263A	Air Pollution Modeling
CEE 263B	Numerical Weather Prediction
CEE 263C	Weather and Storms
CEE 263D	Air Pollution and Global Warming: History, Science, and Solutions
CEE 263G	Energy Policy in California and the West
CEE 263S	Atmosphere/Energy Seminar
CEE 265A	Resilience, Sustainability and Water Resources Development
CEE 265C	Water Resources Management
CEE 265D	Water and Sanitation in Developing Countries
CEE 265E	Adaptation to Sea Level Rise and Extreme Weather Events
CEE 265F	Environmental Governance and Climate Resilience
CEE 265I	Poverty, Infrastructure and Climate
CEE 266A	Watershed Hydrologic Processes and Models
CEE 266B	Water Resources and Hazards
CEE 266C	Dams, Reservoirs, and their Sustainability
CEE 266E	California's Water Policy and Management: Toward A Sustainable Future

CEE 266F	Stochastic Hydrology
CEE 266G	Water Resources Systems Analysis
CEE 267	Applied Data Analysis and Uncertainty Quantification
CEE 269A	Environmental Engineering Seminar
CEE 269B	Environmental Engineering Seminar
CEE 269C	Environmental Engineering Seminar
CEE 270	Movement and Fate of Organic Contaminants in Waters
CEE 270B	Environmental Organic Reaction Chemistry
CEE 271A	Physical and Chemical Treatment Processes
CEE 271B	Environmental Biotechnology
CEE 271D	Introduction to Wastewater Treatment Process Modeling
CEE 271G	Environmental & Ecological Economics
CEE 272	Coastal Contaminants
CEE 272R	Modern Power Systems Engineering
CEE 272T	SmartGrids and Advanced Power Systems Seminar
CEE 273A	Water Chemistry Laboratory
CEE 273B	The Business of Water
CEE 273F	Urban Water Use Efficiency and Conservation
CEE 274A	Environmental Microbiology I
CEE 274B	Microbial Bioenergy Systems
CEE 274D	Pathogens and Disinfection
CEE 274P	Environmental Health Microbiology Lab
CEE 274S	Hopkins Microbiology Course
CEE 275A	California Coast: Science, Policy, and Law
CEE 275B	Process Design for Environmental Biotechnology
CEE 275C	Water, Sanitation and Health
CEE 275D	Environmental Policy Analysis
CEE 275K	The Practice of Environmental Consulting
CEE 275P	Persuasive Communication for Environmental Scientists, Practitioners, and Entrepreneurs
CEE 275S	Environmental Entrepreneurship and Innovation
CEE 276	Introduction to Human Exposure Analysis
CEE 276B	100% Clean, Renewable Energy and Storage for Everything
CEE 276C	Energy Storage Integration - Vehicles, Renewables, and the Grid
CEE 276G	Sustainability Design Thinking
CEE 277F	Advanced Field Methods in Water, Health and Development
CEE 277L	Smart Cities & Communities
CEE 277S	Engineering and Sustainable Development
CEE 277X	Engineering and Sustainable Development: Toolkit
CEE 278A	Air Pollution Fundamentals
CEE 278C	Indoor Air Quality
CEE 278S	Air Pollution Science & Engineering
CEE 279S	Seminar: Issues in Environmental Science, Technology and Sustainability
CEE 287	Earthquake Resistant Design and Construction
CEE 288	Introduction to Performance Based Earthquake Engineering
CEE 293	Foundations and Earth Structures
CEE 297M	Managing Critical Infrastructure
CEE 299E	Graduate Summer Research in CEE
CEE 299L	Independent Project in Civil and Environmental Engineering
CEE 301	The Energy Seminar
CEE 316	Sustainable Built Environment Research
CEE 322	Data Analytics for Urban Systems
CEE 323A	Infrastructure Finance and Governance
CEE 323B	Infrastructure Finance and Governance
CEE 323C	Reinventing Disruptive Innovation for Civil Engineering
CEE 324	Industrialized Construction
CEE 325	CapaCity Design Studio
CEE 330	Racial Equity in Energy
CEE 341	Virtual Design and Construction
CEE 350	Engineering Writing, Reviewing and Presentations
CEE 361	Turbulence Modeling for Environmental Fluid Mechanics
CEE 363A	Mechanics of Stratified Flows
CEE 363F	Geophysical Fluid Dynamics
CEE 363G	Field Techniques in Coastal Oceanography
CEE 365A	Advanced Topics in Environmental Fluid Mechanics and Hydrology
CEE 365B	Advanced Topics in Environmental Fluid Mechanics and Hydrology
CEE 365C	Advanced Topics in Environmental Fluid Mechanics and Hydrology
CEE 365D	Advanced Topics in Environmental Fluid Mechanics and Hydrology
CEE 370A	Environmental Research
CEE 370B	Environmental Research
CEE 370C	Environmental Research
CEE 370D	Environmental Research
CEE 374A	Introduction to Physiology of Microbes in Biofilms
CEE 374B	Introduction to Physiology of Microbes in Biofilms
CEE 374C	Introduction to Physiology of Microbes in Biofilms
CEE 374D	Introduction to Physiology of Microbes in Biofilms
CEE 374S	Advanced Topics in Microbial Pollution
CEE 374W	Advanced Topics in Water, Health and Development
CEE 377	Research Proposal Writing in Environmental Engineering and Science
CEE 379	Introduction to PHD Studies in Civil and Environmental Engineering
CEE 385	Performance-Based Earthquake Engineering
CHEM 10	Exploring Research and Problem Solving Across the Sciences
CHEM 25N	Science in the News
CHEM 279	Chemophysical analyses of costs to lower atmospheric concentrations of greenhouse gases

CHEM 459	Frontiers in Interdisciplinary Biosciences
CHEMENG 60Q	Environmental Regulation and Policy
CHEMENG 70Q	Masters of Disaster
CHEMENG 120B	Energy and Mass Transport
CHEMENG 174	Environmental Microbiology I
CHEMENG 274	Environmental Microbiology I
CHEMENG 432	Electrochemical Energy Conversion
CHEMENG 456	Microbial Bioenergy Systems
CHEMENG 459	Frontiers in Interdisciplinary Biosciences
CHEMENG 501	Special Topics in Semiconductor Processing
CHEMENG 516	Special Topics in Energy and Catalysis
CHEMENG 521	Special Topics in Nanostructured Materials for Energy and the Environment
CHILATST 125S	Chicano/Latino Politics
CHINA 118	Humanities Core: Everybody Eats: The Language, Culture, and Ethics of Food in East Asia
CHINA 118A	Food Culture in China: Past and Present
CHINA 371	Critical Theory and Ecology: A Cross-Cultural Perspective
CHPR 113	Healthy/Sustainable Food Systems: Maximum Sustainability across Health, Economics, and Environment
CHPR 166	Food and Society: Exploring Eating Behaviors in Social, Environmental, and Policy Context
CHPR 232	Social and Structural Determinants of Health: Achieving Health Equity
CLASSICS 14N	Ecology in Philosophy and Literature
CME 197	Human-Centered Design Methods in Data Science
CME 211	Software Development for Scientists and Engineers
COMM 1B	Media, Culture, and Society
COMM 51A	Race in Science
COMM 51B	Race in Technology
COMM 104W	Reporting, Writing, and Understanding the News
COMM 108	Media Processes and Effects
COMM 164	The Psychology of Communication About Politics in America
COMM 172	Media Psychology
COMM 177C	Specialized Writing and Reporting: Health and Science Journalism
COMM 272	Media Psychology
COMM 277C	Specialized Writing and Reporting: Health and Science Journalism
COMPLIT 207	Why is Climate Change Un-believable? Interdisciplinary Approaches to Environmental Action
COMPLIT 348	US-Mexico Border Fictions: Writing La Frontera, Tearing Down the Wall
COMPLIT 368A	Imagining the Oceans
COMPMED 11SC	Life in the Zoo: Behavior, Welfare and Enrichment
COMPMED 80N	Animal behavior: sex, death, and sometimes food!
COMPMED 84Q	Globally Emerging Zoonotic Diseases
CS 22A	The Social & Economic Impact of Artificial Intelligence
CS 325B	Data for Sustainable Development
CS 377E	Designing Solutions to Global Grand Challenges
CSRE 30SI	Housing Justice and Stratification in the Bay Area
CSRE 31SI	Food + Race
CSRE 51A	Race in Science
CSRE 109A	Federal Indian Law
CSRE 109B	Native Nation Building
CSRE 121	Discourse of the Colonized: Native American and Indigenous Voices
CSRE 123C	"Third World Problems?" Environmental Justice Around the World
CSRE 125E	Shades of Green: Exploring and Expanding Environmental Justice in Practice
CSRE 178	Ethics and Politics of Public Service
DESINST 250	Oceans by Design
EARTH 1A	Know Your Planet: Research Frontiers
EARTH 1B	Know Your Planet: Big Earth
EARTH 1C	Know Your Planet: Science Outside
EARTH 2	Climate and Society
EARTH 5	Geokids: Earth Sciences Education
EARTH 10	Design for a Habitable Planet
EARTH 14	Our National Parks
EARTH 15	Living on the Edge
EARTH 42	Moving and Shaking in the Bay Area
EARTH 100	Research Preparation for Undergraduates
EARTH 114A	Our National Parks
EARTH 117	Earth Sciences of the Hawaiian Islands
EARTH 126X	Hard Earth: Environmental Justice
EARTH 126Y	Hard Earth: Stanford Graduate-Student Talks Exploring Tough Environmental Dilemmas
EARTH 126Z	Hard Earth: The Interconnected Impacts of Global Climate Change
EARTH 131	Pathways in Sustainability Careers
EARTH 191	Stanford EARTH Field Courses
EARTH 193	Natural Perspectives: Geology, Environment, and Art
EARTH 202	PhD Students on the PhD
EARTH 203	Diversity and Inclusion in the Geosciences
EARTH 214	Software Design in Modern Fortran for Scientists and Engineers
EARTH 218	Communicating Science
EARTH 219	OPINION WRITING IN THE SCIENCES
EARTH 251	Negotiation
EARTH 305A	Teaching in the field: Basic skills for working with students in the field
EARTH 310	Computational Geosciences Seminar
EARTH 400	Directed Research
EARTH 401	Curricular Practical Training
EARTHSYS 4	Coevolution of Earth and Life
EARTHSYS 8	The Oceans: An Introduction to the Marine Environment
EARTHSYS 9	Public Service Internship Preparation
EARTHSYS 10	Introduction to Earth Systems
EARTHSYS 11	Introduction to Geology

EARTHSYS 13SC	People, Land, and Water in the Heart of the West
EARTHSYS 16SI	Environmental Justice in the Bay Area
EARTHSYS 18	Promoting Sustainability Behavior Change at Stanford
EARTHSYS 20	The Cuisine of Change: Promoting Child Health and Combating Food Insecurity
EARTHSYS 21	Peopling of the Globe: Changing Patterns of Land Use and Consumption Over the Last 50,000 Years
EARTHSYS 22	Introduction to Landscape Architecture: Urban Ecology and Environmental Design
EARTHSYS 36N	Life at the Extremes: From the Deep Sea to Deep Space
EARTHSYS 38N	The Worst Journey in the World: The Science, Literature, and History of Polar Exploration
EARTHSYS 39Q	Talking about Earthquakes, Volcanoes, and Floods: Science Communication and Natural Hazards
EARTHSYS 41N	The Global Warming Paradox
EARTHSYS 44N	The Invisible Majority: The Microbial World That Sustains Our Planet
EARTHSYS 46N	Exploring the Critical Interface between the Land and Monterey Bay: Elkhorn Slough
EARTHSYS 46Q	Environmental Impact of Energy Systems: What are the Risks?
EARTHSYS 58Q	Understanding Our Oceans: Scientific Toys, Tools, & Trips
EARTHSYS 61Q	Food and security
EARTHSYS 91	Earth Systems Writers Collective
EARTHSYS 100	Environmental and Geological Field Studies in the Rocky Mountains
EARTHSYS 100A	Data Science for Geoscience
EARTHSYS 101	Energy and the Environment
EARTHSYS 102	Fundamentals of Renewable Power
EARTHSYS 103	Understanding Energy
EARTHSYS 104	The Water Course
EARTHSYS 105	Food and Community: Food Security, Resilience and Equity
EARTHSYS 105A	Ecology and Natural History of Jasper Ridge Biological Preserve
EARTHSYS 105B	Ecology and Natural History of Jasper Ridge Biological Preserve
EARTHSYS 106	World Food Economy
EARTHSYS 106C	Why are Scientists Engineering Our Food?
EARTHSYS 106D	New meat: The Science Behind Scalable Alternatives to Animal Products
EARTHSYS 107	Control of Nature
EARTHSYS 110	Introduction to the Foundations of Contemporary Geophysics
EARTHSYS 111	Biology and Global Change
EARTHSYS 112	Human Society and Environmental Change
EARTHSYS 113	Earthquakes and Volcanoes
EARTHSYS 114	Global Change and Emerging Infectious Disease
EARTHSYS 115	Wetlands Ecology of the Pantanal Prefield Seminar
EARTHSYS 115T	Island Biogeography of Tasmania Prefield Seminar
EARTHSYS 116	Ecology of the Hawaiian Islands
EARTHSYS 117	Earth Sciences of the Hawaiian Islands
EARTHSYS 118	Heritage, Environment, and Sovereignty in Hawaii
EARTHSYS 119	Will Work for Food
EARTHSYS 121	Building a Sustainable Society: New Approaches for Integrating Human and Environmental Priorities
EARTHSYS 122	Evolution of Marine Ecosystems
EARTHSYS 123	Asian Americans and Environmental Justice
EARTHSYS 123A	Biosphere-Atmosphere Interactions
EARTHSYS 124	Measurements in Earth Systems
EARTHSYS 125	Shades of Green: Exploring and Expanding Environmental Justice in Practice
EARTHSYS 126	Perspectives in International Development
EARTHSYS 128	Evolution of Terrestrial Ecosystems
EARTHSYS 130	Designing and Evaluating Community Engagement Programs for Social and Environmental Change
EARTHSYS 130A	Ecosystems of California
EARTHSYS 131	Pathways in Sustainability Careers
EARTHSYS 132	Evolution of Earth Systems
EARTHSYS 133	Social Enterprise Workshop
EARTHSYS 135B	Waste Politics: Contesting Toxicity, Value, and Power
EARTHSYS 136	The Ethics of Stewardship
EARTHSYS 137	Concepts and Analytic Skills for the Social Sector
EARTHSYS 138	International Urbanization Seminar: Cross-Cultural Collaboration for Sustainable Urban Development
EARTHSYS 139	Ecosystem Services: Frontiers in the Science of Valuing Nature
EARTHSYS 141	Remote Sensing of the Oceans
EARTHSYS 142	Remote Sensing of Land
EARTHSYS 143	Molecular Geomicrobiology Laboratory
EARTHSYS 144	Fundamentals of Geographic Information Science (GIS)
EARTHSYS 146A	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation
EARTHSYS 146B	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation
EARTHSYS 147	Ecosystem Ecology and Biogeochemistry
EARTHSYS 148	Grow it, Cook it, Eat it. An Experiential Exploration of How and Why We Eat What We Eat
EARTHSYS 149	Wild Writing
EARTHSYS 150B	Fire: Social and Ecological Contexts of Conflagration
EARTHSYS 151	Biological Oceanography
EARTHSYS 152	Marine Chemistry
EARTHSYS 154	Intermediate Writing: Communicating Climate Change: Navigating the Stories from the Frontlines
EARTHSYS 155	Science of Soils
EARTHSYS 158	Geomicrobiology
EARTHSYS 159	Economic, Legal, and Political Analysis of Climate-Change Policy
EARTHSYS 160	Sustainable Cities
EARTHSYS 162	Data for Sustainable Development

EARTHSYS 163	Tribal Economic Development and Sustainability
EARTHSYS 164	Introduction to Physical Oceanography
EARTHSYS 176	Open Space Management Practicum
EARTHSYS 176A	Open Space Practicum Independent Study
EARTHSYS 177C	Specialized Writing and Reporting: Health and Science Journalism
EARTHSYS 179S	Seminar: Issues in Environmental Science, Technology and Sustainability
EARTHSYS 180	Principles and Practices of Sustainable Agriculture
EARTHSYS 181	Urban Agroecology
EARTHSYS 182	Designing Educational Gardens
EARTHSYS 182A	Ecological Farm Systems
EARTHSYS 185	Feeding Nine Billion
EARTHSYS 186	Farm and Garden Environmental Education Practicum
EARTHSYS 187	FEED the Change: Redesigning Food Systems
EARTHSYS 187A	The Future of Food & Farming Technology
EARTHSYS 188	Social and Environmental Tradeoffs in Climate Decision-Making
EARTHSYS 190	The Multimedia Story
EARTHSYS 191	Concepts in Environmental Communication
EARTHSYS 194	Topics in Writing & Rhetoric: Introduction to Environmental Justice: Race, Class, Gender and Place
EARTHSYS 194A	Environmental Justice Colloquium
EARTHSYS 196	Implementing Climate Solutions at Scale
EARTHSYS 196A	Environmental Justice and Human Rights Lab
EARTHSYS 197	Directed Individual Study in Earth Systems
EARTHSYS 199	Honors Program in Earth Systems
EARTHSYS 200	Environmental Communication in Action: The SAGE Project
EARTHSYS 201	Editing for Publication
EARTHSYS 205	Food and Community: Food Security, Resilience and Equity
EARTHSYS 205VP	Contested markets in the Brazilian Amazon Rainforest
EARTHSYS 206	World Food Economy
EARTHSYS 207	Spanish in Science/Science in Spanish
EARTHSYS 210A	Senior Capstone and Reflection
EARTHSYS 210B	Senior Capstone and Reflection
EARTHSYS 210P	Earth Systems Capstone Project
EARTHSYS 211	Fundamentals of Modeling
EARTHSYS 214	Global Change and Emerging Infectious Disease
EARTHSYS 217	Biology and Global Change
EARTHSYS 219	Will Work for Food
EARTHSYS 223	Biosphere-Atmosphere Interactions
EARTHSYS 225	Shades of Green: Exploring and Expanding Environmental Justice in Practice
EARTHSYS 227	Decision Science for Environmental Threats
EARTHSYS 232	Evolution of Earth Systems
EARTHSYS 233	Mitigating Climate Change through Soil Management
EARTHSYS 235	Podcasting the Anthropocene
EARTHSYS 236	The Ethics of Stewardship
EARTHSYS 238	Land Use Law
EARTHSYS 239	Ecosystem Services: Frontiers in the Science of Valuing Nature
EARTHSYS 241	Remote Sensing of the Oceans
EARTHSYS 242	Remote Sensing of Land
EARTHSYS 243	Environmental Advocacy and Policy Communication
EARTHSYS 247	Ecosystem Ecology and Biogeochemistry
EARTHSYS 249	Wild Writing
EARTHSYS 250	Directed Research
EARTHSYS 251	Biological Oceanography
EARTHSYS 252	Marine Chemistry
EARTHSYS 254	Environmental Governance
EARTHSYS 255	Microbial Physiology
EARTHSYS 256	Soil and Water Chemistry
EARTHSYS 258	Geomicrobiology
EARTHSYS 260	Internship
EARTHSYS 262	Data for Sustainable Development
EARTHSYS 263F	Groundwork for COP21
EARTHSYS 272	Antarctic Marine Geology and Geophysics
EARTHSYS 276	Open Space Management Practicum
EARTHSYS 276A	Open Space Practicum Independent Study
EARTHSYS 277C	Specialized Writing and Reporting: Health and Science Journalism
EARTHSYS 281	Urban Agroecology
EARTHSYS 282A	Ecological Farm Systems
EARTHSYS 286	Farm and Garden Environmental Education Practicum
EARTHSYS 288	Social and Environmental Tradeoffs in Climate Decision-Making
EARTHSYS 289	FEED Lab: Food System Design & Innovation
EARTHSYS 289A	FEED Lab: Food System Design & Innovation
EARTHSYS 289B	FEED Lab: Food System Design & Innovation
EARTHSYS 290	Master's Seminar
EARTHSYS 291	Concepts in Environmental Communication
EARTHSYS 292	Multimedia Environmental Communication
EARTHSYS 293	Environmental Communication Practicum
EARTHSYS 294	Environmental Communication Capstone
EARTHSYS 295	Environmental Communication Seminar
EARTHSYS 296	Implementing Climate Solutions at Scale
EARTHSYS 297	Directed Individual Study in Earth Systems
EARTHSYS 299	M.S. Thesis
EARTHSYS 323	Stanford at Sea
EARTHSYS 332	Theory and Practice of Environmental Education
EARTHSYS 801	TGR Project
EASTASN 94	The Rise of China in World Affairs
EASTASN 117	Health and Healthcare Systems in East Asia
EASTASN 217	Health and Healthcare Systems in East Asia
EASTASN 294	The Rise of China in World Affairs
ECON 17N	Energy, the Environment, and the Economy
ECON 106	World Food Economy

ECON 118	Development Economics
ECON 126	Economics of Health and Medical Care
ECON 127	Economics of Health Improvement in Developing Countries
ECON 146	Economics of Education
ECON 155	Environmental Economics and Policy
ECON 158	Regulatory Economics
ECON 159	Economic, Legal, and Political Analysis of Climate-Change Policy
ECON 206	World Food Economy
ECON 209	Economic, Legal, and Political Analysis of Climate-Change Policy
ECON 214	Development Economics I
ECON 216	Development Economics III
ECON 250	Environmental Economics
ECON 251	Natural Resource and Energy Economics
ECON 341	Public Economics and Environmental Economics Seminar
EDUC 100A	EAST House Seminar: Current Issues and Debates in Education
EDUC 126A	Ethics and Leadership in Public Service
EDUC 126B	Public Service Leadership Program Practicum
EDUC 170	Preparation for Independent Public Service Projects
EDUC 239	Educating Young STEM Thinkers
EDUC 267A	Curriculum and Instruction in Science
EDUC 267B	Curriculum and Instruction in Science
EDUC 267C	Curriculum and Instruction in Science
EDUC 267E	Development of Scientific Reasoning and Knowledge
EDUC 267F	Development of Scientific Reasoning and Knowledge II
EDUC 267G	Integrating the Garden into the Elementary Curriculum
EDUC 280	Learning & Teaching of Science
EDUC 302	Behavior Design: Clubhouse for Helping People with Good Habits & Behavior Change
EDUC 320	Sociology of Science
EDUC 332	Theory and Practice of Environmental Education
EDUC 357	Science and Environmental Education in Informal Contexts
EDUC 359C	Science Literacy
EDUC 362	The Science Curriculum: Values and Ideology in a Contested Terrain
EE 46	Engineering For Good: Contributing to Saving the World and Having Fun Doing It
EE 60N	Man versus Nature: Coping with Disasters Using Space Technology
EE 116	Semiconductor Devices for Energy and Electronics
EE 142	Engineering Electromagnetics
EE 155	Green Electronics
EE 237	Solar Energy Conversion
EE 255	Green Electronics
EE 292H	Engineering, Entrepreneurship & Climate Change
EE 293	Energy storage and conversion: Solar Cells, Fuel Cells, Batteries and Supercapacitors
EE 293B	Fundamentals of Energy Processes
EMED 124	Wilderness First Aid
EMED 126	Wilderness First Responder
EMED 128	Wilderness Medicine: Continued practical experience for high-quality care
EMED 134	The Impact of Climate Change on Human Health
EMED 234	The Impact of Climate Change on Human Health
ENERGY 20N	Technology in the Greenhouse
ENERGY 101	Energy and the Environment
ENERGY 101A	Energizing California
ENERGY 102	Fundamentals of Renewable Power
ENERGY 104	Sustainable Energy for 9 Billion
ENERGY 110	Engineering Economics
ENERGY 112	Exploring Geosciences with MATLAB
ENERGY 118	Safety and Environmental Aspects of Energy Production
ENERGY 120	Fundamentals of Petroleum Engineering
ENERGY 121	Fundamentals of Multiphase Flow
ENERGY 123	When Technology Meets Reality; An In-depth Look at the Deepwater Horizon Blowout and Oil Spill
ENERGY 130	Well Log Analysis I
ENERGY 141	Seismic Reservoir Characterization
ENERGY 146	Reservoir Characterization and Flow Modeling with Outcrop Data
ENERGY 153	Carbon Capture and Sequestration
ENERGY 155	Undergraduate Report on Energy Industry Training
ENERGY 160	Uncertainty Quantification in Data-Centric Simulations
ENERGY 167	Engineering Valuation and Appraisal of Energy Assets and Projects
ENERGY 171	Energy Infrastructure, Technology and Economics
ENERGY 175	Well Test Analysis
ENERGY 180	Oil and Gas Production Engineering
ENERGY 191	Optimization of Energy Systems
ENERGY 192	Undergraduate Teaching Experience
ENERGY 193	Undergraduate Research Problems
ENERGY 194	Special Topics in Energy and Mineral Fluids
ENERGY 199	Senior Project and Seminar in Energy Resources
ENERGY 201	Laboratory Measurement of Reservoir Rock Properties
ENERGY 203	Stanford Climate Ventures
ENERGY 204	Achieving Universal Energy Access by 2030: Can it be done?
ENERGY 212	Environmental Aspects of Oil and Gas Production
ENERGY 214	The Global Price of Oil
ENERGY 216	Entrepreneurship in Energy
ENERGY 217	Research Seminar: Energy Development in the Emerging Economy
ENERGY 218	Safety and Environmental Aspects of Energy Production
ENERGY 221	Fundamentals of Multiphase Flow

ENERGY 222	Advanced Reservoir Engineering
ENERGY 223	Reservoir Simulation
ENERGY 224	Advanced Reservoir Simulation
ENERGY 225	Theory of Gas Injection Processes
ENERGY 226	Thermal Recovery Methods
ENERGY 227	Enhanced Oil Recovery
ENERGY 230	Advanced Topics in Well Logging
ENERGY 240	Data science for geoscience
ENERGY 241	Seismic Reservoir Characterization
ENERGY 246	Reservoir Characterization and Flow Modeling with Outcrop Data
ENERGY 251	Thermodynamics of Equilibria
ENERGY 253	Carbon Capture and Sequestration
ENERGY 255	Master's Report on Energy Industry Training
ENERGY 260	Uncertainty Quantification in Data-Centric Simulations
ENERGY 267	Engineering Valuation and Appraisal of Energy Assets and Projects
ENERGY 269	Geothermal Reservoir Engineering
ENERGY 271	Energy Infrastructure, Technology and Economics
ENERGY 273	Special Topics in Energy Resources Engineering
ENERGY 281	Applied Mathematics in Reservoir Engineering
ENERGY 282	Chemical Kinetics and Basin Modeling
ENERGY 289	Multiscale Methods for Transport in Porous Media
ENERGY 291	Optimization of Energy Systems
ENERGY 293B	Fundamentals of Energy Processes
ENERGY 293C	Energy from Wind and Water Currents
ENERGY 295	Electrochemical Energy Storage Systems: Modeling and Estimation
ENERGY 300	Graduate Directed Reading
ENERGY 301	The Energy Seminar
ENERGY 351	ERE Master's Graduate Seminar
ENERGY 352	ERE PhD Graduate Seminar
ENERGY 355	Doctoral Report on Energy Industry Training
ENERGY 359	Teaching Experience in Energy Resources Engineering
ENERGY 360	Advanced Research Work in Energy Resources Engineering
ENERGY 361	Master's Degree Research in Energy Resources Engineering
ENERGY 362	Engineer's Degree Research in Energy Resources Engineering
ENERGY 363	Doctoral Degree Research in Energy Resources Engineering
ENERGY 365	Special Research Topics in Energy Resources Engineering
ENERGY 369	Practical Energy Studies
ENERGY 801	TGR Project
ENERGY 802	TGR Dissertation
ENGLISH 9CI	Inspired By Science: A Writing Workshop
ENGLISH 91VO	Voices of the Land
ENGLISH 124	The American West
ENGLISH 150C	Reading and Writing Contemporary Environmental Poetry
ENGLISH 157H	Creative Writing & Science: The Artful Interpreter
ENGLISH 168A	Imagining the Oceans
ENGLISH 224B	Nature, Race, and Indigeneity in the U.S. Imagination
ENGLISH 368A	Imagining the Oceans
ENGR 50E	Introduction to Materials Science, Energy Emphasis
ENGR 60	Engineering Economics and Sustainability
ENGR 90	Environmental Science and Technology
ENGR 113A	Solar Decathlon 2015
ENGR 113B	Solar Decathlon 2015
ENGR 113C	Solar Decathlon 2015
ENGR 113D	SOLAR DECATHLON 2015
ENGR 120	Fundamentals of Petroleum Engineering
ENGR 145	Technology Entrepreneurship
ENGR 177A	Engineering and Sustainable Development: Toolkit
ENGR 177B	Engineering and Sustainable Development
ENGR 213	Solar Decathlon
ENGR 277A	Engineering and Sustainable Development: Toolkit
ENGR 277B	Engineering and Sustainable Development
ENVRES 199	Independent study
ENVRES 201	Designing and Evaluating Community Engagement Programs for Social and Environmental Change
ENVRES 220	The Social Ocean: Human Dimensions of Coastal and Marine Ecosystems
ENVRES 221	New Frontiers and Opportunities in Sustainability
ENVRES 222	Climate Law and Policy
ENVRES 223	Topics in Writing & Rhetoric: Introduction to Environmental Justice: Race, Class, Gender and Place
ENVRES 225	E-IPER Current Topics Seminar
ENVRES 226	Energy Law
ENVRES 228	Private Environmental Governance
ENVRES 230	Field Survey Data Collection & Analysis
ENVRES 240	Environmental Decision-Making and Risk Perception
ENVRES 245	Psychological Insights for Science Communication
ENVRES 246	Measuring Success in Environmental Messaging
ENVRES 250	Environmental Governance
ENVRES 270	Graduate Practicum in Environment and Resources
ENVRES 280	Topics in Environment and Resources
ENVRES 290	Capstone Project Seminar in Environment and Resources
ENVRES 300	Introduction to Resource, Energy and Environmental Economics
ENVRES 315	Environmental Research Design Seminar
ENVRES 320	Designing Environmental Research
ENVRES 330	Research Approaches for Environmental Problem Solving
ENVRES 340	E-IPER PhD Writing Seminar

ENVRES 341	Theoretical Underpinnings of Environmental Behavior: Exploration and reflection
ENVRES 380	Innovating Large Scale Sustainable Transformations/Collaborating for the Future
ENVRES 391	Curricular Practical Training
ENVRES 398	Directed Reading in Environment and Resources
ENVRES 399	Directed Research in Environment and Resources
ENVRES 801	TGR Project
ENVRES 802	TGR Dissertation
ENVRINST 198	Prehonors Seminar
ENVRINST 199	Interschool Honors Program in Environmental Science, Technology, and Policy
ENVRINST 260	Water in the West: Challenges and Opportunities
ESS 8	The Oceans: An Introduction to the Marine Environment
ESS 38N	The Worst Journey in the World: The Science, Literature, and History of Polar Exploration
ESS 46N	Exploring the Critical Interface between the Land and Monterey Bay: Elkhorn Slough
ESS 60	Food, Water and War: Life on the Mekong
ESS 61Q	Food and security
ESS 86N	The Most Rational People in the World
ESS 101	Environmental and Geological Field Studies in the Rocky Mountains
ESS 102	Scientific Basis of Climate Change
ESS 106	World Food Economy
ESS 107	Control of Nature
ESS 108	Research Preparation for Undergraduates
ESS 109	Biological and Social Networks
ESS 111	Biology and Global Change
ESS 112	Human Society and Environmental Change
ESS 117	Earth Sciences of the Hawaiian Islands
ESS 118X	Shaping the Future of the Bay Area
ESS 123	Biosphere-Atmosphere Interactions
ESS 125	INTRODUCTION TO PLANETARY SCIENCE
ESS 132	Evolution of Earth Systems
ESS 135	Community Leadership
ESS 141	Remote Sensing of the Oceans
ESS 143	Molecular Geomicrobiology Laboratory
ESS 148	Introduction to Physical Oceanography
ESS 151	Biological Oceanography
ESS 152	Marine Chemistry
ESS 155	Science of Soils
ESS 158	Geomicrobiology
ESS 162	Remote Sensing of Land
ESS 163	Demography and Life History Theory
ESS 164	Fundamentals of Geographic Information Science (GIS)
ESS 165	Advanced Geographic Information Systems
ESS 170	Analyzing land use in a globalized world
ESS 171	Climate Models and Data
ESS 179S	Seminar: Issues in Environmental Science, Technology and Sustainability
ESS 181	Urban Agroecology
ESS 185	Adaptation
ESS 202	Scientific Basis of Climate Change
ESS 205	Fundamentals of Geobiology
ESS 206	World Food Economy
ESS 208	Topics in Geobiology
ESS 209	Biological and Social Networks
ESS 210	Techniques in Environmental Microbiology
ESS 211	Fundamentals of Modeling
ESS 212	Measurements in Earth Systems
ESS 213	Global Change and Emerging Infectious Disease
ESS 214	Introduction to geostatistics and modeling of spatial uncertainty
ESS 218X	Shaping the Future of the Bay Area
ESS 220	Physical Hydrogeology
ESS 221	Contaminant Hydrogeology and Reactive Transport
ESS 223	Biosphere-Atmosphere Interactions
ESS 224	Remote Sensing of Hydrology
ESS 225	Rivers: The Arteries of Earth's Continents
ESS 227	Decision Science for Environmental Threats
ESS 230	Pursuing Sustainability: Managing Complex Social Environmental Systems
ESS 232	Evolution of Earth Systems
ESS 233	Mitigating Climate Change through Soil Management
ESS 240	Advanced Oceanography
ESS 241	Remote Sensing of the Oceans
ESS 242	Antarctic Marine Geology and Geophysics
ESS 243	Molecular Geomicrobiology Laboratory
ESS 244	Marine Ecosystem Modeling
ESS 245	Advanced Biological Oceanography
ESS 246A	Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation
ESS 246B	Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation
ESS 247	Tropical Meteorology
ESS 249	Marine Stable Isotopes
ESS 251	Biological Oceanography
ESS 252	Marine Chemistry
ESS 253S	Hopkins Microbiology Course
ESS 255	Microbial Physiology
ESS 256	Soil and Water Chemistry
ESS 258	Geomicrobiology
ESS 259	Environmental Microbial Genomics
ESS 260	Advanced Statistical Methods for Earth System Analysis
ESS 262	Remote Sensing of Land
ESS 264	Poverty, Infrastructure and Climate
ESS 265	Advanced Geographic Information Systems
ESS 268	Empirical Methods in Sustainable Development
ESS 270	Analyzing land use in a globalized world
ESS 271	Climate Models and Data

ESS 275	Nitrogen in the Marine Environment
ESS 280	Principles and Practices of Sustainable Agriculture
ESS 281	Urban Agroecology
ESS 282	Designing Educational Gardens
ESS 292	Directed Individual Study in Earth System Science
ESS 300	Climate studies of terrestrial environments
ESS 301	Topics in Earth System Science
ESS 305	Climate Change: An Earth Systems Perspective
ESS 306	From Freshwater to Oceans to Land Systems: An Earth System Perspective to Global Challenges
ESS 307	Research Proposal Development and Delivery
ESS 322B	Seminar in Hydrology
ESS 323	Stanford at Sea
ESS 328	Environmental Change and Human Resiliency
ESS 330	Advanced Topics in Hydrogeology
ESS 348	Dynamics of the Atmosphere
ESS 360	Social Structure and Social Networks
ESS 363	Demography and Life History Theory
ESS 363F	Geophysical Fluid Dynamics
ESS 400	Graduate Research
ESS 401	Curricular Practical Training
ESS 801	TGR Project
ESS 802	TGR Dissertation
ETHICSOC 133	Ethics and Politics of Public Service
ETHICSOC 136R	Introduction to Global Justice
ETHICSOC 178M	Introduction to Environmental Ethics
ETHICSOC 185M	Contemporary Moral Problems
ETHICSOC 278M	Introduction to Environmental Ethics
FEMGEN 44Q	Gendered Innovations in Science, Medicine, Engineering, and Environment
FEMGEN 144	Sex, Gender, and Intersectional Analysis in Science, Medicine, Engineering, and Environment
FEMGEN 241	Sex and Gender in Human Physiology and Disease
GEOLSCI 1	Introduction to Geology
GEOLSCI 2	Chemistry of the Earth and Planets
GEOLSCI 5	Living on the Edge
GEOLSCI 6	Data Science for Geoscience
GEOLSCI 42	Moving and Shaking in the Bay Area
GEOLSCI 45	Developing and maintaining a habitable Earth: A global challenge?
GEOLSCI 46Q	Environmental Impact of Energy Systems: What are the Risks?
GEOLSCI 59N	Earthquake 9.0: The Heritage of Fukushima Daiichi 6 Years Later
GEOLSCI 106	Sediments: The Book of Earth's History
GEOLSCI 112	Geomorphology
GEOLSCI 118X	Shaping the Future of the Bay Area
GEOLSCI 120	Planetary Surface Processes: Shaping the Landscape of the Solar System
GEOLSCI 122	Planetary Systems: Dynamics and Origins
GEOLSCI 123	Evolution of Marine Ecosystems
GEOLSCI 124	INTRODUCTION TO PLANETARY SCIENCE
GEOLSCI 132	Evolution of Earth Systems
GEOLSCI 135	Sedimentary Geochemistry and Analysis
GEOLSCI 135A	Sedimentary Geochemistry Field Trip
GEOLSCI 213	Topics in Sedimentary Geology
GEOLSCI 215	Topics in Geobiodiversity and Stable Isotopes
GEOLSCI 218X	Shaping the Future of the Bay Area
GEOLSCI 220	Planetary Surface Processes: Shaping the Landscape of the Solar System
GEOLSCI 224	Rivers: The Arteries of Earth's Continents
GEOLSCI 232	Evolution of Earth Systems
GEOLSCI 251	Sedimentary Basins
GEOLSCI 254	Sedimentology and Rock Physics of Carbonates
GEOLSCI 258	Introduction to Depositional Systems
GEOLSCI 260	Quantifying Uncertainty in Subsurface Systems
GEOLSCI 266	Managing Nuclear Waste: Technical, Political and Organizational Challenges
GEOLSCI 283	Thermochronology and Crustal Evolution
GEOLSCI 293A	Geology of Oman Field Trip
GEOLSCI 311	Interpretation of Tectonically Active Landscapes
GEOLSCI 313	Modeling of Landforms
GEOPHYS 20N	Predicting Volcanic Eruptions
GEOPHYS 50N	Planetary Habitability, World View, and Sustainability
GEOPHYS 60N	Man versus Nature: Coping with Disasters Using Space Technology
GEOPHYS 90	Earthquakes and Volcanoes
GEOPHYS 104	The Water Course
GEOPHYS 108	Tectonics Field Trip
GEOPHYS 110	Introduction to the Foundations of Contemporary Geophysics
GEOPHYS 112	Exploring Geosciences with MATLAB
GEOPHYS 118X	Shaping the Future of the Bay Area
GEOPHYS 119	Planetary Surface Processes: Shaping the Landscape of the Solar System
GEOPHYS 120	Ice, Water, Fire
GEOPHYS 124	INTRODUCTION TO PLANETARY SCIENCE
GEOPHYS 128	MODELING EARTH
GEOPHYS 130	Introductory Seismology
GEOPHYS 141	Remote Sensing of the Oceans
GEOPHYS 150	Geodynamics: Our Dynamic Earth
GEOPHYS 181	Fluids and Flow in the Earth: Computational Methods
GEOPHYS 182	Reflection Seismology
GEOPHYS 183	Reflection Seismology Interpretation
GEOPHYS 184	Journey to the Center of the Earth
GEOPHYS 185	Rock Physics for Reservoir Characterization
GEOPHYS 186	Tectonophysics
GEOPHYS 190	Near-Surface Geophysics: Imaging Groundwater Systems
GEOPHYS 191	Observing Freshwater
GEOPHYS 196	Undergraduate Research in Geophysics
GEOPHYS 201	Frontiers of Geophysical Research at Stanford

GEOPHYS 202	Reservoir Geomechanics
GEOPHYS 203	Fluids and Flow in the Earth: Computational Methods
GEOPHYS 205	Virtual Scientific Presentation and Public Speaking
GEOPHYS 208	Unconventional Reservoir Geomechanics
GEOPHYS 210	Basic Earth Imaging
GEOPHYS 211	Environmental Soundings Image Estimation
GEOPHYS 212	Topics in Climate Change
GEOPHYS 214	Water Management in Agricultural Areas
GEOPHYS 218X	Shaping the Future of the Bay Area
GEOPHYS 219	Planetary Surface Processes: Shaping the Landscape of the Solar System
GEOPHYS 220	Ice, Water, Fire
GEOPHYS 221	Rivers: The Arteries of Earth's Continents
GEOPHYS 222	Reflection Seismology
GEOPHYS 223	Reflection Seismology Interpretation
GEOPHYS 224	Seismic Reflection Processing
GEOPHYS 228	MODELING EARTH
GEOPHYS 229	Earthquake Rupture Dynamics
GEOPHYS 235	Waves and Fields in Geophysics
GEOPHYS 237	Evolution of Terrestrial Planets
GEOPHYS 240	Borehole Seismic Modeling and Imaging
GEOPHYS 241A	Seismic Reservoir Characterization
GEOPHYS 254	Sedimentology and Rock Physics of Carbonates
GEOPHYS 255	Report on Energy Industry Training
GEOPHYS 257	Introduction to Computational Earth Sciences
GEOPHYS 259	Properties of Rocks and Geomaterials
GEOPHYS 260	Rock Physics for Reservoir Characterization
GEOPHYS 262	Rock Physics
GEOPHYS 265	Imaging Radar and Applications
GEOPHYS 270	Electromagnetic Properties of Geological Materials
GEOPHYS 275	Near-Surface Geophysics: Imaging Groundwater Systems
GEOPHYS 280	3-D Seismic Imaging
GEOPHYS 281	Geophysical Inverse Problems
GEOPHYS 284	Hydrogeophysics
GEOPHYS 287	Earthquake Seismology
GEOPHYS 288A	Crustal Deformation
GEOPHYS 288B	Crustal Deformation
GEOPHYS 289	Global Positioning System in Earth Sciences
GEOPHYS 290	Tectonophysics
GEOPHYS 304	Effects of Global Change and Agriculture on Hydrology
GEOPHYS 385A	Reflection Seismology
GEOPHYS 385B	Environmental Geophysics
GEOPHYS 385D	Theoretical Geophysics
GEOPHYS 385E	Tectonics
GEOPHYS 385K	Crustal Mechanics
GEOPHYS 385L	Earthquake Seismology, Deformation, and Stress
GEOPHYS 385N	Experimental Rock Physics
GEOPHYS 385S	Wave Physics
GEOPHYS 385V	Poroelasticity
GEOPHYS 385W	GEOPHYSICAL MULTI-PHASE FLOWS
GEOPHYS 385Z	Radio Remote Sensing
GERMAN 111	The End of the Western World (as we know it): German Responses to Global Challenges
GLOBAL 150N	Climate Change and Mental Health
GSBGEN 332	Sustainable Energy: Business Opportunities and Public Policy
GSBGEN 335	Clean Energy Project Development and Finance
GSBGEN 336	Energy Markets and Policy
GSBGEN 532	Clean Energy Opportunities
GSBGEN 559	The Politics, Policy, and Finance for Solving Global Warming
GSBGEN 569	The Open Road: Innovation in Cars, Driving, and Mobility
HISTORY 1B	Global History: The Early Modern World, 1300 to 1800
HISTORY 40	World History of Science
HISTORY 40A	The Scientific Revolution
HISTORY 42S	The Circle of Life: Visions of Nature in Modern Science, Religion, Politics and Culture
HISTORY 44	Sex, Gender, and Intersectional Analysis in Science, Medicine, Engineering, and Environment
HISTORY 44Q	Gendered Innovations in Science, Medicine, Engineering, and Environment
HISTORY 47	History of South Africa
HISTORY 74	Mexico Since 1876: The Road to Ayotzinapa
HISTORY 79C	The Ethical Challenges of the Climate Catastrophe
HISTORY 102	History of the International System since 1914
HISTORY 103D	Human Society and Environmental Change
HISTORY 106A	Global Human Geography: Asia and Africa
HISTORY 106B	Global Human Geography: Europe and Americas
HISTORY 107	Introduction to Urban Studies
HISTORY 140	World History of Science
HISTORY 144	Sex, Gender, and Intersectional Analysis in Science, Medicine, Engineering, and Environment
HISTORY 147	History of South Africa
HISTORY 151	The American West
HISTORY 174	Mexico Since 1876: The Road to Ayotzinapa
HISTORY 200B	Doing Environmental History: Water Justice
HISTORY 202B	Coffee, Sugar, and Chocolate: Commodities and Consumption in World History, 1200-1800
HISTORY 202J	Climate Politics: Science and Global Governance
HISTORY 203C	History of Ignorance
HISTORY 207B	Environment, Technology and Revolution in World History
HISTORY 223E	Cities of Empire: An Urban Journey through Eastern Europe and the Mediterranean
HISTORY 226E	Famine in the Modern World

HISTORY 232G	Early Modern Cities
HISTORY 243C	People, Plants, and Medicine: Colonial Science and Medicine
HISTORY 243G	Tobacco and Health in World History
HISTORY 254	Popular Culture and American Nature
HISTORY 263C	Nature's Bounty: Natural Resources and U.S. Political Economy
HISTORY 302B	Coffee, Sugar, and Chocolate: Commodities and Consumption in World History, 1200-1800
HISTORY 303C	History of Ignorance
HISTORY 326E	Famine in the Modern World
HISTORY 343C	People, Plants, and Medicine: Colonial Science and Medicine
HISTORY 343G	Tobacco and Health in World History
HISTORY 374	Mexico Since 1876: History of a "Failed State"?
HISTORY 378	The Historical Ecology of Latin America
HISTORY 391C	Early Imperial China
HISTORY 471A	Environmental History of Latin America
HISTORY 471B	Environmental History of Latin America
HRP 224	Social Entrepreneurship and Innovation Lab (SE Lab) - Human & Planetary Health
HRP 256	Economics of Health and Medical Care
HRP 285	Global Leaders and Innovators in Human and Planetary Health
HRP 299	Directed Reading in Health Research and Policy
HUMBIO 2A	Genetics, Evolution, and Ecology
HUMBIO 2B	Culture, Evolution, and Society
HUMBIO 3B	Environmental and Health Policy Analysis
HUMBIO 5E	Science Education in Human Biology
HUMBIO 71A	Race in Science
HUMBIO 112	Conservation Biology: A Latin American Perspective
HUMBIO 113	The Human-Plant Connection
HUMBIO 113S	Healthy/Sustainable Food Systems: Maximum Sustainability across Health, Economics, and Environment
HUMBIO 114	Global Change and Emerging Infectious Disease
HUMBIO 116	Climate Perspectives: Climate Science, Impacts, Policy, Negotiations, and Advocacy
HUMBIO 121E	Ethnicity and Medicine
HUMBIO 122M	Challenges of Human Migration: Health and Health Care of Migrants and Autochthonous Populations
HUMBIO 125	Current Topics and Controversies in Women's Health
HUMBIO 126	Promoting Health Over the Life Course: the Science of Healthy Living
HUMBIO 130	Human Nutrition
HUMBIO 135	Exercise Physiology
HUMBIO 151R	Biology, Health and Big Data
HUMBIO 153	Parasites and Pestilence: Infectious Public Health Challenges
HUMBIO 154B	Principles of Epidemiology
HUMBIO 159	Genes and Environment in Disease Causation: Implications for Medicine and Public Health
HUMBIO 166	Food and Society: Exploring Eating Behaviors in Social, Environmental, and Policy Context
HUMRTS 194A	Environmental Justice Colloquium
HUMRTS 196	Environmental Justice and Human Rights Lab
ILAC 255	Climate Change and Latin American Naturecultures
ILAC 256A	Landscapes in Latin American Cinema
ILAC 263	Visions of the Andes
INTLPOL 200	The Social & Economic Impact of Artificial Intelligence
INTLPOL 204A	Microeconomics for Policy
INTLPOL 224	Economic Development and Challenges of East Asia
INTLPOL 240	Contemporary Issues in International Security
INTLPOL 241S	International Security in a Changing World
INTLPOL 244	U.S. Policy toward Northeast Asia
INTLPOL 256	Technology and National Security: Past, Present, and Future
INTLPOL 271	Climate Politics: Science and Global Governance
INTLPOL 272	Empirical Methods in Sustainable Development
INTLPOL 274	International Urbanization Seminar: Cross-Cultural Collaboration for Sustainable Urban Development
INTLPOL 302	The Global Economy
INTLPOL 306	International Relations Theory and the American Experience
INTLPOL 321	Fundamentals of Cyber Policy and Security
INTLPOL 371	Policy Practicum: Assessing the Impact of China's Global Infrastructure Spending on Climate Change
INTNLREL 61Q	Food and security
INTNLREL 102	History of the International System since 1914
INTNLREL 135A	International Environmental Law and Policy: Oceans and Climate Change
INTNLREL 136R	Introduction to Global Justice
INTNLREL 146A	Energy and Climate Cooperation in the Western Hemisphere
JAPANGEN 160	
JEWISHST 39S	The Other Side: Ethnography and Travel Writing through Jewish, Christian and Muslim Eyes
JEWISHST 129A	Milk and Honey, Wine and Blood: Food, Justice, and Ethnic Identity in Jewish Culture
LATINAM 207	Spanish in Science/Science in Spanish
LATINAM 248	Racial and Gender Inequalities in Latin America
LAW 807B	Policy Practicum: What we can do to Mitigate Climate Warming
LAW 807K	Policy Practicum: The Outlaw Ocean

LAW 807O	Policy Practicum: Assessing the Impact of China's Global Infrastructure Spending on Climate Change
LAW 807W	Policy Practicum: Developing Best Practices for Clean Water Act Enforcement
LAW 908	Advanced Environmental Law Clinic
LAW 908A	Environmental Law Clinic: Clinical Practice
LAW 908B	Environmental Law Clinic: Clinical Methods
LAW 908C	Environmental Law Clinic: Clinical Coursework
LAW 1015	Corporate Social Responsibility
LAW 1047	Business, Social Responsibility, and Human Rights
LAW 2503	Energy Law
LAW 2504	Environmental Law and Policy
LAW 2505	Land Use Law
LAW 2506	Natural Resources Law and Policy
LAW 2508	The Business of Water
LAW 2509	Clean Energy Project Development and Finance
LAW 2510	California Coast: Science, Policy and Law
LAW 2512	Cities and Sustainability: Current Issues, Policy, and Law
LAW 2513	Climate: Politics, Finance, and Infrastructure
LAW 2515	Environmental Justice
LAW 2516	Natural Resources Law and Policy - South Africa: Field Study
LAW 2517	Modern Crosscurrents in Energy and Environmental Law
LAW 2518	U.S. Environmental Law in Transition
LAW 2519	Water Law
LAW 2521	California's Water Policy and Management: Toward a Sustainable Future
LAW 2522	Private Environmental Governance
LAW 2523	Climate, Energy, and Democracy
LAW 2524	Climate and Energy Workshop
LAW 4014	Law, Technology, and Liberty
LAW 4043	The Social & Economic Impact of Artificial Intelligence
LAW 5015	International Dealmaking: Vienna Field Negotiation
LAW 7024	Food Law and Policy
LAW 7030	Federal Indian Law
LAW 7051	Local Government Law
LAW 7824	Advanced Negotiation: Environmental Policy
LAW 8002	Environmental Law and Policy Colloquium
MATSCI 144	Thermodynamic Evaluation of Green Energy Technologies
MATSCI 156	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution
MATSCI 161	Energy Materials Laboratory
MATSCI 256	Solar Cells, Fuel Cells, and Batteries: Materials for the Energy Solution
MATSCI 301	Engineering Energy Policy Change
MATSCI 302	Solar Cells
MATSCI 303	Principles, Materials and Devices of Batteries
ME 30	Engineering Thermodynamics
ME 70	Introductory Fluids Engineering
ME 141	Alternative Energy Systems
ME 170A	Mechanical Engineering Design- Integrating Context with Engineering
ME 170B	Mechanical Engineering Design: Integrating Context with Engineering
ME 182	Electric Transportation
ME 206A	Design for Extreme Affordability
ME 206B	Design for Extreme Affordability
ME 250	Internal Combustion Engines
ME 257	Gas-Turbine Design Analysis
ME 262	Physics of Wind Energy
ME 267	Ethics and Equity in Transportation Systems
ME 352B	Fundamentals of Heat Conduction
ME 357	Gas-Turbine Design Analysis
ME 370A	Energy Systems I: Thermodynamics
ME 370B	Energy Systems II: Modeling and Advanced Concepts
ME 370C	Energy Systems III: Projects
ME 371	Combustion Fundamentals
MED 50Q	Respiration
MED 131	Exploring Israel's Ecosystem in Human and Planetary Health
MED 224	Social Entrepreneurship and Innovation Lab (SE Lab) - Human & Planetary Health
MED 228	Physicians and Social Responsibility
MED 237	Health Law: Improving Public Health
MED 285	Global Leaders and Innovators in Human and Planetary Health
MI 70Q	Photographing Nature
MLA 322	Coffee, Sugar, and Chocolate: Commodities and Consumption in World History. 120--1800
MS&E 52	Introduction to Decision Making
MS&E 92Q	International Environmental Policy
MS&E 152	Introduction to Decision Analysis
MS&E 185	Global Work
MS&E 201	Dynamic Systems
MS&E 220	Probabilistic Analysis
MS&E 243	Energy and Environmental Policy Analysis
MS&E 250A	Engineering Risk Analysis
MS&E 250B	Project Course in Engineering Risk Analysis
MS&E 252	Decision Analysis I: Foundations of Decision Analysis
MS&E 254	The Ethical Analyst
MS&E 292	Health Policy Modeling
MS&E 352	Decision Analysis II: Professional Decision Analysis
MS&E 391	Doctoral Research Seminar in Energy-Environmental Systems Modeling and Analysis
MS&E 394	Advanced Methods in Modeling for Climate and Energy Policy
MS&E 494	The Energy Seminar
MUSIC 16Q	Listening to Climate Change
NATIVEAM 109A	Federal Indian Law
NATIVEAM 109B	Native Nation Building

NATIVEAM 162	Tribal Economic Development and Sustainability
NENS 230	Analysis Techniques for the Biosciences Using MATLAB
OB 601	Organizational Ecology
OB 672	Organization and Environment
OBGYN 256	Current Topics and Controversies in Women's Health
OIT 333	Design for Extreme Affordability
OIT 334	Design for Extreme Affordability
OSPAUSTL 10	Coral Reef Ecosystems
OSPAUSTL 28	Terrestrial Ecology and Conservation
OSPAUSTL 32	Coastal Ecosystems
OSPAUSTL 40	Australian Studies: History, Society and Culture Down Under
OSPGEN 60	Earth's 3rd Pole: Coupled Human-Natural Systems in the Khumbu Valley, Nepal
OSPGEN 74	St. Petersburg: Imagining a City, Building a City
OSPGEN 79	Preserving Biodiversity: Conservation Photography in South Africa
OSPKYOTO 33	Ecology of Japanese Satoyama
OSPMADRD 8A	Cities and Creativity: Cultural and Architectural Interpretations of Madrid
OSPMADRD 89	Environmental Policy
OSPMADRD 194	Madrid University: Earth Energy & Environmental Science
OSPOXFRD 86	From the hills to the sea
OSPPARIS 17	Green Urban Planning Internship
OSPPARIS 66	FOOD CONSUMPTION & PRODUCTION
OSPPARIS 67	INDP STDY: LAND USE IN FRANCEn
OSPPARIS 91	The Future of Globalization: Economics, Politics and the Environment
OSPSANTG 29	Sustainable Cities: Comparative Transportation Systems in Latin America
OSPSANTG 58	Global Change in Chile
OSPSANTG 71	Santiago: Urban Planning, Public Policy, and the Built Environment
OSPSANTG 85	Marine Ecology of Chile and the South Pacific
OUTDOOR 15	Rock Climbing: Intermediate Anchors
OUTDOOR 60	Introduction to Flyfishing
OUTDOOR 70	SCUBA Diving Open Water: Beginner
OUTDOOR 71	SCUBA Diving Open Water: Advanced
OUTDOOR 72	SCUBA Diving Open Water: Rescue
OUTDOOR 101	Introduction to Outdoor Education
OUTDOOR 103	Foundations of Outdoor Education
OUTDOOR 105	Outdoor Living Skills
OUTDOOR 106	Outdoor Leadership Practicum
OUTDOOR 119	Outdoor Educator Apprenticeship
PEDS 150	Social and Environmental Determinants of Health
PEDS 250	Social and Environmental Determinants of Health
PHIL 72	Contemporary Moral Problems
PHIL 76	Introduction to Global Justice
PHIL 164	Central Topics in the Philosophy of Science: Theory and Evidence
PHIL 167B	Philosophy, Biology, and Behavior
PHIL 175A	Ethics and Politics of Public Service
PHIL 177C	Ethics of Climate Change
PHIL 178M	Introduction to Environmental Ethics
PHIL 264	Central Topics in the Philosophy of Science: Theory and Evidence
PHIL 267B	Philosophy, Biology, and Behavior
PHIL 275A	Ethics and Politics of Public Service
PHIL 277C	Ethics of Climate Change
PHIL 278M	Introduction to Environmental Ethics
PHIL 378W	Owning the Earth
PHYSICS 199	The Physics of Energy and Climate Change
PHYSICS 201	The Physics of Energy and Climate Change
PHYSICS 240	Introduction to the Physics of Energy
PHYSICS 241	Introduction to Nuclear Energy
POLECON 230	Strategy Beyond Markets
POLECON 231	Strategy Beyond Markets: Challenges and Opportunities in Developing Economies
POLECON 515	Energy: Innovation, Policy & Business Strategy
POLISCI 73	Energy Policy in California and the West
POLISCI 124A	The American West
POLISCI 133	Ethics and Politics of Public Service
POLISCI 134L	Introduction to Environmental Ethics
POLISCI 136R	Introduction to Global Justice
POLISCI 218X	Shaping the Future of the Bay Area
POLISCI 227B	Environmental Governance and Climate Resilience
POLISCI 241S	Spatial Approaches to Social Science
PSYC 136A	Valuescience: Shedding Illusion to Live and Die Well
PSYC 136B	Valuescience: Shedding Illusion to Live and Die Well
PSYC 150N	Climate Change and Mental Health
PSYCH 298	Advanced Studies in Health Psychology
PSYCH 459	Frontiers in Interdisciplinary Biosciences
PUBLPOL 85	Environmentalism in California
PUBLPOL 101	Introduction to American Politics and Policy: In Defense of Democracy
PUBLPOL 103D	Ethics and Politics of Public Service
PUBLPOL 104	Economic Policy Analysis
PUBLPOL 116	Climate Perspectives: Climate Science, Impacts, Policy, Negotiations, and Advocacy
PUBLPOL 118X	Shaping the Future of the Bay Area
PUBLPOL 135	Regional Politics and Decision Making in Silicon Valley and the Greater Bay Area
PUBLPOL 159	Economic, Legal, and Political Analysis of Climate-Change Policy
PUBLPOL 174	The Urban Economy
PUBLPOL 209	What is Public about Public Lands - Who and How to Manage.
PUBLPOL 218X	Shaping the Future of the Bay Area
PUBLPOL 224	Social Entrepreneurship and Innovation Lab (SE Lab) - Human & Planetary Health
PUBLPOL 265F	Environmental Governance and Climate Resilience
PWR 1GJS	Writing & Rhetoric 1: Our Warded World: The Rhetoric of Conservation
PWR 1JSA	Writing & Rhetoric 1: The Rhetoric of Plants

PWR 1KMB	Writing & Rhetoric 1: Cradle to Cradle: the Rhetoric of Sustainability
PWR 1KMC	Writing & Rhetoric 1: Staying Cool on a Hot Planet: Environmental Rhetoric for a Changing World
PWR 1LO	Writing & Rhetoric 1: What Are We Trying to Sustain? Rhetoric of Nature's Values and Services
PWR 1MGD	Writing & Rhetoric 1: Who Speaks for Nature? Rhetorics of Environmentalism and Justice
PWR 1MS	Writing & Rhetoric 1: Seeing Nature: The Power of Environmental Visual Rhetoric
PWR 1SI	Writing & Rhetoric 1: Super-Storms, Polar Bears, and Droughts: The Rhetoric of Climate Change
PWR 2CR	Writing & Rhetoric 2: Communicating Science to the Public
PWR 2JS	Writing & Rhetoric 2: In Science We Trust
PWR 2KM	Writing & Rhetoric 2: A Planet on the Edge: The Rhetoric of Sustainable Energy
PWR 2LO	Writing & Rhetoric 2: Facing the Future: Climate Change Science, Impacts, and Solutions
PWR 2RL	Writing & Rhetoric 2: The Rhetoric of the Natural and Beyond
PWR 2SB	Writing & Rhetoric 2: Writing 'Science': Fact, Fiction, and Everything Between
PWR 91CL	Self & Science
PWR 91EC	Intermediate Writing: Farmers, Scientists, & Activists: Public Discourse of Food Economies
PWR 91EP	Intermediate Writing: Communicating Climate Change: Navigating the Stories from the Frontlines
PWR 91JS	Stanford Science Podcast
PWR 91KS	Intermediate Writing: Design Thinking and Science Communication
PWR 91NSC	Intermediate Writing: Introduction to Science Communication
PWR 91RS	Intermediate Writing: Communicating Bioinformation
PWR 91S	Intermediate Writing: Communicating Science
PWR 194EP	Topics in Writing & Rhetoric: Introduction to Environmental Justice: Race, Class, Gender and Place
RELIGST 7N	Religion, Ecology, and Environmental Ethics
SINY 122	The Agile City
SINY 148	Grappling with the Global: Gentrification, Immigration, and Sustainability in New York City
SINY 150	Biology, Technology, and Society: The City as a Human Life Support System
SINY 162	Sustainable and Resilient Urban Systems in NYC
SIS 103Q	
SIS 125Q	
SIS 137Q	
SIS 149Q	
SIS 204N	
SIS 235N	
SIS 236N	
SIS 327Q	
SIS 342Q	
SIS 377Q	
SLAVIC 116	Literature and the Dream of Agriculture in Russia and Beyond
SLAVIC 155	St. Petersburg: Imagining a City, Building a City
SOC 22N	The Roots of Social Protest
SOC 105VP	Contested markets in the Brazilian Amazon Rainforest
SOC 118	Social Movements and Collective Action
SOC 152	The Social Determinants of Health
SOC 159	Social and Cultural Dimensions of Global Indigeneity
SOC 160	Formal Organizations
SOC 218	Social Movements and Collective Action
SOC 260	Formal Organizations
SOC 349	Race, Space, and Stratification
SOC 362	Organization and Environment
SOMGEN 260	Preparing for Community, Health and Learning through Service in Sri Lanka
STATS 60	Introduction to Statistical Methods: Precalculus
STATS 110	Statistical Methods in Engineering and the Physical Sciences
STATS 141	Biostatistics
STATS 160	Introduction to Statistical Methods: Precalculus
STATS 245	Data, Models and Applications to Healthcare Analytics
STRAMGT 574	Strategic Thinking in Action - In Business and Beyond II
STS 123	Making of a Nuclear World: History, Politics, and Culture
STS 177	The Cultural Politics of Food and Eating: Technology, History, and Justice
STS 181	Techno-metabolism: Technology, Society, and the Anthropocene
STS 190	Environment and Society
STS 200A	Food and Society: Politics, Culture and Technology
SUST 210	Pursuing Sustainability: Managing Complex Social Environmental Systems
SUST 220	Case Studies in Leading Change for Sustainability
SUST 232	Design for Sustainable Impact
SUST 240	Sustainability Leadership Practicum
SUST 261	Art and Science of Decision Making
SUST 297	Introduction to Systems Transformation
UAR 43	Leland Scholars Program
URBANST 110	Introduction to Urban Studies
URBANST 113	Introduction to Urban Design: Contemporary Urban Design in Theory and Practice
URBANST 114	Urban Culture in Global Perspective
URBANST 122	Ethics and Politics of Public Service
URBANST 124	Spatial Approaches to Social Science
URBANST 125	Shades of Green: Exploring and Expanding Environmental Justice in Practice

URBANST 132	Concepts and Analytic Skills for the Social Sector
URBANST 138	Smart Cities & Communities
URBANST 146	Retaking the Commons: Public Space and Heritage for Sustainable Cities
URBANST 147	Archaeology of Human Rights
URBANST 155A	Environmental Justice Colloquium
URBANST 163	Land Use: Planning for Equitable and Sustainable Cities
URBANST 164	Sustainable Cities
URBANST 172A	Introduction to Urban and Regional Planning
URBANST 173	The Urban Economy
URBANST 174	Defining Smart Cities: Visions of Urbanism for the 21st Century
URBANST 181	Urban Agroecology
URBANST 183	Team Urban Design Studio

Courses

EARTHSYS 4. Coevolution of Earth and Life. 4 Units.
Earth is the only planet in the universe currently known to harbor life. When and how did Earth become inhabited? How have biological activities altered the planet? How have environmental changes affected the evolution of life? Are we living in a sixth mass extinction? In this course, we will develop and use the tools of geology, paleontology, geochemistry, and modeling that allow us to reconstruct Earth's 4.5 billion year history and to reconstruct the interactions between life and its host planet over the past 4 billion years. We will also ask what this long history can tell us about life's likely future on Earth. We will also use One half-day field trip.
Same as: GEOLSCI 4

EARTHSYS 8. The Oceans: An Introduction to the Marine Environment. 4 Units.
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.
Same as: ESS 8

EARTHSYS 9. Public Service Internship Preparation. 1 Unit.
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.
Same as: EDUC 9, HUMBIO 9, PUBLPOL 74, URBANST 101

EARTHSYS 10. Introduction to Earth Systems. 4 Units.
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 11. Introduction to Geology. 5 Units.
Why are earthquakes, volcanoes, and natural resources located at specific spots on the Earth surface? Why are there rolling hills to the west behind Stanford, and soaring granite walls to the east in Yosemite? What was the Earth like in the past, and what will it be like in the future? Lectures, hands-on laboratories, in-class activities, and one virtual field trip will help you see the Earth through the eyes of a geologist. Topics include plate tectonics, the cycling and formation of different types of rocks, and how geologists use rocks to understand Earth's history.
Same as: GEOLSCI 1

EARTHSYS 13SC. People, Land, and Water in the Heart of the West. 2 Units.
Salmon River. Sun Valley. Pioneer Mountains. The names speak of powerful forces and ideas in the American West. Central Idaho - a landscape embracing snow-capped mountains, raging rivers, sagebrush deserts, farms, ranches, and resort communities - is our classroom for this field-based seminar led by David Freyberg, professor of Civil and Environmental Engineering, and David Kennedy, professor emeritus of History. nnThis course focuses on the history and future of a broad range of natural resource management issues in the western United States. We will spend a week on campus preparing for a two-week field course in Idaho exploring working landscapes, private and public lands, water and fisheries, conservation, and the history and literature of the relationship between people and the land in the American West. After the first week spent on campus, we will drive to Idaho to begin the field portion of our seminar. In Idaho, we will spend time near Twin Falls, at Lava Lake Ranch near Craters of the Moon National Monument, in Custer County at the Upper Salmon River, and near Stanley in the Sawtooth National Forest. No prior camping experience is required, but students should be comfortable living outdoors in mobile base camps for periods of several days. Students will investigate specific issues in-depth and present their findings at the end of the course.

EARTHSYS 16SI. Environmental Justice in the Bay Area. 2 Units.
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.
Same as: URBANST 16SI

EARTHSYS 18. Promoting Sustainability Behavior Change at Stanford. 2 Units.
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.

EARTHSYS 20. The Cuisine of Change: Promoting Child Health and Combating Food Insecurity. 1 Unit.
ASB Course. The course on nutrition, health and food insecurity is split into four projects: 1) Workshop a Story, in which students craft a personal narrative with input from the class, 2) Pose a Question, in which students in pairs attempt to educate the class on many sides of the same issue, 3) Create a Dish, in which students develop original dishes in support of local organizations, and 4) Teach a Class, in which students, in teams, develop a curriculum to be implemented in over the spring break trip. Furthermore, each section will expand the scope of the issue from the individual to the community and all the way up to national policies. The course will be a mix of some of the best lecturers and professors that we¿ve encountered in our time at Stanford as well as a smattering of community challenges. Come with a willingness to push your comfort zone, as some of the activities include creative presentations, taking a no added sugar challenge, get vulnerable, and developing an intelligent attitude toward healthy eating.

EARTHSYS 21. Peopling of the Globe: Changing Patterns of Land Use and Consumption Over the Last 50,000 Years. 3-5 Units.
Fossil, genetic and archaeological evidence suggest that modern humans began to disperse out of Africa about 50,000 years ago. Subsequently, humans have colonized every major landmass on earth. This class introduces students to the data and issues regarding human dispersal, migration and colonization of continents and islands around the world. We explore problems related to the timing and cause of colonizing events, and investigate questions about changing patterns of land use, demography and consumption. Students are introduced to critical relationships between prehistoric population changes and our contemporary environmental crisis.
Same as: ANTHRO 18, ARCHLGY 12

EARTHSYS 22. Introduction to Landscape Architecture: Urban Ecology and Environmental Design. 1 Unit.
This 1 unit, nine-week course provides an introduction to landscape architecture, covering a brief history of the field, making connections between science and sustainable and resilient urban ecosystems, and exploring a range of projects and topics that landscape architects touch. From public spaces and streetscapes to shorelines and trails, landscape architecture projects combine art and science in the pursuit of connecting and engaging humans with built and natural environments. The practice can be used to contribute to and achieve complex goals such as climate resilience, environmental restoration, habitat creation, green infrastructure planning, and aesthetic appeal. Through targeted readings, lectures, thoughtful discussions, and foundational assignments encouraging students to get outside and observe their surrounding landscapes, students will receive an introduction to landscape architecture and engage with a creative application of earth systems science. This course begins during Week 2 of fall quarter and will invite practicing landscape architects and urban designers to give biweekly guest lectures. Students of all class years and majors are encouraged to enroll. Guest lectures will be open to the Stanford community.

EARTHSYS 26. Sustainability in Athletics. 1 Unit.
This interactive, seminar-style course explores the intersection of environmental sustainability and athletics. Athletic teams and organizations provide a unique lens to analyze environmental sustainability due to their global reach, enormous fan bases and widely recognized sport icons. At the same time, the athletics industry produces an enormous environmental footprint with its travel, gear, competitive fueling, events, venue construction and maintenance. Because of this position, the sports industry has the opportunity and responsibility to create meaningful change in support of a sustainable future. We will explore the many ways that the athletics industry can make this change by inviting weekly speakers from a multitude of sports realms to share their expertise, vision and advice. There will be six learning modules addressing sustainability in terms of athletic gear and equipment, sports nutrition, facilities and stadiums, game days and events, the national and international stage, and individual sustainability superstars. Through taking this course, students will develop an understanding for the current state of athletic sustainability as well as future directions for the industry in this space.

EARTHSYS 36N. Life at the Extremes: From the Deep Sea to Deep Space. 3 Units.
Preference to freshmen. Microbial life is diverse and resilient on Earth; could it survive elsewhere in our solar system? This seminar will investigate the diversity of microbial life on earth, with an emphasis on extremophiles, and consider the potential for microbial life to exist and persist in extraterrestrial locales. Topics include microbial phylogenetic and physiological diversity, biochemical adaptations of extremophiles, ecology of extreme habitats, and apparent requirements and limits of life. Format includes lectures, discussions, lab-based activities and local field trips. Basics of microbiology, biochemistry, and astrobiology.

EARTHSYS 38N. The Worst Journey in the World: The Science, Literature, and History of Polar Exploration. 3 Units.
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.
Same as: ESS 38N, GEOLSCI 38N

EARTHSYS 39Q. Talking about Earthquakes, Volcanoes, and Floods: Science Communication and Natural Hazards. 4 Units.
In an age of fake news, how do we communicate the importance of scientific facts? How do we compel action from an individual to a national level when the facts alone aren¿t enough? In this class you will learn the basic tools of science communication through the lens of natural hazards such as earthquakes, volcanoes, and extreme weather. You will learn the basics of the science that drives these hazards, and how to communicate that science to different audiences. Recent research has shown that relaying scientific knowledge alone to potentially vulnerable populations does not have a significant impact on increasing their resilience to those hazards. Therefore, it is increasingly important to train a new generation of science communicators and translators who can effectively relay complex information in engaging and understandable ways. This will be a hands-on course where you will be working individually and in small groups to discuss class topics, share, and peer review each other¿s writing each week. This course satisfies the Write 2 requirement for undergraduates.

EARTHSYS 41N. The Global Warming Paradox. 3 Units.
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 44N. The Invisible Majority: The Microbial World That Sustains Our Planet. 3 Units.
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 46N. Exploring the Critical Interface between the Land and Monterey Bay: Elkhorn Slough. 3 Units.
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.
Same as: ESS 46N

EARTHSYS 46Q. Environmental Impact of Energy Systems: What are the Risks?. 3 Units.
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.
Same as: GEOLSCI 46Q

EARTHSYS 55Q. Am I a Part of Earth? Understanding of Rock, Water, and Time. 3 Units.
Am I a part of Earth? Not only is this a question of personal meaning, but also a complex question that shapes how we interact with the natural world. Answering it calls for both scientific and experiential understanding of Earth processes, as well as how geologic thinking and our individual thinking about nature have changed through time. By connecting Earth processes and rates of transformations to personal experience, we can rigorously interrogate our relationship to and/or separation from Earth.nnIn this course, you will think like a philosopher and a geochemist. You will commune with nature and calculate the history of rocks. You will use real data analysis of Earth processes to understand the limits of our knowledge about Earth history (Deep Time). You will explore your interactions with Earth materials through mindfulness activities and discuss different views of humans relative to nature through history. You will have autonomy in a course-long project that synthesizes your growing understanding of your relationship to and/or separation from Earth.nnThis course welcomes all, from rock collectors to hikers and ecofeminists to meditators. No prior experience with philosophy or Earth science is required, though an introductory high school chemistry and algebra course will be helpful. The only requirement is a willingness to examine your personal relationship with Earth from scientific and humanistic perspectives.

EARTHSYS 58Q. Understanding Our Oceans: Scientific Toys, Tools, & Trips. 3 Units.
In popular science magazines we read about deep ocean critters recently discovered or the latest threats coral reefs face. But what is it actually like to do science in the ocean-to research ocean life in the various ocean ecosystems? In this course, we will explore the latest advances in marine science-what technologies are allowing scientists to explore and investigate the ocean and what are we discovering. We will have 2 one-day fieldtrips (on Fridays) to marine research centers in Moss Landing, Monterey, and institutions in the Bay Area. This course will also expose students to what life as a marine biology/science graduate student is like.

EARTHSYS 61Q. Food and security. 3 Units.
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.
Same as: ESS 61Q, INTNLREL 61Q

EARTHSYS 91. Earth Systems Writers Collective. 1 Unit.
Come join a community of environmental writers, publish your work, and get course credit at the same time! Are you currently working on an article, an op-ed, translating your class projects into publishable pieces or pursuing a new writing project? Are you interested in publishing your work in the quarterly Earth Systems newsletter and the annual Earth Systems magazine? In this weekly seminar, you will collaborate with others and get constructive feedback from a community of peer writers. You can enroll in the Earth Systems Writers Collective for 1 unit, or just join without signing up for course credit. May be repeated for credit.

EARTHSYS 95. Liberation Through Land: Organic Gardening and Racial Justice. 2 Units.
Through field trips, practical work and readings, this course provides students with the tools to begin cultivating a relationship to land that focuses on direct engagement with sustainable gardening, from seed to harvest. The course will take place on the O'Donohue Family Stanford Educational Farm, where students will be given the opportunity to learn how to sow seeds, prepare garden beds, amend soils, build compost, and take care of plants. The history of forced farm labor in the U.S., from slavery to low-wage migrant labor, means that many people of color encounter agricultural spaces as sites of trauma and oppression. In this course we will explore the potential for revisiting a narrative of peaceful relation to land and crop that existed long before the trauma occurred, acknowledging the beautiful history of POC coexistence with land. Since this is a practical course, there will be a strong emphasis on participation. Application available at https://goo.gl/forms/cbYX3gSGdrHgHBJH3; deadline to apply is September 18, 2018, at midnight. The course is co-sponsored by the Institute for Diversity in the Arts (IDA) and the Earth Systems Program.
Same as: AFRICAAM 95, CSRE 95

EARTHSYS 96. Land Justice: Unearthing Histories & Seeding Liberation. 2 Units.
Through readings, class discussions, direct interviews, peer reviews, and blog posts, this course grounds students in United States land histories, explores contemporary efforts towards food and land justice, and equips students with the frameworks to envision and work towards an equitable and just food and land management system, and greater environmental movement. Teams of students will have the opportunity to delve deeper into course concepts through direct engagement with our community partners. This course acknowledges the ways that historical and contemporary colonial violence, racism, and systemic injustice shape our food and land systems, while empowering students to envision and help build an equitable, just, sovereign, and healthy land future. Although this is an online course, there will be a strong emphasis on community engagement and in-class participation. If you are interested in enrolling in this course, please apply by Friday, March 12, 2021 through the following form: https://bit.ly/37yO9Tk. (Cardinal Course certified by the Haas Center).

EARTHSYS 100. Environmental and Geological Field Studies in the Rocky Mountains. 3 Units.
Three-week, field-based program in the Greater Yellowstone/Teton and Wind River Mountains of Wyoming. Field-based exercises covering topics including: basics of structural geology and petrology; glacial geology; western cordillera geology; paleoclimatology; chemical weathering; aqueous geochemistry; and environmental issues such as acid mine drainage and changing land-use patterns.
Same as: ESS 101

EARTHSYS 100A. Data Science for Geoscience. 3 Units.
This course provides an overview of the most relevant areas of data science to address geoscientific challenges and questions as they pertain to the environment, earth resources & hazards. The focus lies on the methods that treat common characters of geoscientific data: multivariate, multi-scale, compositional, geospatial and space-time. In addition, the course will treat those statistical method that allow a quantification of the human dimension by looking at quantifying impact on humans (e.g. hazards, contamination) and how humans impact the environment (e.g. contamination, land use). The course focuses on developing skills that are not covered in traditional statistics and machine learning courses.
Same as: GEOLSCI 6

EARTHSYS 101. Energy and the Environment. 3 Units.
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. Recommended: MATH 21 or 42.
Same as: ENERGY 101

EARTHSYS 102. Fundamentals of Renewable Power. 3 Units.
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. Recommended: Math 21 or 42.
Same as: ENERGY 102

EARTHSYS 103. Understanding Energy. 3-5 Units.
Energy is the number one contributor to climate change and has significant consequences for our society, political system, economy, and environment. Energy is also a fundamental driver of human development and opportunity. In taking this course, students will not only understand the fundamentals of each energy resource -- including significance and potential, conversion processes and technologies, drivers and barriers, policy and regulation, and social, economic, and environmental impacts -- students will also be able to put this in the context of the broader energy system. Both depletable and renewable energy resources are covered, including oil, natural gas, coal, nuclear, biomass and biofuel, hydroelectric, wind, solar thermal and photovoltaics (PV), geothermal, and ocean energy, with cross-cutting topics including electricity, storage, climate change and greenhouse gas emissions (GHG), sustainability, green buildings, energy efficiency, transportation, and the developing world. The course is 4 units, which includes lecture and in-class discussion, readings and videos, homework assignments, virtual field trips, and a small-group discussion section once a week for 50 minutes (live participation is required, many different times will be offered). Lectures will be recorded and available on Canvas. No in-person field trips will be offered for AY 2020-2021 ¿ but alumni of the class can optionally attend field trips in future quarters. Enroll for 5 units to also attend the Workshop, an interactive discussion section on cross-cutting topics that meets once per week for 80 minutes (timing TBD). The 3-unit option requires instructor approval - please contact Diana Gragg. Open to all: pre-majors and majors, with any background! Website: https://energy.stanford.edu/understanding-energy. CEE 107S/207S Understanding Energy: Essentials is a shorter (3 unit) version of this course, offered summer quarter. Students should not take both for credit. Prerequisites: Algebra.
Same as: CEE 107A, CEE 207A

EARTHSYS 104. The Water Course. 4 Units.
The Central Valley of California provides a third of the produce grown in the U.S., but recent droughts and increasing demand have raised concerns about both food and water security. The pathway that water takes from rainfall to the irrigation of fields or household taps (¿the water course¿) determines the quantity and quality of the available water. Working with various data sources (measurements made on the ground, in wells, and from satellites) allows us to model the water budget in the valley and explore the recent impacts on freshwater supplies.
Same as: EARTHSYS 204, GEOPHYS 104, GEOPHYS 204

EARTHSYS 105. Food and Community: Food Security, Resilience and Equity. 2-3 Units.
What can communities do to bolster food security, resiliency, and equity in the face of climate change? This course aims to respond to this question, in three parts. In Part 1, we will explore the most current scientific findings on trends in anthropogenic climate forcing and the anticipated impacts on global and regional food systems. Specifically, Part I will review the anticipated impact of climate change on severe weather events, crop losses, and food price volatility and the influence of these impacts on global and regional food insecurity and hunger. In Part II, we will consider what communities can do to promote food security and equity in the face of these changes, by reviewing the emerging literature on food system resiliency. Finally, we will facilitate a conference in which multi-disciplinary teams from around the country will gather to initiate regional planning projects designed to enhance food system resilience and equity. Cardinal Course (certified by Haas Center). Limited enrollment. May be repeated for credit.
Same as: EARTHSYS 205

EARTHSYS 105A. Ecology and Natural History of Jasper Ridge Biological Preserve. 4 Units.
Ecology and Natural History of Jasper Ridge Biological Preserve an upper-division course, aims to help student learn ecology and natural history using a ¿living laboratory¿, the Jasper Ridge Preserve. The course¿s central goal is that, as a community of learning, we examine ¿via introductory discussions, followed by hands-on experiences in the field¿ the scientific basis of: ecological research, archaeology, edaphology, geology, hydrology, species interactions, land management, and multidisciplinary environmental education. The 10 sessions that compose the academic program are led by the instructors, faculty (world-experts on the themes of each session), and JRBP staff. In addition, this class trains students to become JRBP Docents that therefore join the Jasper Ridge education affiliates community. nnAfter completing this course and as new affiliates of Jasper Ridge, participants will be able to lead research-focused educational tours, assist with classes and research, and attend continuing education activities available to members of the JRBP community.
Same as: BIO 105A

EARTHSYS 105B. Ecology and Natural History of Jasper Ridge Biological Preserve. 4 Units.
Ecology and Natural History of Jasper Ridge Biological Preserve an upper-division course, aims to help students learn ecology and natural history using a living laboratory, the Jasper Ridge Preserve. The course's central goal is that, as a community of learning, we examine via introductory discussions, followed by hands-on experiences in the field, the scientific basis of: ecological research, archaeology, edaphology, geology, hydrology, species interactions, land management, and multidisciplinary environmental education. The 10 sessions that compose the academic program are led by the instructors, faculty (world-experts on the themes of each session), and JRBP staff. In addition, this class trains students to become JRBP Docents that therefore join the Jasper Ridge education affiliates community. After completing this course, and as new affiliates of Jasper Ridge, participants will be able to lead research-focused educational tours, assist with classes and research, and attend continuing education activities available to members of the JRBP community.
Same as: BIO 105B

EARTHSYS 106. World Food Economy. 5 Units.
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. Grades based on mid-term exam and group modeling project and presentation. Enrollment is by application only and will be capped at 25, with priority given to upper level undergraduates in Economics and Earth Systems and graduate students (graduate students enroll in 206). Application found at https://economics.stanford.edu/academics/undergraduate-program/forms.
Same as: EARTHSYS 206, ECON 106, ECON 206, ESS 106, ESS 206

EARTHSYS 106B. Sustainable and Equitable Water Management. 3-4 Units.
California has committed itself to sustainable groundwater management, with passage of the Sustainable Groundwater Management Act in 2014, and safe drinking water access for all, with California's Human Right to Water Act in 2012. Yet, groundwater overdraft continues while over 1 million residents lack access to safe drinking water. Working with a water agency in the San Joaquin Valley, we will explore feedback loops between the two Acts and develop a plan for water management that meet the co-equal objectives of sustainable and equitable resource governance. We will work with "big" and "small" data, exploring the possibilities but also the limitations of using publicly available data for assessment and monitoring. The course will include guest speakers and interaction with public agencies and other key stakeholders.nThis is a Cardinal Course certified by the Haas Center.
Same as: EARTHSYS 206B, GEOPHYS 106, GEOPHYS 206

EARTHSYS 106C. Why are Scientists Engineering Our Food?. 2 Units.
This lecture and discussion course will review the scientific evidence on the use and impacts of genetic engineering in global food and agricultural systems. The class will cover the history and details of crop genetic improvement, ranging from primitive domestication to CRISPR technologies. We will examine the risks and benefits of crop genetic technologies in agriculture with regards to productivity, farm incomes, food safety, human health and nutrition, and environmental impacts. We will also discuss the current and future use of genetic engineering techniques for enhancing climate resilience and nutritional outcomes in agricultural systems worldwide. Finally, we will discuss the ethics of using modern genetic approaches for crop improvement, and the policy environment surrounding the use of these genetic techniques.nnOur expectation is that students enrolled in the course will attend all class sections and participate actively in the discussions. Students will be asked to identify peer-reviewed, scientific papers on the impacts of specific crop genetic improvements. Depending on the class size, students will also be asked to help lead class discussions. At the end of the course, students will work in groups to debate a selected topic on the use of genetic engineering in agriculture, to be announced during the course.nnPrerequisites: One course in biology and one course in economics are suggested. Completion of "Feeding Nine Billion" and "The World Food Economy" classes would also be helpful, as would a class in genetics, but there are no strict course requirements.

EARTHSYS 106D. New meat: The Science Behind Scalable Alternatives to Animal Products. 2 Units.
Plant-based meat products and the technologies used to produce them have increased in complexity from tofu (~200 BC) and wheat gluten-based meat replacements (6th century AD) to the Beyond Burger and the Impossible Burger (both 2016), which use mechanically extracted plant proteins and genetically engineered yeast producing soy leghemoglobin, respectively. This course will cover the scientific challenges and processes used to create convincing and marketable plant-based and clean meats, including the biological and chemical processes used to produce plant-based meat and clean meat; the environmental and economic drivers behind the market for meat replacements; and the dietary roles of plant- and animal-based proteins. This course is intended for undergraduates interested in learning about the technical and scientific developments involved in the production of clean and plant-based meat. Students should be familiar with introductory biology and chemistry.

EARTHSYS 107. Control of Nature. 3 Units.
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.
Same as: ESS 107

EARTHSYS 109. Rethinking Meat: An Introduction to Alternative Proteins. 1 Unit.
How do we feed a growing population in the face of climate change? Will Impossible Burgers become the new norm? Are you curious to learn about a frontier in bio- and chemical-engineering? Are you passionate about animal rights, human health, and sustainable agriculture? Learn about the environmental, ethical, and economic drivers behind the market for meat replacements. We'll take a deep dive into the science and technology used to develop emerging plant, fermentation and cell-based meat alternatives and explore the political challenges and behavioral adaptation needed to decrease meat consumption. Hear from entrepreneurs, researchers, and innovative startups developing sustainable and marketable alternative proteins through weekly guest lectures from industry leaders.
Same as: EARTHSYS 209, ESS 103, ESS 203, ETHICSOC 107

EARTHSYS 110. Introduction to the Foundations of Contemporary Geophysics. 3 Units.
Introduction to the foundations of contemporary geophysics. Topics drawn from broad themes in: whole Earth geodynamics, geohazards, natural resources, and environment. In each case the focus is on how the interpretation of a variety of geophysical measurements (e.g., gravity, seismology, heat flow, electromagnetics, and remote sensing) can be used to provide fundamental insight into the behavior of the Earth. The course will include a weekend field trip. Prerequisite: CME 100 or MATH 51, or co-registration in either.
Same as: GEOPHYS 110

EARTHSYS 111. Biology and Global Change. 4 Units.
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 BIO 81 or graduate standing.
Same as: BIO 117, EARTHSYS 217, ESS 111

EARTHSYS 112. Human Society and Environmental Change. 4 Units.
Interdisciplinary approaches to understanding human-environment interactions with a focus on economics, policy, culture, history, and the role of the state. Prerequisite: ECON 1.
Same as: EARTHSYS 212, ESS 112, HISTORY 103D

EARTHSYS 113. Earthquakes and Volcanoes. 3 Units.
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/zr8ar28efmuo5wtlj6gj2jbxle76r4lu.
Same as: GEOPHYS 90

EARTHSYS 114. Global Change and Emerging Infectious Disease. 3 Units.
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, plague, and HIV.
Same as: EARTHSYS 214, ESS 213, HUMBIO 114

EARTHSYS 115. Wetlands Ecology of the Pantanal Prefield Seminar. 2-3 Units.
This seminar will prepare students for their overseas field experience in the Pantanal, Brazil, the largest wetland in the world, studying wetlands ecology and conservation in situ. Students will give presentations on specific aspects of the Pantanal and lay the groundwork for the presentations they will be giving during the field seminar where access to the internet and to other scholarly resources will be quite limited. Additional topics include: logistics, health and safety, cultural sensitivity, geography and politics, and basic language skills; also, post-field issues such as reverse culture shock, and ways in which participants can consolidate and build up their abroad experiences after they return to campus. Students will have the opportunity to participate in a pilot study aimed at developing a series of innovative online curriculum based upon their field experience.

EARTHSYS 115N. Desert Biogeography of Namibia Prefield Seminar. 3 Units.
Desert environments make up a third of the land areas on Earth, ranging from the hottest to the coldest environments. Aridity leads to the development of unique adaptations among the organisms that inhabit them. Climate change and other processes of desertification as well as increasing human demand for habitable and cultivatable areas have resulting in increasing need to better understand these systems. Namibia is a model system for studying these processes and includes the Sossuvlei (Sand Sea) World Heritable Site. This seminar will prepare students for their overseas field experience in Namibia. The seminar will provide an introduction to desert biogeography and culture, using Namibia as a case study. During the seminar, students will each give two presentations on aspects of desert biogeography and ecology, specific organisms and their adaptations to arid environments, cultural adaptations of indigenous peoples and immigrants, ecological threats and conservation efforts, and/or national and international policy towards deserts. Additional assignments include a comprehensive dossier and a final exam. Students will also carry out background research for the presentations they will be giving during the field seminar where access to the internet and to other scholarly resources will be limited. In addition, we will cover logistics, health and safety, cultural sensitivity, geography, and politics. We will deal with post-field issues such as reverse culture shock, and ways in which participants can consolidate and build up their abroad experiences after they return to campus.
Same as: AFRICAST 114N

EARTHSYS 115T. Island Biogeography of Tasmania Prefield Seminar. 3 Units.
Islands are natural laboratories for studying a wide variety of subjects including biological diversity, cultural diversity, epidemiology, geology, climate change, conservation, and evolution. This field seminar focuses on Island Biogeography in one of the most extraordinary and well-preserved ecosystems in the world: Tasmania. Tasmanian devils, wombats, and wallabies ¿ the names conjure up images of an exotic faraway place, a place to appreciate the incredibly diversity of life and how such striking forms of life came to be. This course will prepare students for their overseas seminar in Tasmania. Students will give presentations on specific aspects of the Tasmania and will lay the groundwork for the presentations they will be giving during the field seminar where access to the internet and to other scholarly resources will be quite limited. Additional topics to be addressed include: logistics, health and safety, group dynamics, cultural sensitivity, history, and politics. We will also address post-field issues such as reverse culture shock, and ways to consolidate and build up abroad experiences after students return to campus.

EARTHSYS 116. Ecology of the Hawaiian Islands. 4 Units.
Terrestrial and marine ecology and conservation biology of the Hawaiian Archipelago. Taught in the field in Hawaii as part of quarter-long sequence of courses including Earth Sciences and Anthropology. Topics include ecological succession, plant-soil interactions, conservation biology, biological invasions and ecosystem consequences, and coral reef ecology. Restricted to students accepted into the Earth Systems of Hawaii Program.
Same as: BIO 116

EARTHSYS 117. Earth Sciences of the Hawaiian Islands. 4 Units.
Progression from volcanic processes through rock weathering and soil-ecosystem development to landscape evolution. The course starts with an investigation of volcanic processes, including the volcano structure, origin of magmas, physical-chemical factors of eruptions. Factors controlling rock weathering and soil development, including depth and nutrient levels impacting plant ecosystems, are explored next. Geomorphic processes of landscape evolution including erosion rates, tectonic/volcanic activity, and hillslope stability conclude the course. Methods for monitoring and predicting eruptions, defining spatial changes in landform, landform stability, soil production rates, and measuring biogeochemical processes are covered throughout the course. This course is restricted to students accepted into the Earth Systems of Hawaii Program.
Same as: EARTH 117, ESS 117

EARTHSYS 118. Heritage, Environment, and Sovereignty in Hawaii. 4 Units.
This course explores the cultural, political economic, and environmental status of contemporary Hawaiians. What sorts of sustainable economic and environmental systems did Hawaiians use in prehistory? How was colonization of the Hawaiian Islands informed and shaped by American economic interests and the nascent imperialsm of the early 20th centrury? How was sovereignty and Native Hawaiian identity been shaped by these forces? How has tourism and the leisure industry affected the natural environment? This course uses archaeological methods, ethnohistorical sources, and historical analysis in an exploration of contemporary Hawaiian social economic and political life.
Same as: CSRE 118E, NATIVEAM 118

EARTHSYS 119. Will Work for Food. 1 Unit.
This is a speaker series class featuring highly successful innovators in the food system. Featured speakers will talk in an intimate, conversational manner about their current work, as well as about their successes, failures, and learnings along the way. Additional information can be found here: http://feedcollaborative.org/speaker-series/.
Same as: EARTHSYS 219

EARTHSYS 121. Building a Sustainable Society: New Approaches for Integrating Human and Environmental Priorities. 3 Units.
"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 122. Evolution of Marine Ecosystems. 3-4 Units.
Life originally evolved in the ocean. When, why, and how did the major transitions occur in the history of marine life? What triggered the rapid evolution and diversification of animals in the Cambrian, after more than 3.5 billion years of Earth's history? What caused Earth's major mass extinction events? How do ancient extinction events compare to current threats to marine ecosystems? How has the evolution of primary producers impacted animals, and how has animal evolution impacted primary producers? In this course, we will review the latest evidence regarding these major questions in the history of marine ecosystems. We will develop familiarity with the most common groups of marine animal fossils. We will also conduct original analyses of paleontological data, developing skills both in the framing and testing of scientific hypotheses and in data analysis and presentation.
Same as: BIO 119, GEOLSCI 123, GEOLSCI 223B

EARTHSYS 123. Asian Americans and Environmental Justice. 3-5 Units.
One central tenet of the environmental justice movement is centering the leadership of frontline communities. Unfortunately, the struggles of Asian Americans on the frontlines of corporate environmental pollution and extraction are less visible and less well-known. In this course, we will explore the Asian American voices that have contributed to the development of the environmental justice movement and the leadership that is shaping the future of this movement.nThis course is designed to provide students with education about the history of the environmental justice movement, the future being envisioned, and the strategies that are needed to get to the vision. It will draw on lectures, readings, guest presentations, case studies, and the instructor's more than 15 years of experience with organizing and social justice campaigns. Students will learn about the principles guiding the environmental justice movement; the vision and framework of how we achieve a just transition to a regenerative economy; the process of organizing and campaign work to advance a community agenda; and skills in collecting, analyzing, and communicating information.
Same as: ASNAMST 123

EARTHSYS 123A. Biosphere-Atmosphere Interactions. 3-4 Units.
How do ecosystems respond to climate, and how do ecosystems influence climate? Covers the role of the terrestrial land surface in earth's climate system, including among others photosynthesis, transpiration, greenhouse gasses, radiation, and atmospheric water vapor. For each of these topics, attention is paid to both the underlying processes and how they can be mathematically represented in earth system models. Instruments and techniques used to measure these processes are also discussed, and, where appropriate, demonstrated.
Same as: EARTHSYS 223, ESS 123, ESS 223

EARTHSYS 124. Measurements in Earth Systems. 3-4 Units.
A classroom, laboratory, and field class designed to provide students familiarity with techniques and instrumentation used to track biological, chemical, and physical processes operating in earth systems, encompassing upland, aquatic, estuarine, and marine environments. Topics include gas and water flux measurement, nutrient and isotopic analysis, soil and water chemistry determination. Students will develop and test hypotheses, provide scientific evidence and analysis, culminating in a final presentation.
Same as: ESS 212

EARTHSYS 125. Shades of Green: Exploring and Expanding Environmental Justice in Practice. 3-4 Units.
Historically, discussions of race, ethnicity, culture, and equity in the environment have been shaped by a limited view of the environmental justice movement, often centered on urban environmental threats and separated from other types of environmental and climate advocacy. This course will seek to expand on these discussions by exploring topics such as access to outdoor spaces, definitions of wilderness, inclusion in environmental organizations, gender and the outdoors, the influence of colonialism on ways of knowing, food justice and ethics, and the future of climate change policy. The course will also involve a community partnership project. In small groups students will work with an environmental organization to problem-solve around issues of equity, representation, and access. We value a diversity of experiences and epistemologies and welcome undergraduates from all disciplines. Since this is a practical course, there will be a strong emphasis on participation and commitment to community partnerships. This course requires instructor approval, please submit an application by March 16th at midnight. Application available at https://forms.gle/chBoCLX3WKSA7kBF6.
Same as: CSRE 125E, EARTHSYS 225, URBANST 125

EARTHSYS 126. Perspectives in International Development. 3 Units.
In this course, we explore the contested nature of development as a concept, goal, intervention, project, and policy. Because development is often associated with ideas surrounding poverty and well-being it is used as a tool by government agencies, multilateral organizations, and non-governmental organizations to achieve livelihood improvement and biodiversity/natural resource conservation. Development projects have the potential to achieve goals that are socially, ecologically, and economically focused while providing a just distribution of benefits. What does ¿development¿ really mean? What does it include (and not include)? And who? When (under what conditions) does development work? How do we measure? Who decides? Who benefits from development, and who pays the costs? We will try to answer these questions and more like them, each week exploring themes related to development while drawing from various disciplines and contexts.

EARTHSYS 128. Evolution of Terrestrial Ecosystems. 4 Units.
The what, when, where, and how do we know it regarding life on land through time. Fossil plants, fungi, invertebrates, and vertebrates (yes, dinosaurs) are all covered, including 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. The course involves both lecture and lab components. Graduate students registering at the 200-level are expected to write a term paper, but can opt out of some labs where appropriate.
Same as: BIO 148, BIO 228, GEOLSCI 128, GEOLSCI 228

EARTHSYS 130. Designing and Evaluating Community Engagement Programs for Social and Environmental Change. 3 Units.
Non-profit organizations seeking to achieve social and environmental change often run outreach and education programs to engage community members in their cause. Effective application of social science theory and methods may improve the design and evaluation of such community engagement programs. In this class, we partner with environmental and social justice organizations in the Bay Area to explore two questions: 1) How can recent findings from the social sciences be applied to design more effective community engagement programs ? 2) How can we rigorously evaluate outreach and education programs to ensure they are achieving the desired objectives? The course will include an overview of key theories from psychology, sociology, and education, field trips to partnering organizations, and a term-long community-engaged research project focused on designing and/or evaluating a local outreach or educational program that is meant to achieve social and environmental change.
Same as: ENVRES 201

EARTHSYS 130A. Ecosystems of California. 4 Units.
California is home to a huge diversity of ecosystem types and processes. This course provides an introduction to the natural history, systematics, and ecosystem ecology of California ecosystems, based on a combination of lectures, student-led projects, and weekend field trips. Ecosystems to be explored will range from coasts to mountains and from desert to wetlands. Requirements include three essays and participation in three field trips (of six options).
Same as: BIO 130

EARTHSYS 131. Pathways in Sustainability Careers. 1 Unit.
Interactive, seminar-style sessions expose students to diverse career pathways in sustainability. Professionals from a variety of careers discuss their work, their career development and decision-points in their career pathways, as well as life style aspects of their choices.
Same as: EARTH 131

EARTHSYS 132. Evolution of Earth Systems. 4 Units.
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.
Same as: EARTHSYS 232, ESS 132, ESS 232, GEOLSCI 132, GEOLSCI 232

EARTHSYS 133. Social Enterprise Workshop. 4 Units.
Social Enterprise Workshop: A team based class to design solutions to social issues. In the class students will identify issues they are interested in, such as housing, food, the environment, or college access. They will join teams of like-minded students. Working under the guidance of an experienced social entrepreneur, together they will develop a solution to one part of their issue and write a business plan for that solution. The class will also feature guests who are leaders in the field of social entrepreneurship who will share their stories and help with the business plans. The business plan exercise can be used for both nonprofits and for-profits. Previous students have started successful organizations and raised significant funds based on the business plans developed in this class. There are no prerequisites, and students do not need to have an idea for a social enterprise to join the class. Enrollment limited to 20. May be repeated for credit.
Same as: URBANST 133

EARTHSYS 135B. Waste Politics: Contesting Toxicity, Value, and Power. 3 Units.
Waste is increasingly central as an object and medium of political contestation in the contemporary world, from struggles over garbage, labor, and dignity in Senegal; to explosive remnants of war acting as rogue infrastructure in the Korean demilitarized zone. In response, waste has also become a productive concept in the environmental humanities and humanistic social sciences. In this course we will read a selection of foundational texts focused on waste, many of which draw on case studies from different parts of the world. The case of China will be emphasized, however, since China has emerged in the last few decades as a center not only of global industrial production, but also for processing the world¿s waste, contesting pollution, and fighting for environmental justice. By pairing key theoretical texts with texts dealing with waste-related issues in China and elsewhere, we will ultimately ask how contemporary global waste politics disrupts western understandings of waste, recycling, value, and more.
Same as: ANTHRO 135B, ANTHRO 235B

EARTHSYS 136. The Ethics of Stewardship. 2-3 Units.
What responsibilities do humans have to nonhuman nature and future generations? How are human communities and individuals shaped by their relationships with the natural world? What are the social, political, and moral ramifications of drawing sustenance and wealth from natural resources? Whether we realize it or not, we grapple with such questions every time we turn on the tap, fuel up cars, or eat meals -and they are key to addressing issues like global climate change and environmental justice. In this class, we consider several perspectives on this ethical question of stewardship: the role of humans in the global environment. In addition to reading written work and speaking with land stewards, we will practice stewardship at the Stanford Educational Farm. This course must be taken for a minimum of 3 units and a letter grade to be eligible for Ways credit.
Same as: EARTHSYS 236

EARTHSYS 137. Concepts and Analytic Skills for the Social Sector. 4 Units.
How to develop 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, market/user analysis, communications, funding, recruitment and impact evaluation. Perspectives from the field of social entrepreneurship, design thinking and social change organizing. Opportunities and limits of using methods from the for-profit sector to meet social goals. Focus is on integrating theory with practical applications, including several case exercises and simulations.One-day practicum where students advise an actual social impact organization. Enrollment limited to 20. Prerequisite:consent of instructor. Email lalitvak@stanford.edu.
Same as: URBANST 132

EARTHSYS 138. International Urbanization Seminar: Cross-Cultural Collaboration for Sustainable Urban Development. 4-5 Units.
(formerly IPS 274) 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).
Same as: CEE 126, INTLPOL 274, URBANST 145

EARTHSYS 139. Ecosystem Services: Frontiers in the Science of Valuing Nature. 3 Units.
This course explores the science of valuing nature, beginning with its historical origins and then a primary focus on its recent development and frontiers. The principal aim of the course is to enable new research and real-world applications of InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) tools and approaches. We will discuss the interconnections between people and nature and key research frontiers, such as in the realms of biodiversity, resilience, human health, poverty alleviation, and sustainable development. The science we¿ll explore is in the service of decisions, and we will use examples from real life to illustrate why this science is so critical to informing why, where, how, and how much people need nature. Prerequisite. Basic to intermediate GIS skills are required (including working with raster, vector and tabular data; loading and editing rasters, shapefiles, and tables into a GIS; understanding coordinate systems; and performing basic raster math).
Same as: BIO 138, BIO 238, EARTHSYS 239

EARTHSYS 141. Remote Sensing of the Oceans. 3-4 Units.
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.
Same as: EARTHSYS 241, ESS 141, ESS 241, GEOPHYS 141

EARTHSYS 142. Remote Sensing of Land. 4 Units.
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.
Same as: EARTHSYS 242, ESS 162, ESS 262

EARTHSYS 143. Molecular Geomicrobiology Laboratory. 3-4 Units.
In this course, students will be studying the biosynthesis of cyclic lipid biomarkers, molecules that are produced by modern microbes that can be preserved in rocks that are over a billion years old and which geologist use as molecular fossils. Students will be tasked with identifying potential biomarker lipid synthesis genes in environmental genomic databases, expressing those genes in a model bacterial expression system in the lab, and then analyzing the lipid products that are produced. The overall goal is for students to experience the scientific research process including generating hypotheses, testing these hypotheses in laboratory experiments, and communicating their results through a publication style paper. Prerequisites: BIO83 and CHEM 121 or permission of the instructor.
Same as: BIO 142, ESS 143, ESS 243

EARTHSYS 143H. Quantitative methods for marine ecology and conservation. 4 Units.
The goal of this course is to learn the foundations of ecological modelling with a specific (but not exclusive) focus on marine conservation and sustainable exploitation of renewable resources. Students will be introduced to a range of methods ¿ from basic to advanced ¿to characterize population structure, conduct demographic analyses, estimate extinction risk, identify temporal trends and spatial patterns, quantify the effect of environmental determinants and anthropogenic pressures on the dynamics of marine populations, describe the potential for adaptation to climate change. This course will emphasize learning by doing, and will rely heavily on practical computer laboratories, in R and/or Phyton, based on data from our own research activities or peer reviewed publications. Students with a background knowledge of statistics, programming and calculus will be most welcome.
Same as: BIOHOPK 143H, BIOHOPK 243H, CEE 164H, CEE 264H, EARTHSYS 243H

EARTHSYS 144. Fundamentals of Geographic Information Science (GIS). 1-4 Unit.
"Everything is somewhere, and that somewhere matters." The rapid growth and maturity of spatial data technologies over the past decade represent a paradigm shift in the applied use of location data from high-level overviews of administrative interests, to highly personalized location-based services that place the individual at the center of the map, at all times. The use of spatial data and related technology continues to grow in fields ranging from environmental sciences to epidemiology to market prediction. This course will present an overview of current approaches to the use of spatial data and its creation, capture, management, analysis and presentation, in a research context. Topics will include modeling of geographic objects and associated data, modeling of geographic space and the conceptual foundations of "spatial thinking," field data collection, basic spatial statistical analysis, remote sensing & the use of satellite-based imagery, "Big Data" and machine learning approaches to spatial data, and cartographic design and presentation including the use of web-based "Storymap" platforms.n nThe course will consist of weekly lectures, guest speakers, computer lab assignments and an individual final project requirement. nnThis course must be taken for a minimum of 3 units and a letter grade to be eligible for Ways credit. In AY 2020-21, a letter grade or `CR' grade satisfies the Ways requirement.
Same as: ESS 164

EARTHSYS 146A. Atmosphere, Ocean, and Climate Dynamics: The Atmospheric Circulation. 3 Units.
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.
Same as: CEE 161I, CEE 261I, ESS 246A

EARTHSYS 146B. Atmosphere, Ocean, and Climate Dynamics: the Ocean Circulation. 3 Units.
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: MATH 51 or CME100; and PHYSICS 41; and a course that introduces the equations of fluid motion (e.g. ESS 246A, ESS 148, or CEE 101B).
Same as: CEE 162I, CEE 262I, ESS 246B

EARTHSYS 147. Ecosystem Ecology and Biogeochemistry. 3 Units.
An introduction to ecosystem ecology and terrestrial biogeochemistry. This course will focus on the dynamics of carbon and other biologically essential elements in the Earth System, on spatial scales from local to global. Prerequisites: Biology 117, Earth Systems 111, or graduate standing.
Same as: BIO 147, BIO 240, EARTHSYS 247

EARTHSYS 148. Grow it, Cook it, Eat it. An Experiential Exploration of How and Why We Eat What We Eat. 3 Units.
This course provides an introductory exploration of the social, cultural, and economic forces that influence contemporary human diets. Through the combination of interrelated lectures by expert practitioners and hands-on experience planting, tending, harvesting, cooking, and eating food from Stanford's dining hall gardens, students will learn to think critically about modern agricultural practices and the relationship between cuisine and human and ecological health outcomes. Students will also learn and apply basic practices of human-centered design to develop simple frameworks for understanding various eating behaviors in Stanford¿s dining halls and to develop and test hypotheses for how R&DE Stanford Dining might influence eating behaviors to effect better health outcomes for people and the planet. This class, which is offered through the FEED Collaborative in the School of Earth, Energy and Environmental Sciences, requires an application. For more information about the FEED Collaborative, application procedures and deadlines, and other classes we teach, please visit our website at http://feedcollaborative.org.

EARTHSYS 149. Wild Writing. 3 Units.
What is the wild? What is our relationship to nature, and why does this relationship matter? We will interrogate these questions through the work of influential, diverse, primarily American environmental writers who have given voice to many ways of knowing the wonder, fragility, complexity, and power of the natural world and have inspired readers to act on behalf of social-environmental causes. This course centers the work of diverse voices, including Indigenous, Black, and Chicana writers, enabling us to consider some of the many ways that people have understood and experienced nature throughout history and the relevance of these manifold ways of knowing to our conceptualizations of nature today. Students will develop their responses to the question of what is the wild and why it matters through a series of synchronous and asynchronous in-the-field writing exercises that integrate personal narrative 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.nIf you are interested in signing up for the course, complete this pre-registration form:nhttps://stanforduniversity.qualtrics.com/jfe/form/SV_9XqZeZs036WIvop.
Same as: EARTHSYS 249

EARTHSYS 150B. Fire: Social and Ecological Contexts of Conflagration. 3 Units.
Over 1 million acres burned from California wildland fires in 2018, yet conservative estimates suggest that four times as many acres burned annually in California preceding European colonialism. In this course we will explore how climate, land management, urban development, and human social institutions contribute to contrasts in wild and prescribed (intentional anthropogenic) fire patterns worldwide. We will investigate the socio-ecological values and harms associated with different fire and land-use policies and practices, ranging from Indigenous and small-scale contexts, conservation projects, and large-scale fire suppression efforts.
Same as: ANTHRO 150B

EARTHSYS 151. Biological Oceanography. 3-4 Units.
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 (ESS/EARTHSYS 152/252). Prerequisites: BIO 43 and ESS 8 or equivalent.
Same as: EARTHSYS 251, ESS 151, ESS 251

EARTHSYS 152. Marine Chemistry. 3-4 Units.
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 (ESS/EARTHSYS 151/251).
Same as: EARTHSYS 252, ESS 152, ESS 252

EARTHSYS 154. Intermediate Writing: Communicating Climate Change: Navigating the Stories from the Frontlines. 4 Units.
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.
Same as: PWR 91EP

EARTHSYS 155. Science of Soils. 3-4 Units.
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.
Same as: ESS 155

EARTHSYS 157. Stanford Science Podcast. 3 Units.
In this course, students will explore how podcasts can be used as a tool for effective science communication. Through a series of workshops and guest speakers, students in this course will learn the necessary journalistic and technical skills to produce high quality podcast episodes, from interviewing and storytelling to audio editing and digital publishing. Podcast episodes will highlight the cutting edge research being done at Stanford, and students will choose specific stories based on their own interests, from earth sciences to public health to big data. Final podcast episodes will be published on iTunes.
Same as: PWR 91JS

EARTHSYS 158. Geomicrobiology. 3 Units.
How microorganisms shape the geochemistry of the Earth's crust including oceans, lakes, estuaries, subsurface environments, sediments, soils, mineral deposits, and rocks. Topics include mineral formation and dissolution; biogeochemical cycling of elements (carbon, nitrogen, sulfur, and metals); geochemical and mineralogical controls on microbial activity, diversity, and evolution; life in extreme environments; and the application of new techniques to geomicrobial systems. Recommended: introductory chemistry and microbiology such as CEE 274A.
Same as: EARTHSYS 258, ESS 158, ESS 258

EARTHSYS 159. Economic, Legal, and Political Analysis of Climate-Change Policy. 5 Units.
This course will advance students understanding of economic, legal, and political approaches to avoiding or managing the problem of global climate change. Theoretical contributions as well as empirical analyses will be considered. It will address economic issues, legal constraints, and political challenges associated with various emissions-reduction and adaptation strategies, and it will consider policy efforts at the local, national, and international levels. Specific topics include: interactions among overlapping climate policies, the strengths and weaknesses of alternative policy instruments, trade-offs among alternative policy objectives, and decision making under uncertainty. Prerequisites: Econ 50 or its equivalent.
Same as: ECON 159, ECON 209, PUBLPOL 159

EARTHSYS 160. Sustainable Cities. 4-5 Units.
Community-engaged learning course that exposes students to sustainability concepts and urban planning as a tool for determining sustainable outcomes in the Bay Area. The focus will be on 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 remote team-based projects in collaboration with Bay Area community partners. Prerequisites: Consent of the instructor. (Cardinal Course certified by the Haas Center.).
Same as: URBANST 164

EARTHSYS 162. Data for Sustainable Development. 3-5 Units.
The sustainable development goals (SDGs) encompass many important aspects of human and ecosystem well-being that are traditionally difficult to measure. This project-based course will focus on ways to use inexpensive, unconventional data streams to measure outcomes relevant to SDGs, including poverty, hunger, health, governance, and economic activity. Students will apply machine learning techniques to various projects outlined at the beginning of the quarter. The main learning goals are to gain experience conducting and communicating original research. Prior knowledge of machine learning techniques, such as from CS 221, CS 229, CS 231N, STATS 202, or STATS 216 is required. Open to both undergraduate and graduate students. Enrollment limited to 24. Students must apply for the class by filling out the form at https://goo.gl/forms/9LSZF7lPkHadix5D3. A permission code will be given to admitted students to register for the class.
Same as: CS 325B, EARTHSYS 262

EARTHSYS 163. Tribal Economic Development and Sustainability. 3-5 Units.
Native Americans, Alaska Natives and Inuit are disproportionately on the forefront of climate change and are being forced to adapt to climate change now. One of the biggest challenges Indigenous Nations face is building sustainable businesses that respect the environment while providing for current and future generations. This course will survey environmental, regulatory, political and financing issues associated with economic development on tribal, Alaska Native and Inuit lands. We will examine Indigenous business success stories as well as an overview of major challenges to building sustainable businesses. We will engage with Indigenous leaders and industry experts to discuss the challenges of building businesses that provide jobs and economic opportunities for Indigenous communities now while also taking into account the responsibilities Indigenous leadership has to future generations.
Same as: NATIVEAM 162

EARTHSYS 164. Introduction to Physical Oceanography. 4 Units.
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.
Same as: CEE 162D, CEE 262D, ESS 148

EARTHSYS 168. Land Use: Planning for Equitable and Sustainable Cities. 3 Units.
Approximately 80% of Americans live in urban areas (Source: Statista, 2019) and that percentage is growing. Take a moment to wonder what makes a city, why did it develop that way, and is that a good thing? Why are homes located in a specific area and businesses or factories located in another? How did someone decide where the roads would go, how much park or open space is available to play in and can you easily walk to a bus or train to get to your destination? Did cities develop fairly, equitably, and in a sustainable manner? Answering these questions begins with an exploration of land use, a seemingly technical term that refers to the relationship between humans and the built environment. While ¿land use¿ may not be part of your daily vernacular, everyone has experienced the power of its impact. nn nnThe goal of land use planning is to maximize the health, safety, and economic well-being of residents in ways that reflect the unique needs, desires, and culture of those who live and work within the community. However, recent events have highlighted growing inequalities in American society. How have government decisions related to land use, growth, and development contributed to these growing inequalities, and can new approaches make society better? nn nnThis is an introductory course that will review the history and trends of land use policies, as well as address a number of current themes to demonstrate the power and importance of land use. Students will explore how urban areas function, how stakeholders influence land use choices, and how land use decisions contribute to positive and negative outcomes. nn nnThrough case studies, guest speakers, selective readings and interactive assignments, this survey course seeks to demystify the concept of land use for the non-city planner. By exploring the contemporary history of land use in the United States, students will learn how land use has been used as a tool for discriminatory redlining and NIMBYism. Students will learn about current land use planning efforts that seek to make cities more resilient and equitable to address issues like gentrification, environmental justice, and affordable housing.
Same as: PUBLPOL 163, URBANST 163

EARTHSYS 176. Open Space Management Practicum. 4-5 Units.
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 East Bay Regional Parks District. Grass Roots Ecology 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.nnAll students must complete the course application and turn it into Rachel Engstrand (rce212@stanford.edu) and Briana Swette (bswette@stanford.edu) by email. To receive priority consideration and an enrollment code, please submit the application by Monday September 10th, 2018. The course application consists of a short paragraph about your background and interest in and preparation for working on a real-world community-engaged earth systems project. The total course enrollment is necessarily limited by the project-based nature of the class.
Same as: EARTHSYS 276

EARTHSYS 176A. Open Space Practicum Independent Study. 1-2 Unit.
Additional practicum units for students intent on continuing their projects from EARTHSYS 176. Students who enroll in 176A must have completed EARTHSYS 176: Open Space Management Practicum, or have consent of the instructors.

EARTHSYS 177C. Specialized Writing and Reporting: Health and Science Journalism. 4-5 Units.
Practical, collaborative, writing-intensive advanced journalistic reporting and writing course in the specific practices and standards of health and science journalism. Science and journalism students learn how to identify and write engaging stories about medicine, global health, science, and related environmental issues; how to assess the quality and relevance of science news; how to cover the health and science beats effectively and efficiently; and how to build bridges between the worlds of journalism and science. Instructed Winter Quarter 2019 by Dr. Seema Yasmin, http://www.seemayasmin.com. nnnLimited enrollment: preference to students enrolled in or considering the Earth Systems Master of Arts, Environmental Communication Program and the Graduate Journalism Program. Prerequisite: EarthSys 191/291, COMM 104w, or consent of instructor. Admission by application only, available from dr.yasmin@stanford.edu (Meets Earth Systems WIM requirement.).
Same as: COMM 177C, COMM 277C, EARTHSYS 277C

EARTHSYS 179S. Seminar: Issues in Environmental Science, Technology and Sustainability. 1-2 Unit.
Invited faculty, researchers and professionals share their insights and perspectives on a broad range of environmental and sustainability issues. Students critique seminar presentations and associated readings.
Same as: CEE 179S, CEE 279S, ESS 179S

EARTHSYS 180. Principles and Practices of Sustainable Agriculture. 3-4 Units.
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. Application required. Deadline: September 10 for Autumn and March 10 for Spring. nnApplication: https://stanforduniversity.qualtrics.com/jfe/form/SV_244JnBoEP7zs8Dz.
Same as: ESS 280

EARTHSYS 181. Urban Agroecology. 3 Units.
Urban agriculture takes many forms in cities around the world and provides significant amounts of food and other resources and benefits for urban communities. This Earth Systems practicum explores the application of agroecological principles to the design and stewardship of urban farms and gardens. Students will explore social and ecological dimensions of urban agriculture including issues of environmental justice, diversity, equity, and inclusion while gaining land stewardship and small-scale food production skills at the Stanford Educational Farm.nnIn addition to online lectures and discussions, the course will be taught in-person, outdoors to small sections at the Stanford Educational Farm. Due to COVID-19, the farm is restricted in the number of people who can be on site at any one time. The class will have a lecture and discussion from 1-2pm on Mondays and students will be assigned to two hands-on sections at the farm. Section times are Mondays 2:40-4pm, Wednesdays 1-2:20pm and Wednesdays 2:40-4pm.nnSpace is very limited. Applications are due by Friday 3/19. Students will be notified if they are admitted to the course by 3/25. For the course application go to: https://stanforduniversity.qualtrics.com/jfe/form/SV_8vTDHt4B9cgfXdI.
Same as: EARTHSYS 281, ESS 181, ESS 281, URBANST 181

EARTHSYS 182. Designing Educational Gardens. 2 Units.
A project-based course emphasizing 'ways of doing 's sustainable agricultural systems based at the new Stanford Educational Farm. Students will work individually and in small groups on the design of a new educational garden and related programs for the Stanford Educational Farm. The class will meet on 6 Fridays over the course of winter quarter. Class meetings will include an introduction to designing learning gardens and affiliated programs, 3 field trips to exemplary educational gardens in the bay area that will include tours and discussions with garden educators, and work sessions for student projects. By application only.
Same as: ESS 282

EARTHSYS 182A. Ecological Farm Systems. 1-2 Unit.
An in-person, outdoor, project-based course in sustainable agricultural systems. Students will work individually or in small groups on projects at the Stanford Educational Farm. Potential projects this fall include building educational gardens, orchard establishment and management, and seedling propagation for plant donations for low-income families in partnership with Valley Verde in San Jose. Students are also encouraged to develop their own sustainable agriculture projects based on their interests.nn nnThe class will meet in-person, outdoors at the Stanford Educational Farm. Students will be required to follow farm and University COVID-19 protocols. By application only. The Winter 2021 application can be found here (Deadline Dec. 28): https://stanforduniversity.qualtrics.com/jfe/form/SV_abKbQxC1Q2cCC2h.
Same as: EARTHSYS 282A

EARTHSYS 182B. Sustainable Agriculture Projects. 1-2 Unit.
This is a project-based sustainable agriculture course. Students will work individually or in small groups on projects of their choosing at the Stanford Educational Farm or remotely. Students can develop their own projects related to sustainable agriculture and food systems or work on projects proposed by the farm team or with community partners (unfortunately we are not allowed to sponsor in-person projects in the community due to the pandemic but remote projects with community based organizations are encouraged). To apply, go to: https://stanforduniversity.qualtrics.com/jfe/form/SV_4Z8cZA4nzm3JJ0a.

EARTHSYS 183. Adaptation. 3 Units.
Adaptation is the process by which organisms or societies become better suited to their environments. In this class, we will explore three distinct but related notions of adaptation. Biological adaptations arise through natural selection, while cultural adaptations arise from a variety of processes, some of which closely resemble natural selection. A newer notion of adaptation has emerged in the context of climate change where adaptation takes on a highly instrumental, and often planned, quality as a response to the negative impacts of environmental change. We will discuss each of these ideas, using their commonalities and subtle differences to develop a broader understanding of the dynamic interplay between people and their environments. Topics covered will include, among others: evolution, natural selection, levels of selection, formal models of cultural evolution, replicator dynamics, resilience, rationality and its limits, complexity, adaptive management.
Same as: ESS 185

EARTHSYS 185. Feeding Nine Billion. 4-5 Units.
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 186. Farm and Garden Environmental Education Practicum. 2 Units.
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. Application required. Deadline: March 14.nnApplication: https://stanforduniversity.qualtrics.com/jfe/form/SV_9SPufdULCh93rbT.
Same as: EARTHSYS 286

EARTHSYS 187. FEED the Change: Redesigning Food Systems. 2-3 Units.
FEED the Change is a project-based course focused on solving real problems in the food system. Targeted at upper-class undergraduates, this course provides an opportunity for students to meet and work with thought-leading innovators, to gain meaningful field experience, and to develop connections with faculty, students, and others working to create impact in the food system. Students in the course will develop creative confidence by learning and using the basic principles and methodologies of human-centered design, storytelling, and media design. Students will also learn basic tools for working effectively in teams and for analyzing complex social systems. FEED the Change is taught at the d.school and is offered through the FEED Collaborative in the School of Earth. This class requires an application. For application information and more information about our work and about past class projects, please visit our website at http://feedcollaborative.org/classes/.

EARTHSYS 187A. The Future of Food & Farming Technology. 1 Unit.
"How are we going to feed X billion people by the year ____?" A historical refrain from corporate agribusiness, academia, national policy makers and, increasingly today, investors and technologists in innovation hotspots like Silicon Valley. But with only 60 global harvests remaining due to soil degradation, the compounding feedback loop between agriculture and climate change, and nearly a billion of our current population starving or undernourished and another billion of them overweight or obese, it begs the question of whether this is the right problem for which our food system should be solving. Some even argue, including the designers of this course, that this question is responsible for the various existential crises we face today.nnThis course will examine the history of agricultural innovation and technology to look for insights as to why our food system has gone so far off the rails. We will utilize the Stanford Educational Farm as a scaled-down model of our agricultural systems, where each student will step into the role of a modern, large scale farmer under simulated conditions. Through gamified scenarios based on real-world challenges faced by farmers, students will gain a deeper understanding of the problems facing our agriculture. Based on this nuanced understanding, students will propose new and novel uses of existing and/or emerging technologies to solve these problems. These ideas will be circulated in the marketplace of your peer farmers, where ideas will either be adopted, modified and built upon, or abandoned. This process will tap into, challenge, and hone your creative problem solving abilities. In the end, we will see who has what it takes to fundamentally shift the course of our food system,nnThis class is for students who are (a) aspiring ag-tech entrepreneurs (b) generally interested in emerging technologies or (c) seeking a deeper understanding of how large scale agriculture works.nnThe application for this course can be found on the d.school¿s website: https://dschool.stanford.edu/classes/nnCourse meets : Saturday May 4th, 10 am to 3pm, Saturday May 11th, 10am to 3pm, Saturday May 25th, 10am to 3pm.

EARTHSYS 188. Social and Environmental Tradeoffs in Climate Decision-Making. 1-2 Unit.
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.
Same as: EARTHSYS 288

EARTHSYS 190. The Multimedia Story. 2-3 Units.
Stories are how we understand ourselves and the world. This course will teach how to plan, research, report and produce a long-form, rich-media science/environment feature story. Students will work in groups or individually to master the blending of text with data visualization, photos, audio, and video. Teachers are experienced digital journalists at leading national and international publications with a close eye on trends and innovations in online, investigative, and data journalism. nnUsing the landmark New York Times story "Snow Fall" (http://nyti.ms/1eTyf2Y) as a departure point, the course will examine the questions: how do we engage and inform the public around critical environmental topics? nnHow do we explain complex and sometimes hidden factors shaping the future of our world? Students are asked to express interest through this form: http://goo.gl/rDQogB.

EARTHSYS 191. Concepts in Environmental Communication. 3 Units.
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 scope of research and practice in environmental communication. Intended for graduate students and advanced undergraduates, with a background in Earth or environmental science and/or policy studies, or in communication or journalism studies with a specific interest in environmental and science communication. Prerequisite: Earth Systems core (EarthSys 111 and EarthSys 112) or equivalent. (Meets Earth Systems WIM requirement.).
Same as: EARTHSYS 291

EARTHSYS 193. Natural Perspectives: Geology, Environment, and Art. 1 Unit.
Multi-day field trip that combines exploration of regional geology, ecology, and environmental history with guided drawing exercises in the Eastern Sierra Nevada of California. 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. Preference for freshmen and sophomores.
If you are interested in signing up for the course, complete this pre-registration form: https://stanforduniversity.qualtrics.com/SE/?SID=SV_9RF2rDopROzwOxf.
Same as: EARTH 193

EARTHSYS 194. Topics in Writing & Rhetoric: Introduction to Environmental Justice: Race, Class, Gender and Place. 4 Units.
This course examines the rhetoric, history and key case studies of environmental justice while encouraging critical and collaborative thinking, reading and researching about diversity in environmental movements within the global community and at Stanford, including the ways race, class and gender have shaped environmental battles still being fought today. We center diverse voices by bringing leaders, particularly from marginalized communities on the frontlines to our classroom to communicate experiences, insights and best practices. Together we will develop and present original research projects which may serve a particular organizational or community need, such as racialized dispossession, toxic pollution and human health, or indigenous land and water rights, among many others. Prerequisite: PWR 2.
Same as: ENVRES 223, PWR 194EP

EARTHSYS 194A. Environmental Justice Colloquium. 1 Unit.
This colloquium brings the voices and vision of leading Environmental Justice (EJ) advocates to the Stanford community, in order to educate, inspire, and transform our understanding of environmental science. Environmental Justice advances a positive vision for policies and actions that fight environmental racism. EJ approaches involve centering the voices and leadership of marginalized communities in 1) ensuring equitable access to environmental benefits, and 2) preventing or mitigating the disproportionate impacts of environmental harms for all communities, regardless of gender, class, race, ethnicity, or other social positions. This colloquium highlights the work of leading EJ thinkers and practitioners, speaking from frontline organizations on a wide range of topics. These topics include acting on toxic exposures and health disparities for community resilience, climate justice and youth action, Indigenous land and water rights, green cities and Afrofuturism, food justice and intersecting social movements, queer ecologies, and more. The colloquium will host a weekly speaker, and final symposium at the end of the quarter. nnThe first meeting for this course will take place during WEEK 3.
Same as: HUMRTS 194A, URBANST 155A

EARTHSYS 196. Implementing Climate Solutions at Scale. 3 Units.
Climate change is the biggest problem humanity has ever faced, and this course will teach students about the means and complexity of solving it. The instructors will guide the students in the application of key data and analysis tools for their final project, which will involve developing integrated plans for eliminating greenhouse gas emissions (100% reductions) by 2050 for a country, state, province, sector, or industry.
Same as: EARTHSYS 296

EARTHSYS 196A. Environmental Justice and Human Rights Lab. 1 Unit.
The Environmental Justice and Human Rights Lab is an intellectual hub and supportive learning community for students engaging in environmental justice and human rights work of any kind. Environmental justice (EJ) advances a positive vision for policies and actions that fight environmental racism, and human rights (HR) center on the notion that all people, by virtue of their existence and regardless of any given status or classification, are equally entitled to fundamental rights and protections. Our semi-structured weekly sessions will foster an open learning environment for students and peer-to-peer learning connections. Sessions will include giving and receiving feedback on capstone or community-based projects, independent research, or other relevant coursework or extracurricular activity. We also welcome students who are new to these topics and would like to learn more. We are open to students of all backgrounds and disciplines at any stage of their research or project work. Following EJ and HR principles, we seek to center local, contextualised knowledge and leadership through ethical research partnerships with community members. To do so, we follow community-based participatory research approaches and decolonizing methodologies. Examples of our work to date include 1) enabling graduate students to effectively bring EJ and HR approaches into dissertation research, 2) supporting campus leaders and directly participating in diversity, equity, and inclusion (DEI) initiatives, and 3) educating and learning from one another about critical EJ and HR scholarship and anti-racist approaches to our work. Lab interests include addressing inequitable impacts of climate change, advancing decolonial approaches to land and water management, promoting food justice, combatting human trafficking and labor exploitation, promoting fair and just immigration policies, and additional EJ and HR research topics. Note that this lab is intended as an open space for engagement. If you are unable to enroll for credit, but would still like to participate, please email humanrights@stanford.edu.
Same as: HUMRTS 196

EARTHSYS 197. Directed Individual Study in Earth Systems. 1-9 Unit.
Under supervision of an Earth Systems faculty member on a subject of mutual interest.

EARTHSYS 198. Seminar on Philosophy, Politics, and the Environment. 1 Unit.
Much public discourse that touches upon the relationship of human society to the natural environment acknowledges the fundamental connection between people and the environment, but avoids or simplifies discussion of broader philosophical and political views of what this relationship is, has been, and ought to be. Expansive conceptual categories of the study of politics, economics, and society, such as capitalism, socialism, democracy, human welfare, and distribution, are often left out entirely, or used quickly and not defined clearly. In thinking big about human society and the natural world, what is ideal, and what is possible? This once-weekly seminar aims to help students develop the breadth and depth of their thinking about the relationship of human society to nature at the level of political, social, and economic philosophy. It will provide an organized setting for the understanding and critical discussion of these abstract but sometimes world-shaping ideas. Particular attention will be paid to the wide range of such views put forth in recent history, the various assumptions built into each view, and to the differing levels of influence and political effectiveness achieved by each. Discussions will be based on a weekly reading from a philosophically oriented work about humanity and the environment, such as a book chapter or a piece of long-form journalism. Grading/credit based on weekly participation and a short reflective paper.
Same as: EARTHSYS 298

EARTHSYS 199. Honors Program in Earth Systems. 1-9 Unit.
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EARTHSYS 200. Environmental Communication in Action: The SAGE Project. 3 Units.
This course is focused on writing about sustainability for a public audience through an ongoing project, SAGE (Sound Advice for a Green Earth), that is published by Stanford Magazine. Students contribute to 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 201. Editing for Publication. 2 Units.
Most student writing experiences end with a "final" written draft, but that leaves out crucial steps in the publication process. In this course, advanced students take responsibility for final editing and publication of the environmental advice column SAGE, starting with answers researched and written by students in EARTHSYS 200. Topics include developmental editing and project management for the SAGE project, structural editing for overall organization and impact of individual pieces, line editing for clarity and style, and fact checking and copy editing for accuracy and consistency.

EARTHSYS 204. The Water Course. 4 Units.
The Central Valley of California provides a third of the produce grown in the U.S., but recent droughts and increasing demand have raised concerns about both food and water security. The pathway that water takes from rainfall to the irrigation of fields or household taps (¿the water course¿) determines the quantity and quality of the available water. Working with various data sources (measurements made on the ground, in wells, and from satellites) allows us to model the water budget in the valley and explore the recent impacts on freshwater supplies.
Same as: EARTHSYS 104, GEOPHYS 104, GEOPHYS 204

EARTHSYS 205. Food and Community: Food Security, Resilience and Equity. 2-3 Units.
What can communities do to bolster food security, resiliency, and equity in the face of climate change? This course aims to respond to this question, in three parts. In Part 1, we will explore the most current scientific findings on trends in anthropogenic climate forcing and the anticipated impacts on global and regional food systems. Specifically, Part I will review the anticipated impact of climate change on severe weather events, crop losses, and food price volatility and the influence of these impacts on global and regional food insecurity and hunger. In Part II, we will consider what communities can do to promote food security and equity in the face of these changes, by reviewing the emerging literature on food system resiliency. Finally, we will facilitate a conference in which multi-disciplinary teams from around the country will gather to initiate regional planning projects designed to enhance food system resilience and equity. Cardinal Course (certified by Haas Center). Limited enrollment. May be repeated for credit.
Same as: EARTHSYS 105

EARTHSYS 205A. Fundamentals of Geobiology. 3 Units.
Lecture and discussion covering key topics in the history of life on Earth, as well as basic principles that apply to life in the universe. 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.
Same as: ESS 205, GEOLSCI 205

EARTHSYS 205VP. Contested markets in the Brazilian Amazon Rainforest. 2-3 Units.
Strategies of environmental movements to contain domestic and foreign corporations that are viewed as major perpetrators of rainforest devastation and the socio-economic degradation of this vast region. Topics: Origins, roles and inter-relations among corporations (zero deforestation agreements in soybean agriculture and cattle ranching), the development of environmental law and the efficacy of government and NGO movements¿ strategies, and whether this emerging economy shapes social classes, groups, tribes, family life to further embed inequality and immobility. This course must be taken for a minimum of 3 units and a letter grade to be eligible for Ways credit.
Same as: SOC 105VP, SOC 205VP

EARTHSYS 206. World Food Economy. 5 Units.
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. Grades based on mid-term exam and group modeling project and presentation. Enrollment is by application only and will be capped at 25, with priority given to upper level undergraduates in Economics and Earth Systems and graduate students (graduate students enroll in 206). Application found at https://economics.stanford.edu/academics/undergraduate-program/forms.
Same as: EARTHSYS 106, ECON 106, ECON 206, ESS 106, ESS 206

EARTHSYS 206B. Sustainable and Equitable Water Management. 3-4 Units.
California has committed itself to sustainable groundwater management, with passage of the Sustainable Groundwater Management Act in 2014, and safe drinking water access for all, with California's Human Right to Water Act in 2012. Yet, groundwater overdraft continues while over 1 million residents lack access to safe drinking water. Working with a water agency in the San Joaquin Valley, we will explore feedback loops between the two Acts and develop a plan for water management that meet the co-equal objectives of sustainable and equitable resource governance. We will work with "big" and "small" data, exploring the possibilities but also the limitations of using publicly available data for assessment and monitoring. The course will include guest speakers and interaction with public agencies and other key stakeholders.nThis is a Cardinal Course certified by the Haas Center.
Same as: EARTHSYS 106B, GEOPHYS 106, GEOPHYS 206

EARTHSYS 207. Spanish in Science/Science in Spanish. 2 Units.
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.
Same as: BIO 208, LATINAM 207

EARTHSYS 209. Rethinking Meat: An Introduction to Alternative Proteins. 1 Unit.
How do we feed a growing population in the face of climate change? Will Impossible Burgers become the new norm? Are you curious to learn about a frontier in bio- and chemical-engineering? Are you passionate about animal rights, human health, and sustainable agriculture? Learn about the environmental, ethical, and economic drivers behind the market for meat replacements. We'll take a deep dive into the science and technology used to develop emerging plant, fermentation and cell-based meat alternatives and explore the political challenges and behavioral adaptation needed to decrease meat consumption. Hear from entrepreneurs, researchers, and innovative startups developing sustainable and marketable alternative proteins through weekly guest lectures from industry leaders.
Same as: EARTHSYS 109, ESS 103, ESS 203, ETHICSOC 107

EARTHSYS 210A. Senior Capstone and Reflection. 3 Units.
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. Prerequisite: Completion of an approved Earth Systems internship (EARTHSYS 260).

EARTHSYS 210B. Senior Capstone and Reflection. 3 Units.
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. Prerequisite: Completion of an approved Earth Systems internship (EARTHSYS 260).

EARTHSYS 210P. Earth Systems Capstone Project. 2 Units.
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. Prerequisite: EARTHSYS 210A, B, or C.

EARTHSYS 211. Fundamentals of Modeling. 3-5 Units.
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.
Same as: ESS 211

EARTHSYS 212. Human Society and Environmental Change. 4 Units.
Interdisciplinary approaches to understanding human-environment interactions with a focus on economics, policy, culture, history, and the role of the state. Prerequisite: ECON 1.
Same as: EARTHSYS 112, ESS 112, HISTORY 103D

EARTHSYS 214. Global Change and Emerging Infectious Disease. 3 Units.
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, plague, and HIV.
Same as: EARTHSYS 114, ESS 213, HUMBIO 114

EARTHSYS 217. Biology and Global Change. 4 Units.
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 BIO 81 or graduate standing.
Same as: BIO 117, EARTHSYS 111, ESS 111

EARTHSYS 219. Will Work for Food. 1 Unit.
This is a speaker series class featuring highly successful innovators in the food system. Featured speakers will talk in an intimate, conversational manner about their current work, as well as about their successes, failures, and learnings along the way. Additional information can be found here: http://feedcollaborative.org/speaker-series/.
Same as: EARTHSYS 119

EARTHSYS 223. Biosphere-Atmosphere Interactions. 3-4 Units.
How do ecosystems respond to climate, and how do ecosystems influence climate? Covers the role of the terrestrial land surface in earth's climate system, including among others photosynthesis, transpiration, greenhouse gasses, radiation, and atmospheric water vapor. For each of these topics, attention is paid to both the underlying processes and how they can be mathematically represented in earth system models. Instruments and techniques used to measure these processes are also discussed, and, where appropriate, demonstrated.
Same as: EARTHSYS 123A, ESS 123, ESS 223

EARTHSYS 225. Shades of Green: Exploring and Expanding Environmental Justice in Practice. 3-4 Units.
Historically, discussions of race, ethnicity, culture, and equity in the environment have been shaped by a limited view of the environmental justice movement, often centered on urban environmental threats and separated from other types of environmental and climate advocacy. This course will seek to expand on these discussions by exploring topics such as access to outdoor spaces, definitions of wilderness, inclusion in environmental organizations, gender and the outdoors, the influence of colonialism on ways of knowing, food justice and ethics, and the future of climate change policy. The course will also involve a community partnership project. In small groups students will work with an environmental organization to problem-solve around issues of equity, representation, and access. We value a diversity of experiences and epistemologies and welcome undergraduates from all disciplines. Since this is a practical course, there will be a strong emphasis on participation and commitment to community partnerships. This course requires instructor approval, please submit an application by March 16th at midnight. Application available at https://forms.gle/chBoCLX3WKSA7kBF6.
Same as: CSRE 125E, EARTHSYS 125, URBANST 125

EARTHSYS 227. Decision Science for Environmental Threats. 3-5 Units.
Decision science is the study of how people make decisions. It aims to describe these processes in ways that will help people make better or more well-informed decisions. It is an interdisciplinary field that draws upon psychology, economics, political science, and management, among other disciplines. It is being used in a number of domain areas and for a variety of applications, including managing freshwater resources, designing decision support tools to aid in coastal adaptation to sea-level rise, and creating "nudges" to enhance energy efficiency behaviors. This course covers behavioral theories of probabilistic inference, intuitive prediction, preference, and decision making. Topics include heuristics and biases, risk perceptions and attitudes, strategies for combining different sources of information and dealing with conflicting objectives, and the roles of group and emotional processes in decision making. This course will introduce students to foundational theories of decision science, and will involve applying these theories to understand decisions about environmental threats.
Same as: ESS 227

EARTHSYS 232. Evolution of Earth Systems. 4 Units.
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.
Same as: EARTHSYS 132, ESS 132, ESS 232, GEOLSCI 132, GEOLSCI 232

EARTHSYS 233. Mitigating Climate Change through Soil Management. 2 Units.
Climate change is one of the greatest crises facing our world. Increasing soil organic carbon storage may be a key strategy for mitigating global climate change, with the potential to offset approximately 20% of annual global fossil fuel emissions. In this course, we will learn about soil carbon cycling, its contribution to the global carbon cycle, how carbon is stored in soil, and land management practices that can increase or decrease soil carbon stocks, thereby mitigating or exacerbating climate change. Although the content is centered on soil carbon, the processes and skills learned in this course can be applied to design solutions to any environmental problem.nnPrerequisites: Some knowledge of soils, introductory chemistry, and introductory biology would be useful but not necessary. Please email the instructor if you have any concerns or questions.
Same as: ESS 233

EARTHSYS 235. Podcasting the Anthropocene. 3 Units.
The Anthropocene refers to the proposed geologic age defined by the global footprint of humankind. It's an acknowledgement of the tremendous influence people and societies exert on Earth systems. Students taking the course will identify a subject expert, workshop story ideas with fellow students and instructors, conduct interviews, iteratively write audio scripts, and learn the skills necessary to produce final audio podcast as their final project. Our expectation is that the final projects will be published on the award-winning Generation Anthropocene podcast, with possible opportunities to cross post in collaboration with external media partners. Students taking EARTHSYS 135/235 are strongly encouraged to take EARTHSYS 135A/235A beforehand. Meets Earth Systems WIM requirement. (Cardinal Course certified by the Haas Center).

EARTHSYS 236. The Ethics of Stewardship. 2-3 Units.
What responsibilities do humans have to nonhuman nature and future generations? How are human communities and individuals shaped by their relationships with the natural world? What are the social, political, and moral ramifications of drawing sustenance and wealth from natural resources? Whether we realize it or not, we grapple with such questions every time we turn on the tap, fuel up cars, or eat meals -and they are key to addressing issues like global climate change and environmental justice. In this class, we consider several perspectives on this ethical question of stewardship: the role of humans in the global environment. In addition to reading written work and speaking with land stewards, we will practice stewardship at the Stanford Educational Farm. This course must be taken for a minimum of 3 units and a letter grade to be eligible for Ways credit.
Same as: EARTHSYS 136

EARTHSYS 238. Land Use Law. 3 Units.
(Same as LAW 2505.) This course focuses on the pragmatic (more than theoretical) aspects of contemporary land use law and policy, including: the tools and legal foundation of modern land use law; the process of land development; vested property rights, development agreements, and takings; growth control, sprawl, and housing density; and direct democracy over land use. We explore how land use decisions affect environmental quality and how land use decision-making addresses environmental impacts. Special Instructions: All graduate students from other departments are encouraged to enroll, and no pre-requisites apply. Student participation is essential. Roughly two-thirds of the class time will involve a combination of lecture and classroom discussion. The remaining time will engage students in case studies based on actual land use issues and disputes. Elements used in grading: Attendance, class participation, writing assignments, and final exam. Elements used in grading: Attendance, Class Participation, Final Exam.

EARTHSYS 239. Ecosystem Services: Frontiers in the Science of Valuing Nature. 3 Units.
This course explores the science of valuing nature, beginning with its historical origins and then a primary focus on its recent development and frontiers. The principal aim of the course is to enable new research and real-world applications of InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) tools and approaches. We will discuss the interconnections between people and nature and key research frontiers, such as in the realms of biodiversity, resilience, human health, poverty alleviation, and sustainable development. The science we¿ll explore is in the service of decisions, and we will use examples from real life to illustrate why this science is so critical to informing why, where, how, and how much people need nature. Prerequisite. Basic to intermediate GIS skills are required (including working with raster, vector and tabular data; loading and editing rasters, shapefiles, and tables into a GIS; understanding coordinate systems; and performing basic raster math).
Same as: BIO 138, BIO 238, EARTHSYS 139

EARTHSYS 240. Data science for geoscience. 3 Units.
This course provides an overview of the most relevant areas of data science (applied statistics, machine learning & computer vision) to address geoscience challenges, questions and problems. Using actual geoscientific research questions as background, principles and methods of data scientific analysis, modeling, and prediction are covered. Data science areas covered are: extreme value statistics, multi-variate analysis, factor analysis, compositional data analysis, spatial information aggregation models, spatial estimation, geostatistical simulation, treating data of different scales of observation, spatio-temporal modeling (geostatistics). Application areas covered are: process geology, hazards, natural resources. Students are encouraged to participate actively in this course by means of their own data science research challenge or question.
Same as: ENERGY 240, ESS 239, GEOLSCI 240

EARTHSYS 241. Remote Sensing of the Oceans. 3-4 Units.
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.
Same as: EARTHSYS 141, ESS 141, ESS 241, GEOPHYS 141

EARTHSYS 242. Remote Sensing of Land. 4 Units.
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.
Same as: EARTHSYS 142, ESS 162, ESS 262

EARTHSYS 243. Environmental Advocacy and Policy Communication. 3 Units.
Although environmental science suggests that coordinated policy action is critically necessary to address a host of pressing issues - from global climate change to marine pollution to freshwater depletion - governments have been slow to act. This course focuses on the translation of environmental science to public discourse and public policy, with an emphasis on the causes of our current knowledge-to-action gap and policy-sphere strategies to address it. We will read classic works of environmental advocacy, map our political system and the public relations and lobbying industries that attempt to influence it, grapple with analytical perspectives on effective and ethical environmental policy communication, engage with working professionals in the field, learn effective strategies for written and oral communication with policymakers, and write and workshop op-eds.nnApplication required. Deadline Dec. 1. nApply here: https://stanforduniversity.qualtrics.com/jfe/form/SV_4IuQC5BcQdn3j6Z¿.

EARTHSYS 243H. Quantitative methods for marine ecology and conservation. 4 Units.
The goal of this course is to learn the foundations of ecological modelling with a specific (but not exclusive) focus on marine conservation and sustainable exploitation of renewable resources. Students will be introduced to a range of methods ¿ from basic to advanced ¿to characterize population structure, conduct demographic analyses, estimate extinction risk, identify temporal trends and spatial patterns, quantify the effect of environmental determinants and anthropogenic pressures on the dynamics of marine populations, describe the potential for adaptation to climate change. This course will emphasize learning by doing, and will rely heavily on practical computer laboratories, in R and/or Phyton, based on data from our own research activities or peer reviewed publications. Students with a background knowledge of statistics, programming and calculus will be most welcome.
Same as: BIOHOPK 143H, BIOHOPK 243H, CEE 164H, CEE 264H, EARTHSYS 143H

EARTHSYS 247. Ecosystem Ecology and Biogeochemistry. 3 Units.
An introduction to ecosystem ecology and terrestrial biogeochemistry. This course will focus on the dynamics of carbon and other biologically essential elements in the Earth System, on spatial scales from local to global. Prerequisites: Biology 117, Earth Systems 111, or graduate standing.
Same as: BIO 147, BIO 240, EARTHSYS 147

EARTHSYS 249. Wild Writing. 3 Units.
What is the wild? What is our relationship to nature, and why does this relationship matter? We will interrogate these questions through the work of influential, diverse, primarily American environmental writers who have given voice to many ways of knowing the wonder, fragility, complexity, and power of the natural world and have inspired readers to act on behalf of social-environmental causes. This course centers the work of diverse voices, including Indigenous, Black, and Chicana writers, enabling us to consider some of the many ways that people have understood and experienced nature throughout history and the relevance of these manifold ways of knowing to our conceptualizations of nature today. Students will develop their responses to the question of what is the wild and why it matters through a series of synchronous and asynchronous in-the-field writing exercises that integrate personal narrative 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.nIf you are interested in signing up for the course, complete this pre-registration form:nhttps://stanforduniversity.qualtrics.com/jfe/form/SV_9XqZeZs036WIvop.
Same as: EARTHSYS 149

EARTHSYS 250. Directed Research. 1-9 Unit.
Independent research. Student develops own project with faculty supervision. May be repeated for credit.

EARTHSYS 251. Biological Oceanography. 3-4 Units.
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 (ESS/EARTHSYS 152/252). Prerequisites: BIO 43 and ESS 8 or equivalent.
Same as: EARTHSYS 151, ESS 151, ESS 251

EARTHSYS 252. Marine Chemistry. 3-4 Units.
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 (ESS/EARTHSYS 151/251).
Same as: EARTHSYS 152, ESS 152, ESS 252

EARTHSYS 254. Environmental Governance. 3 Units.
How do we work together to solve environmental problems? Across the globe, who has a voice, and who ultimately decides how to balance conservation and development? How do we build governance institutions that facilitate both environmental sustainability and social equity? This seminar on environmental governance will focus on the challenges and opportunities for managing common-pool resources, like fisheries, forests, and water. Because managing environmental resources is often about managing people, we will explore the motivations underlying human behavior towards the environment. We will discuss how institutions encode our cultural values and beliefs, and how we can reshape these institutions to achieve more sustainable outcomes. Coursework includes foundational readings and a pragmatic exploration of case studies. Teaching cases address topics in community-based conservation, international protected areas, market-based approaches, coping with environmental risk, and other themes. Interested undergraduate and graduate students from any discipline are welcome.
Same as: ENVRES 250

EARTHSYS 255. Microbial Physiology. 3 Units.
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.
Same as: BIO 180, ESS 255, GEOLSCI 233A

EARTHSYS 256. Soil and Water Chemistry. 3 Units.
(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.
Same as: ESS 256

EARTHSYS 258. Geomicrobiology. 3 Units.
How microorganisms shape the geochemistry of the Earth's crust including oceans, lakes, estuaries, subsurface environments, sediments, soils, mineral deposits, and rocks. Topics include mineral formation and dissolution; biogeochemical cycling of elements (carbon, nitrogen, sulfur, and metals); geochemical and mineralogical controls on microbial activity, diversity, and evolution; life in extreme environments; and the application of new techniques to geomicrobial systems. Recommended: introductory chemistry and microbiology such as CEE 274A.
Same as: EARTHSYS 158, ESS 158, ESS 258

EARTHSYS 260. Internship. 1 Unit.
Supervised field, lab, or public/private sector project. May consist of directed research under the supervision of a Stanford faculty member, participation in one of several off campus Stanford programs, or an approved non-Stanford program or opportunity relevant to the student's Earth Systems studies. Required of and restricted to declared Earth Systems majors. This is a 1 unit, credit/no credit course, consisting of at least 270 hours of work. Course can be fulfilled any quarter. For more course requirements, please visit: https://earth.stanford.edu/esys/undergrad/internship.

EARTHSYS 262. Data for Sustainable Development. 3-5 Units.
The sustainable development goals (SDGs) encompass many important aspects of human and ecosystem well-being that are traditionally difficult to measure. This project-based course will focus on ways to use inexpensive, unconventional data streams to measure outcomes relevant to SDGs, including poverty, hunger, health, governance, and economic activity. Students will apply machine learning techniques to various projects outlined at the beginning of the quarter. The main learning goals are to gain experience conducting and communicating original research. Prior knowledge of machine learning techniques, such as from CS 221, CS 229, CS 231N, STATS 202, or STATS 216 is required. Open to both undergraduate and graduate students. Enrollment limited to 24. Students must apply for the class by filling out the form at https://goo.gl/forms/9LSZF7lPkHadix5D3. A permission code will be given to admitted students to register for the class.
Same as: CS 325B, EARTHSYS 162

EARTHSYS 263F. Groundwork for COP21. 1 Unit.
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 272. Antarctic Marine Geology and Geophysics. 3 Units.
For upper-division undergraduates and graduate students. Intermediate and advanced topics in marine geology and geophysics, focusing on examples from the Antarctic continental margin and adjacent Southern Ocean. Topics: glaciers, icebergs, and sea ice as geologic agents (glacial and glacial marine sedimentology, Southern Ocean current systems and deep ocean sedimentation), Antarctic biostratigraphy and chronostratigraphy (continental margin evolution). Students interpret seismic lines and sediment core/well log data. Examples from a recent scientific drilling expedition to Prydz Bay, Antarctica.
Same as: ESS 242

EARTHSYS 276. Open Space Management Practicum. 4-5 Units.
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 East Bay Regional Parks District. Grass Roots Ecology 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.nnAll students must complete the course application and turn it into Rachel Engstrand (rce212@stanford.edu) and Briana Swette (bswette@stanford.edu) by email. To receive priority consideration and an enrollment code, please submit the application by Monday September 10th, 2018. The course application consists of a short paragraph about your background and interest in and preparation for working on a real-world community-engaged earth systems project. The total course enrollment is necessarily limited by the project-based nature of the class.
Same as: EARTHSYS 176

EARTHSYS 276A. Open Space Practicum Independent Study. 1-2 Unit.
Additional practicum units for students intent on continuing their projects from EARTHSYS 276. Students who enroll in 276A must have completed EARTHSYS 276: Open Space Management Practicum, or have consent of the instructors.

EARTHSYS 277C. Specialized Writing and Reporting: Health and Science Journalism. 4-5 Units.
Practical, collaborative, writing-intensive advanced journalistic reporting and writing course in the specific practices and standards of health and science journalism. Science and journalism students learn how to identify and write engaging stories about medicine, global health, science, and related environmental issues; how to assess the quality and relevance of science news; how to cover the health and science beats effectively and efficiently; and how to build bridges between the worlds of journalism and science. Instructed Winter Quarter 2019 by Dr. Seema Yasmin, http://www.seemayasmin.com. nnnLimited enrollment: preference to students enrolled in or considering the Earth Systems Master of Arts, Environmental Communication Program and the Graduate Journalism Program. Prerequisite: EarthSys 191/291, COMM 104w, or consent of instructor. Admission by application only, available from dr.yasmin@stanford.edu (Meets Earth Systems WIM requirement.).
Same as: COMM 177C, COMM 277C, EARTHSYS 177C

EARTHSYS 281. Urban Agroecology. 3 Units.
Urban agriculture takes many forms in cities around the world and provides significant amounts of food and other resources and benefits for urban communities. This Earth Systems practicum explores the application of agroecological principles to the design and stewardship of urban farms and gardens. Students will explore social and ecological dimensions of urban agriculture including issues of environmental justice, diversity, equity, and inclusion while gaining land stewardship and small-scale food production skills at the Stanford Educational Farm.nnIn addition to online lectures and discussions, the course will be taught in-person, outdoors to small sections at the Stanford Educational Farm. Due to COVID-19, the farm is restricted in the number of people who can be on site at any one time. The class will have a lecture and discussion from 1-2pm on Mondays and students will be assigned to two hands-on sections at the farm. Section times are Mondays 2:40-4pm, Wednesdays 1-2:20pm and Wednesdays 2:40-4pm.nnSpace is very limited. Applications are due by Friday 3/19. Students will be notified if they are admitted to the course by 3/25. For the course application go to: https://stanforduniversity.qualtrics.com/jfe/form/SV_8vTDHt4B9cgfXdI.
Same as: EARTHSYS 181, ESS 181, ESS 281, URBANST 181

EARTHSYS 282A. Ecological Farm Systems. 1-2 Unit.
An in-person, outdoor, project-based course in sustainable agricultural systems. Students will work individually or in small groups on projects at the Stanford Educational Farm. Potential projects this fall include building educational gardens, orchard establishment and management, and seedling propagation for plant donations for low-income families in partnership with Valley Verde in San Jose. Students are also encouraged to develop their own sustainable agriculture projects based on their interests.nn nnThe class will meet in-person, outdoors at the Stanford Educational Farm. Students will be required to follow farm and University COVID-19 protocols. By application only. The Winter 2021 application can be found here (Deadline Dec. 28): https://stanforduniversity.qualtrics.com/jfe/form/SV_abKbQxC1Q2cCC2h.
Same as: EARTHSYS 182A

EARTHSYS 282B. Sustainable Agriculture Projects. 1-2 Unit.
This is a project-based sustainable agriculture course. Students will work individually or in small groups on projects of their choosing at the Stanford Educational Farm or remotely. Students can develop their own projects related to sustainable agriculture and food systems or work on projects proposed by the farm team or with community partners (unfortunately we are not allowed to sponsor in-person projects in the community due to the pandemic but remote projects with community based organizations are encouraged). To apply, go to: https://stanforduniversity.qualtrics.com/jfe/form/SV_4Z8cZA4nzm3JJ0a.
Same as: EARTHSYS 182B

EARTHSYS 286. Farm and Garden Environmental Education Practicum. 2 Units.
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. Application required. Deadline: March 14.nnApplication: https://stanforduniversity.qualtrics.com/jfe/form/SV_9SPufdULCh93rbT.
Same as: EARTHSYS 186

EARTHSYS 288. Social and Environmental Tradeoffs in Climate Decision-Making. 1-2 Unit.
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.
Same as: EARTHSYS 188

EARTHSYS 289. FEED Lab: Food System Design & Innovation. 3-4 Units.
FEED Lab is a course in which entrepreneurial and motivated students, engaged industry-thought leaders, and deeply experienced and connected faculty work together to design solutions to some of the food system's most consequential problems. Whether you're passionate about transforming the food system, or merely curious explore it, all students in this course will leave with practical design skills, enhanced leadership abilities, and confidence that their work will leave a lasting impact on the organizations with whom we collaborate. Students who complete this course gain access to the broad network of the FEED Collaborative, whose mission is to equip and inspire the next generation of leaders in the food system, and to connect them to meaningful opportunities after Stanford. To learn more about the FEED Collaborative, visit https://feedcollab.stanford.edu/. This course requires an application, which can be found here: https://forms.gle/5Rd93yVg8XjRCig26.
Same as: SUST 231

EARTHSYS 289A. FEED Lab: Food System Design & Innovation. 3-4 Units.
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 289B. FEED Lab: Food System Design & Innovation. 3-4 Units.
Primarily a follow-on course to EARTHSYS 289A, this course is an experiential education platform that enables students already experienced in design thinking to collaborate with faculty and industry thought-leaders on projects of real consequence in the local food system. A select cohort of students will work in small, diverse teams and will interact closely with the teaching team in an intentionally creative and informal classroom setting. Students will deepen their skills in design thinking and social entrepreneurship by working on projects sponsored by leading innovators in the FEED Collaborative's network. Some projects may turn into summer internships or research projects for students interested in continuing their work. Admission is by application: http://feedcollaborative.org/classes/.

EARTHSYS 290. Master's Seminar. 2 Units.
Required of and open only to Earth Systems co-terminal MS and MA students. This remote course has several elements, including, skill building through experiential learning and reflection and professional development. Students will either work in teams with a community partner in the Bay area on a predetermined project, or select a self-designed project with a partner anywhere in the world. The idea is to complete a well-defined, manageable, but important project to a high standard under significant time constraints. Our community partners have requested help with achieving their missions and seminar students will utilize their backgrounds in social/environmental problem solving to deliver a final product. Our partners have requested help with such efforts as grant and report writing, data analysis, curriculum development, symposium organizing, presentation research and preparation and communications to raise awareness about an environmental challenge. If you choose to design your own project, the instructor will help you to create this opportunity. Students will give oral presentations on their project progress throughout the quarter, culminating in a final presentation at a symposium with our partners. Students will also explore how best to communicate their interdisciplinary skills and goals through their resumes, cv¿s or cover letters, portfolios or linkedIn profiles in preparation for the next phase of their career. Guest speakers and in class workshops will complement these activities.

EARTHSYS 291. Concepts in Environmental Communication. 3 Units.
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 scope of research and practice in environmental communication. Intended for graduate students and advanced undergraduates, with a background in Earth or environmental science and/or policy studies, or in communication or journalism studies with a specific interest in environmental and science communication. Prerequisite: Earth Systems core (EarthSys 111 and EarthSys 112) or equivalent. (Meets Earth Systems WIM requirement.).
Same as: EARTHSYS 191

EARTHSYS 292. Multimedia Environmental Communication. 3 Units.
Introductory theory and practice of effective, accurate and engaging use of photography, audio and video production in communicating environmental science and policy concepts to the public. Emphasis on fundamental techniques, storytelling and workflow more than technical how to or gear. Includes extensive instructor and peer critiquing of work and substantial out-of-class group project work. Limited class size, preference to Earth Systems master's students. No previous multimedia experience necessary.

EARTHSYS 293. Environmental Communication Practicum. 1-5 Unit.
Students complete an internship or similar practical experience in a professional environmental communication setting. Potential placements include environmental publications, environmental or outdoor education placements, NGOs, government agencies, on-campus departments, programs, or centers, and science centers and museums. Restricted to students admitted to the Earth Systems Master of Arts, Environmental Communication Program. Can be completed in any quarter.

EARTHSYS 294. Environmental Communication Capstone. 1-3 Unit.
The Earth Systems Master of Arts, Environmental Communication capstone project provides students with an opportunity to complete an ambitious independent project demonstrating mastery of an area of environmental communication. Capstone projects are most often applied communication projects such as writing, photography, or video projects; expressive or artistic works; or student-initiated courses, workshops, or curriculum materials. Projects focused on academic scholarship or communication theory research may also be considered. Restricted to students enrolled in the Earth Systems Master of Arts, Environmental Communication Program.

EARTHSYS 295. Environmental Communication Seminar. 1 Unit.
Weekly seminar for students enrolled in the Earth Systems Master of Arts, Environmental Communication Program, to be taken twice for credit during degree progress. Includes discussion of and reflection on current topics in environmental communication, skills and professional development workshop sessions, and mentoring and peer support for MA capstone projects.

EARTHSYS 296. Implementing Climate Solutions at Scale. 3 Units.
Climate change is the biggest problem humanity has ever faced, and this course will teach students about the means and complexity of solving it. The instructors will guide the students in the application of key data and analysis tools for their final project, which will involve developing integrated plans for eliminating greenhouse gas emissions (100% reductions) by 2050 for a country, state, province, sector, or industry.
Same as: EARTHSYS 196

EARTHSYS 297. Directed Individual Study in Earth Systems. 1-9 Unit.
Under supervision of an Earth Systems faculty member on a subject of mutual interest.

EARTHSYS 298. Seminar on Philosophy, Politics, and the Environment. 1 Unit.
Much public discourse that touches upon the relationship of human society to the natural environment acknowledges the fundamental connection between people and the environment, but avoids or simplifies discussion of broader philosophical and political views of what this relationship is, has been, and ought to be. Expansive conceptual categories of the study of politics, economics, and society, such as capitalism, socialism, democracy, human welfare, and distribution, are often left out entirely, or used quickly and not defined clearly. In thinking big about human society and the natural world, what is ideal, and what is possible? This once-weekly seminar aims to help students develop the breadth and depth of their thinking about the relationship of human society to nature at the level of political, social, and economic philosophy. It will provide an organized setting for the understanding and critical discussion of these abstract but sometimes world-shaping ideas. Particular attention will be paid to the wide range of such views put forth in recent history, the various assumptions built into each view, and to the differing levels of influence and political effectiveness achieved by each. Discussions will be based on a weekly reading from a philosophically oriented work about humanity and the environment, such as a book chapter or a piece of long-form journalism. Grading/credit based on weekly participation and a short reflective paper.
Same as: EARTHSYS 198

EARTHSYS 299. M.S. Thesis. 1-9 Unit.
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EARTHSYS 301. CURRICULAR PRACTICAL TRAINING - CPT. 1 Unit.
CPT course required for international students completing degree.

EARTHSYS 308. Carbon Dioxide and Methane Removal, Utilization, and Sequestration. 1 Unit.
This is a seminar on carbon dioxide and methane removal, utilization, and sequestration options, and their role in decarbonizing the global energy system. This course will cover topics including the global carbon balance, utilizing atmospheric carbon in engineered solutions, recycling and sequestering fossil-based carbon, and enhancing natural carbon sinks. The multidisciplinary lectures and discussions will cover elements of technology, economics, policy and social acceptance, and will be led by a series of guest lecturers. Short group project on carbon solutions.
Same as: ENERGY 308, ENVRES 295, ESS 308, ME 308

EARTHSYS 323. Stanford at Sea. 16 Units.
(Graduate students register for 323H.) Five weeks of marine science including oceanography, marine physiology, policy, maritime studies, conservation, and nautical science at Hopkins Marine Station, followed by five weeks at sea aboard a sailing research vessel in the Pacific Ocean. Shore component comprised of three multidisciplinary courses meeting daily and continuing aboard ship. Students develop an independent research project plan while ashore, and carry out the research at sea. In collaboration with the Sea Education Association of Woods Hole, MA. Only 6 units may count towards the Biology major. 2020-21 academic year offering of this course is dependent on COVID-19 regulations.
Same as: BIOHOPK 182H, BIOHOPK 323H, ESS 323

EARTHSYS 332. Theory and Practice of Environmental Education. 3 Units.
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.
Same as: EDUC 332

EARTHSYS 801. TGR Project. 0 Units.
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