

EARTH, ENVIRONMENTAL AND PLANETARY SCIENCES

Contact Information

Earth, Environmental and Planetary Sciences

<https://eeps.rice.edu/>

105 Keith Wiess Geological Labs

713-348-4880

Julia K. Morgan

Department Chair

morganj@rice.edu

Earth, Environmental and Planetary Sciences encompass a range of interrelated disciplines focused on understanding the origin of Earth and planetary systems, the processes that operate within them, and their evolution through time. Topics represented in our field include the physics and chemistry of the solid Earth and its planetary neighbors, the causes and consequences of plate tectonics, and the origin and importance of the oceans and atmosphere. The study of past and present-day environmental processes is integral to understanding the impacts of Earth's climate, land surface evolution, natural resources, and natural hazards on the biosphere, including humans.

The Department of Earth, Environmental and Planetary Sciences offers undergraduate and graduate programs for a wide range of interests. All undergraduate majors take a five-course core sequence, typically in the freshman through junior years, gaining a fundamental understanding of Earth and planetary systems, processes, materials, history, and interactions. Majors also take a course in applied laboratory, field, and computational techniques, and introductory courses in mathematics, chemistry, and possibly, physics and biology. The BS degree provides three areas of specialization:

- *Geoscience* - focused on Earth systems and processes, including upper-level courses in solid Earth geophysics, geochemistry, tectonics, and a range of elective options.
- *Environmental Earth Science** - emphasizing interactions between Earth processes and Earth's biosphere, enhanced by upper-level electives selected from BioSciences, Chemistry, Civil and Environmental Engineering, and more.
- *Planetary Science* - designed to apply our knowledge of the Earth to other planetary systems in our solar system, enhanced by upper-level electives in Physics and Astronomy and beyond.

The BS degree with a major in Earth, Environmental and Planetary Sciences should be chosen by students planning a career or further study in Earth, Environmental or Planetary Sciences, or a related field. The BA degree is a more flexible program that still provides a comprehensive overview of Earth, Environmental and Planetary Sciences, but can be combined easily with other majors or professional career paths. Many undergraduate students engage in research projects during their careers, gaining the opportunity to work with complex and highly interconnected problems, gaining skills to become leaders and entrepreneurs in the real world - field and laboratory opportunities abound! Future career opportunities include academia, working in industry, business or

government, or working with and for societal issues. Many students present their own research projects at national and international professional conferences.

The department also offers an undergraduate minor providing a solid introduction to the broad field of Earth, Environmental and Planetary Sciences*, and allowing students to gain exposure to additional advanced topics, while pursuing their major in another field.

The department offers two graduate degrees, a Master of Science and Doctor of Philosophy. Students select research projects in concert with their research advisors, and have the opportunity to work on a wide-range of open-ended, complex, and highly interconnected problems.

Faculty members have joint research projects with scientists at over 100 institutions worldwide, giving an international scope to the department with research programs on all the continents, in all of the oceans, and on four planets. Faculty research interests span a wide range of topics; see <https://eeps.rice.edu> for more information. Many departmental research programs involve substantial field activities, both on land and at sea. Several courses also include field trips to a variety of destinations and geologic settings.

*Students interested in an undergraduate major with an environmental emphasis have multiple options at Rice University, spanning the Schools of Natural Sciences, Engineering, Humanities, and Social Sciences, including:

- *Environmental Earth Science Area of Specialization* under the BS degree with a major in Earth, Environmental and Planetary Sciences, described above. This major is built upon a strong foundation in Earth Science, and focuses on the interface between the Earth and life.
- *Environmental Science (BS and BA degrees)* is a broad and interdisciplinary program that incorporates humanities and social sciences perspectives of environmental issues, in addition to natural sciences. This major is jointly administered by the *BioSciences* and *Earth, Environmental and Planetary Sciences* departments, and offers two corresponding Major Concentrations: *Earth Science* and *Ecology and Evolutionary Biology*.
- *Environmental Engineering Area of Specialization* within the Bachelor of Science in Chemical Engineering (BSChE) degree.
- *Environmental Engineering Major Concentration* within the BA degree with a major in Civil and Environmental Engineering.

Similarly, students interested in an undergraduate minor with an environmental emphasis have three options at Rice University:

- *Minor in Earth, Environmental and Planetary Sciences* offered by the Earth, Environmental and Planetary Sciences department, with a strong Earth Science basis.
- *Minor in Energy and Water Sustainability* offered through the Civil and Environmental Engineering department, highlighting engineering and economic considerations.
- *Minor in Environmental Studies*, an interdisciplinary minor drawing broadly from the Schools of Natural Sciences, Engineering, Humanities, and Social Sciences.

Bachelor's Programs

- [Bachelor of Arts \(BA\) Degree with a Major in Earth, Environmental and Planetary Sciences](https://ga.rice.edu/programs-study/departments-programs/natural-sciences/earth-environmental-planetary-sciences/earth-environmental-planetary-sciences-ba/) (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/earth-environmental-planetary-sciences/earth-environmental-planetary-sciences-ba/>)

- Bachelor of Science (BS) Degree with a Major in Earth, Environmental and Planetary Sciences (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/earth-environmental-planetary-sciences/earth-environmental-planetary-sciences-bs/>)

Minor

- Minor in Earth, Environmental and Planetary Sciences (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/earth-environmental-planetary-sciences/earth-environmental-planetary-sciences-minor/>)

Master's Program

- Master of Science (MS) Degree in the field of Earth, Environmental and Planetary Sciences (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/earth-environmental-planetary-sciences/earth-environmental-planetary-sciences-ms/>)

Doctoral Program

- Doctor of Philosophy (PhD) Degree in the field of Earth, Environmental and Planetary Sciences (<https://ga.rice.edu/programs-study/departments-programs/natural-sciences/earth-environmental-planetary-sciences/earth-environmental-planetary-sciences-phd/>)

Chair

Julia K. Morgan

Professors

Jonathan Ajo-Franklin
Rajdeep Dasgupta
Helge Gonnermann
Richard G. Gordon
Andre Izidoro
Cin-Ty Lee
Adrian Lenardic
Alan R. Levander
Caroline A. Masiello
Julia K. Morgan
Fenglin Niu
Colin A. Zelt

Associate Professor

Laurence Yeung

Assistant Professors

Sylvia Dee
Melodie French
Kirsten Siebach
Mark Torres

Professors Emeriti

John B. Anderson
André W. Droxler
Dieter Heymann
William P. Leeman
Andreas Lüttge
Peter R. Vail

Lecturers

Kenneth C. Abdulah
Dorothy Ballentine
Gelu Costin
Tim Diedesch
Catherine Donohue
Gary G. Gray
Jeffrey A. Nunn
Malcolm Ross
Eric Scott
John Sneider

Professor, Joint Appointment

Maarten V. de Hoop

Associate Professor, Joint Appointment

Andrea Isella

Assistant Professor, Joint Appointment

Pedram Hassanzadeh

Wiess Visiting Scholars

Francis Albarede
Janne Blichert-Toft
Terry Plank

Adjunct Faculty

Kenneth C. Abdulah
Faruk Alpak
Mauricio Araya
K. K. Bissada
Albert Colman
Christian Davies
Jeffrey J. Dravis
Justin Hayles
Stephen J. Mackwell
Patrick J. McGovern
Daniel Minisini
Chin Man Mok
James Pindell
Malcolm Ross
Kurt Rudolph
Lori Summa

For Rice University degree-granting programs:

To view the list of official course offerings, please see [Rice's Course Catalog](https://courses.rice.edu/admweb!/SWKSCAT.cat?p_action=cata) (https://courses.rice.edu/admweb!/SWKSCAT.cat?p_action=cata).

To view the most recent semester's course schedule, please see [Rice's Course Schedule](https://courses.rice.edu/admweb!/SWKSCAT.cat) (<https://courses.rice.edu/admweb!/SWKSCAT.cat>).

Earth, Environmental and Planetary Sciences (EEPS)

EEPS 101 - THE EARTH

Short Title: THE EARTH

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Study of the nature of the Earth and its processes. Mutually Exclusive: Cannot register for EEPS 101 if student has credit for ENST 101/ESCI 115/ESCI 301.

EEPS 102 - HISTORY OF THE EARTH AND LIFE

Short Title: HISTORY OF THE EARTH & LIFE

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Study of Earth's systems over the past 4.6 billion years. Topics include evolution of life, continents, ocean basins and climate.

EEPS 103 - FIELD TRIPS FOR THE EARTH

Short Title: FIELD TRIPS FOR THE EARTH

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture/Laboratory

Credit Hour: 1

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: In this course, students will gain a better appreciation of our planet, from how it formed and evolved through millions of years to how its surface environment has been shaped by life, including by humans. These concepts will be introduced through one or more field trips in Texas. Through this course, students will become better stewards of our planet.

EEPS 106 - INVESTIGATING EARTH'S SURFACE

Short Title: INVESTIGATING EARTH'S SURFACE

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture/Laboratory

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Students will learn the fundamental processes that shape the Earth's surface and explore the relative time scales and magnitudes on which these processes operate through hands-on experiences. This will include field investigations on campus and around the Houston-Galveston area (with specific emphasis on bayou/riparian, coastal, and urban systems) as well as case studies from the US National Parks that exemplify these various landforms and processes. To provide the foundational knowledge for these investigations, students will spend some class time learning about Earth's major systems (geosphere, biosphere, hydrosphere, cryosphere, and atmosphere), but this course will focus primarily on Earth's geosphere and its geomorphology.

EEPS 107 - CLIMATE CHANGE AND EXTREME WEATHER

Short Title: CLIMATE CHANGE&EXTREME WEATHER

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: This undergraduate course will introduce students to the fundamentals of natural and anthropogenic climate change. After briefly reviewing Earth's composition and its fluid envelopes, we will cover the basic physics of the climate system, providing tools to understand weather and climate phenomena (e.g. monsoons, El Niño), the greenhouse effect, and climate feedbacks. Building on this understanding, a succinct tour of geologic history will help us paint a more complete picture of Earth's climate variations and how they affected human evolution and history. With this context, we will be able to judge the anomalous character of recent climate change, establish its anthropogenic nature, and discuss solutions to the current climate crisis. Students from any major are encouraged to enroll and engage on important topic. Cross-list: ENST 201.

EEPS 108 - NATURAL DISASTERS

Short Title: NATURAL DISASTERS

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: In this course students will learn about the science behind natural disasters. The topics that will be discussed include earthquakes, tsunamis, volcanic eruptions, hurricanes, and tornadoes. We will cover the fundamental Earth Science concepts and processes required to understand these phenomena.

EEPS 109 - OCEANOGRAPHY**Short Title:** OCEANOGRAPHY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Introduction to the oceans, with an emphasis on how the physics, chemistry, geology, and biology of the oceans are linked.**EEPS 110 - THE EARTH SYSTEM, ENVIRONMENT, AND SOCIETY****Short Title:** EARTH, ENVIRONMENT, & SOCIETY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** This course introduces the Earth system, and explores how the environment has changed over time, and the physical, chemical and biological processes responsible for these changes. The course places special emphasis on human-Earth interactions, in the past, present, and future. Topics will include Earth's ecosystems, oceans, and atmosphere, natural resources, natural hazards including catastrophic events, as well as climate change and the role of humans in modifying Earth's environment.**EEPS 111 - INHABITING PLANET EARTH****Short Title:** INHABITING PLANET EARTH**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Why is Earth habitable? How do we sustain our existence on this unique planet? This course will introduce students to our species' interactions with Planet Earth. We will explore how Earth formed and what systems through time have made the planet habitable, how we use the rock record to investigate past surface environments and climate changes, and how humans are altering Earth's future. The first segment covers the building of Planet Earth and geologic factors that control habitability. The second segment covers rocks of the American Southwest as a case study for how we read the rock record to understand ancient surface environments and climate changes. The final segment of the course will focus on human impacts on our planet, environmental policy and reading the recently published National Climate Assessment.**EEPS 113 - ENVIRONMENTAL CRISIS SEMINAR****Short Title:** ENVIRONMENTAL CRISIS SEMINAR**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Living with Rising Seas: Sea level change is one of today's most urgent environmental crises. 80% the world's most densely populated cities, including Houston, are located along the coast and are facing the ever pressing challenge of rising seas. In this seminar, we will explore the following topics through literature reviews and group discussions: How fast is sea level rising? How do we predict sea level changes? Why does sea level change? Are there places with sea level dropping and why? What are some complications that Houston has that make rising seas a higher risk? Where and whom are most vulnerable to sea level rise? What are the physical damage and socioeconomic impacts of sea level rise? What can we do to mitigate sea level rise? Can we live in harmony with the rising sea and how do we adapt to it? Seminar topics vary annually.**EEPS 114 - DISCOVERIES IN EARTH, ENVIRONMENTAL AND PLANETARY SCIENCES SEMINAR****Short Title:** DISCOVERIES IN EEPS SEMINAR**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Overview of exciting discoveries, research and recent advances in Earth, Environmental, and Planetary Sciences, facilitated through discussions with graduate students and faculty, as well as laboratory visits and demonstrations. Topics may vary. Distribution Credit for ESCI/ENST 114 no longer eligible beginning Fall 2019.**EEPS 115 - THE PLANETS****Short Title:** THE PLANETS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** The physical, chemical, and geological development of the solar system from 4.6 billion years ago until today. All planets, their major satellites, comets, and asteroids will be discussed.

EEPS 116 - THE EARTH AND THE SOLAR SYSTEM**Short Title:** EARTH AND THE SOLAR SYSTEM**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** This course will provide students with an understanding of how the Earth and Solar System formed and evolved, emphasizing the evidence supporting theories of formation and evolution and the history of these theories. The course includes formation of the Universe, the elements, the stars, the Sun and the Solar System, the early Earth and Earth history, the other planets and the history of modern space exploration.**EEPS 220 - INTRODUCTION TO COMPUTATION IN THE EARTH, ENVIRONMENT AND PLANETARY SCIENCES****Short Title:** INTRO TO EEPS COMPUTATION**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Prerequisite(s):** MATH 101 (may be taken concurrently) or MATH 105 or MATH 111 (may be taken concurrently) or MATH 112 (may be taken concurrently)**Description:** A broad introduction to solving earth, environmental, and planetary science problems using programming and basic computational methods. The course will consist of a series of two week modules using the MATLAB environment. Each module consists of lectures to present theory and labs to provide guidance with relevant programming techniques. Recommended Prerequisite(s): Math 102 or equivalent, and PHYS 101 and 102 or equivalents. May be taken concurrently.**EEPS 234 - CLIMATE CHANGE, ECONOMICS, AND THE WINE INDUSTRY: APPLIED ENVIRONMENTAL PROBLEM SOLVING FOR THE 21ST****Short Title:** CLIMATE ECONOMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** Wine has been produced throughout the subtropics for thousands of years, and is a pillar of the international dining, leisure, and tourism economies. Climate change is altering weather conditions at wineries whose grape production is critically sensitive to seasonal microclimates. This poses a major threat to the wine industry, but also offers opportunities for targeted adaptation. Wine grapes are sensitive not only to climate, but to soil type and health, bedrock geology, and shade (or terroir - all the environmental factors that influence grapes). To adapt and maintain wine economies in France and worldwide, wine makers require high-resolution seasonal climate predictions coupled with geospatial mapping linking grape production and terroir. Themes, Learning Outcomes: This course will immerse students in an environmental problem solving challenge, working in teams to identify climate change 'choke points' for wine makers. This highly interdisciplinary course will introduce concepts from climate change to microeconomics, using the wine industry as a case study. This course will take place over a three week period during Rice Global Maymester.**EEPS 238 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar, Independent Study, Internship/Practicum, Laboratory, Lecture, Lecture/Laboratory**Credit Hours:** 1-4**Course Level:** Undergraduate Lower-Level**Description:** Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**EEPS 299 - EXPERIENTIAL EDUCATION IN EARTH, ENVIRONMENTAL, AND PLANETARY SCIENCES****Short Title:** EXPERIENTIAL ED IN EARTH SCI**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Internship/Practicum**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Lower-Level**Description:** This course is designed to allow currently enrolled undergraduate students to gain experience in a department/faculty-approved internship/practicum with the goal of further developing their professional skills. Repeatable for Credit.

EEPS 307 - ENERGY AND THE ENVIRONMENT**Short Title:** ENERGY AND THE ENVIRONMENT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course explores the physical principles of energy use and its impacts on Earth's environment and climate. Topics will include energy mechanics, climate change, and the environmental impacts and future prospects of various fossil fuel and alternative energy sources. Cross-list: CEVE 307, ENST 307.**EEPS 309 - VISUALIZING NATURE****Short Title:** VISUALIZING NATURE**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** An experimental course combining the scientific disciplines of the earth sciences with the artistic disciplines of creative photography to study the natural landscape and related ecosystems. The course will combine classroom lectures and laboratory demonstrations in geoscience with classes in the use of digital and film-based cameras and illustrated lectures on recognized achievements in landscape photography. Extensive field trips will be scheduled. Students will travel frequently, at times in pairs, other times in larger groups and as a full class, accompanied by one or both professors. The budget for the course includes funding both for travel and for photography expenses. Instructor Permission Required. Cross-list: FOTO 390.**EEPS 321 - EARTH AND PLANETARY SURFACE ENVIRONMENTS****Short Title:** EARTH AND PLANETARY SURFACES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 101 or ESCI 107 or ESCI 108 or ESCI 110 or ESCI 111 or ESCI 115 or ESCI 301 or EEPS 101 (may be taken concurrently) or EEPS 107 (may be taken concurrently) or EEPS 108 (may be taken concurrently) or EEPS 109 (may be taken concurrently) or EEPS 110 (may be taken concurrently) or EEPS 111 (may be taken concurrently) or EEPS 115 (may be taken concurrently) or EEPS 116 (may be taken concurrently)**Description:** This course introduces the processes that shape Earth and other planetary surfaces as well as how records of these processes are preserved on landscapes and in sediment deposits. This course will cover a range of topics including surface hydrology, erosion, sediment transport, and chemical weathering and connect them to the development and interpretation of the stratigraphic record. All topics will be treated using descriptive (qualitative) approaches as well as a range of quantitative methods. This course requires a once-a-week 3-hour lab. Prerequisites EEPS 101/ENST 101 or EEPS 107/ENST 107 or EEPS 108 or EEPS 110 or EEPS 111 can be taken concurrently or with permission of instructor. Recommended Prerequisite(s): MATH 101, 102, PHYS 101 or 111, CHEM 121 or 151.**EEPS 322 - EARTH AND PLANETARY CHEMISTRY AND MATERIALS****Short Title:** EARTH AND PLANETARY MATERIALS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 101 or ESCI 107 or ESCI 108 or ESCI 110 or ESCI 111 or ESCI 115 or ESCI 301 or EEPS 101 (may be taken concurrently) or EEPS 107 (may be taken concurrently) or EEPS 108 (may be taken concurrently) or EEPS 109 (may be taken concurrently) or EEPS 110 (may be taken concurrently) or EEPS 111 (may be taken concurrently) or EEPS 115 (may be taken concurrently) or EEPS 116 (may be taken concurrently)**Description:** This course introduces chemistry of the Solar System materials and geochemical cycles in Earth and rocky planets through whole planet scale cycles. Specific topics include rock-forming processes related to the chemical and physical differentiation of the solid Earth and terrestrial planets into their main reservoirs, e.g., continental crust, oceanic crust, mantle, and core. Beginning with the bulk composition of planetary bodies, and an overview of the chemical and petrologic properties of the rocks that make up each of these reservoirs, the basic principles of petrology and geochemistry will be presented in the context of the rock cycle, plate tectonics, as well as the origin of economically and societally important ore deposits. Some basic concepts as to how the whole planet scale processes influence the chemistry of surface environment of Earth will be also be introduced. A laboratory and field trip, where students will see petrologic and geochemical principles applied, will be required. Recommended Prerequisite(s): MATH 101 and MATH 102, PHYS 101 or 111, and CHEM 121 or CHEM 151

EEPS 323 - EARTH AND PLANETARY STRUCTURE AND DYNAMICS**Short Title:** EARTH AND PLANETARY STRUCTURE**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 101 or ESCI 107 or ESCI 108 or ESCI 110 or ESCI 111 or ESCI 115 or ESCI 301 or EEPS 101 (may be taken concurrently) or EEPS 107 (may be taken concurrently) or EEPS 108 (may be taken concurrently) or EEPS 109 (may be taken concurrently) or EEPS 110 (may be taken concurrently) or EEPS 111 (may be taken concurrently) or EEPS 115 (may be taken concurrently) or EEPS 116 (may be taken concurrently)**Description:** This course covers the formation and differentiation of Earth and planetary bodies, the resulting structure and composition of planetary interiors, and the geophysical tools that reveal these details. The mechanics and deformation of the Earth's crust and lithosphere are presented, emphasizing rock strength and rheology, earthquakes and faulting, brittle and ductile deformation mechanisms and processes, and an introduction to tectonic systems. A required 3-hour lab and field trip will further develop skills for recognition, interpretation, and analysis of Earth structures and deformation processes. Prerequisites ESCI 101 or ESCI 107 or ESCI 108 or ESCI 110 or ESCI 111 or ESCI 115 or ESCI 301 can be taken concurrently or with permission of instructor. Recommended Prerequisite(s): MATH 101 and (PHYS 101 or 111). These may be taken concurrently.**EEPS 324 - EARTH'S INTERIOR****Short Title:** EARTH'S INTERIOR**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 101 or ESCI 115 or EEPS 101**Description:** Formation of Earth and solar system, Earth differentiation and geochronology. Structural seismology and the composition of Earth's interior. Density, Earth's gravity, and the geoid. Heat flow and Earth energetics. Earth's core and magnetic field. Mantle convection and plate tectonics. Oceanic and continental crust. Recommended Prerequisite(s): MATH 212 and (PHYS 101 or PHYS 111 or PHYS 125 or PHYS 141) or (PHYS 102 or PHYS 112 or PHYS 126 or PHYS 142).**EEPS 325 - OCEANS, ATMOSPHERES AND CLIMATE****Short Title:** OCEANS, ATMOSPHERES & CLIMATE**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Distribution Group:** Distribution Group III**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 101 or ESCI 107 or ESCI 109 or ESCI 110 or ESCI 111 or ESCI 201 or EEPS 101 or EEPS 107 or EEPS 108 or EEPS 109 or EEPS 110 or EEPS 111 or EEPS 115 or EEPS 116**Description:** Earth's climate system is characterized by complex interactions between the ocean, atmosphere, and land surfaces that are constantly evolving. This course will cover the physics and chemistry of the ocean and atmosphere to explore the mechanisms that control global and regional climate. Topics include: Earth's energy balance, atmosphere and ocean circulation, and biogeochemical climate feedbacks. We will also explore records of past climate (historical and pre-historical) and projections of future climate. Students will engage in lab-based activities to understand fluid flow in the atmosphere and ocean and complete problem sets including programming assignments.**EEPS 334 - THE EARTH LABORATORY****Short Title:** EARTH LABORATORY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (ESCI 322 or EEPS 322) and (ESCI 323 or EEPS 323 (may be taken concurrently)) and (ESCI 101 or ESCI 107 or ESCI 108 or ESCI 110 or ESCI 111 or ESCI 115 or ESCI 301 or EEPS 101 or EEPS 107 or EEPS 108 or EEPS 109 or EEPS 110 or EEPS 111 or EEPS 115 or EEPS 116)**Description:** A capstone course aimed at the interpretation of the Earth's history through the integration of geological observations in the field. Includes the introduction to the basic methods of description, recording, and interpretation of geologic features in the field, including rock and outcrop description, geologic mapping and cross-section construction. The course includes a required seven-day excursion during Spring Break. Taught every Spring. ESCI 323 may be taken concurrently with ESCI 334.**EEPS 340 - GLOBAL BIOGEOCHEMICAL CYCLES****Short Title:** GLOBAL BIOGEOCHEMICAL CYCLES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Distribution Group:** Distribution Group III**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course introduces students to the coupled nature of the biosphere, atmosphere and hydrosphere using as focal points elemental cycles such as those of carbon and nitrogen. This is a writing-intensive class, and will include 3 required Saturday field trips. Mutually Exclusive: Cannot register for EEPS 340 if student has credit for EBIO 540.

EEPS 390 - GEOLOGY FIELD CAMP**Short Title:** GEOLOGY FIELD CAMP**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Independent Study**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Field course typically involving geologic mapping in one or more of sedimentary, metamorphic, igneous rocks and structures. Not offered by Rice University. Students must take an approved field camp from another university and transfer credit to Rice University. Recommended Prerequisite(s): ESCI 334 or EEPS 334**EEPS 391 - PRACTICAL EXPERIENCE IN EARTH, ENVIRONMENTAL AND PLANETARY SCIENCE****Short Title:** PRACTICAL EXPERIENCE IN EEPS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Independent Study**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Comprises participating in a science expedition or research experience, follow-up analysis of some aspect of the data acquired, and a written report. Must be approved in advance by one of the department undergraduate advisors. Instructor Permission Required. Instructor Permission Required.**EEPS 401 - SEMINAR: UNDERGRADUATE HONORS THESIS****Short Title:** SEM: UG HONORS THESIS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to and presentation of original undergraduate research for EEPS Undergraduate Honors Thesis candidates. Students will be introduced to basic research protocols and approaches, and will learn how to give presentations on their research, and gain experience presenting their research. Repeatable for Credit. Repeatable for Credit.**EEPS 403 - SEMINAR: DEPARTMENT RESEARCH****Short Title:** SEMINAR: DEPARTMENT RESEARCH**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to current research in the Earth, Environmental and Planetary Sciences department. Students will learn how to give a presentation and will get experience presenting their research. Graduate/Undergraduate Equivalency: EEPS 603. Mutually Exclusive: Cannot register for EEPS 403 if student has credit for EEPS 603. Repeatable for Credit.**EEPS 404 - SEMINAR: DEPARTMENT RESEARCH****Short Title:** SEMINAR: DEPARTMENT RESEARCH**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to current research in the Earth, Environmental and Planetary Sciences department. Students will learn how to give a presentation and will get experience presenting their research. Graduate/Undergraduate Equivalency: EEPS 604. Mutually Exclusive: Cannot register for EEPS 404 if student has credit for EEPS 604. Repeatable for Credit.**EEPS 405 - SEMINAR: CURRENT RESEARCH IN EARTH, ENVIRONMENTAL AND PLANETARY SCIENCES****Short Title:** SEM:CURRENT RESEARCH IN EEPS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** A series of lectures and paper discussions in various areas of Earth, Environmental and Planetary sciences. Graduate/Undergraduate Equivalency: EEPS 605. Mutually Exclusive: Cannot register for EEPS 405 if student has credit for EEPS 605. Repeatable for Credit.**EEPS 406 - SEMINAR: CURRENT RESEARCH IN EARTH SCIENCE****Short Title:** SEM:CURR RESRCH EARTH SCIENCE**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** A series of lectures and paper discussions in various areas of Earth science. Graduate/Undergraduate Equivalency: EEPS 606. Mutually Exclusive: Cannot register for EEPS 406 if student has credit for EEPS 606. Repeatable for Credit.

EEPS 410 - OPTICAL MINERALOGY AND PETROGRAPHY**Short Title:** OPTICAL MINERALOGY & PETROGRPH**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 322 or EEPS 322**Description:** This is a lab course focused on the identification of minerals with petrographic microscopy. Principles of crystallography, mineral optics, and mineral chemistry will be covered in the first third of the course. The second third of the course will focus on the identification of minerals in igneous, metamorphic, and sedimentary rocks with emphasis on petrogenetic interpretation. The last third of the course will involve each student working on specific petrologic themes in the context of regional tectonics or magmatic processes. Taught every other Fall. Graduate/Undergraduate Equivalency: EEPS 610. Mutually Exclusive: Cannot register for EEPS 410 if student has credit for EEPS 610/ESCI 410/ESCI 610.**EEPS 411 - CHARACTERIZATION OF EARTH, ENVIRONMENTAL, AND PLANETARY MATERIALS****Short Title:** MATERIALS CHARACTERIZATION**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 111 or CHEM 121 or CHEM 151**Description:** This course will provide an overview of various characterization methods used in geological, chemical, material science and other natural science and engineering research. The techniques that will be discussed include but not limited to electron beam methods (imaging and spectroscopy), X-ray methods, ion-beam analysis, vibrational spectroscopies, and Synchrotron-based techniques. Graduate/Undergraduate Equivalency: EEPS 611. Mutually Exclusive: Cannot register for EEPS 411 if student has credit for EEPS 611/ESCI 419/ESCI 619.**EEPS 412 - ADVANCED PETROLOGY****Short Title:** ADVANCED PETROLOGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 322 or EEPS 322**Description:** Evaluation of the evolution of igneous rocks in the Earth's crust and mantle. Topics will include phase equilibria, experimental studies, and geochemistry. Labs will stress thin section petrography. Graduate/Undergraduate Equivalency: EEPS 612. Mutually Exclusive: Cannot register for EEPS 412 if student has credit for EEPS 612. Repeatable for Credit.**EEPS 413 - ADVANCED PETROLOGY II****Short Title:** ADVANCED PETROLOGY II**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course will bring together constraints from field geology, petrography, petrology, geochemistry, and geodynamics to tackle advanced A87 research questions of whole Earth processes that are relevant in the 21st century. The topics that may be covered include, but are not limited to, interplay between magmatic and tectonic processes, magma generation, migration, extraction, and dynamic stability in various settings, magmatic differentiation, volatiles and fluids exchange between various reservoirs and effects on long-term climate, ore genesis, and formation and modification of continents. Graduate/Undergraduate Equivalency: EEPS 613. Mutually Exclusive: Cannot register for EEPS 413 if student has credit for EEPS 613/ESCI 411/ESCI 611.**EEPS 415 - GEOCHEMISTRY OF EARTH'S SURFACE****Short Title:** GEOCHEM EARTH'S SURFACE**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course will cover concepts in aqueous geochemistry in the context of chemical weathering and Earth's major biogeochemical cycles. Central to this course will be weekly student-led discussions of scientific literature. Students will also learn basic numerical modeling and data analysis techniques using MATLAB, field methods, and basic analytical chemistry. Graduate/Undergraduate Equivalency: EEPS 615. Mutually Exclusive: Cannot register for EEPS 415 if student has credit for EEPS 615/ESCI 407/ESCI 607.**EEPS 417 - TRACE-ELEMENT AND ISOTOPE GEOCHEMISTRY FOR EARTH AND ENVIRONMENTAL SCIENCE****Short Title:** TRACE-ELEMENT& ISOTOPE GEOCHEM**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to the principles of trace-element and isotope geochemistry and their applications to high and low temperature processes in the earth. Topics to be covered are trace-element partitioning, basic quantum physics, radiogenic isotopic systems and stable isotope fractionation. Graduate/Undergraduate Equivalency: EEPS 617. Recommended Prerequisite(s): ESCI 322 or EEPS 322. Mutually Exclusive: Cannot register for EEPS 417 if student has credit for EEPS 617/ESCI 430/ESCI 630.

EEPS 418 - TRACE ELEMENT AND ISOTOPE GEOCHEMISTRY**Short Title:** ISOTOPE GEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** An introduction to the principles and techniques of stable and radiogenic geochemistry in the geosciences. The course will begin by examining the fundamental physics relevant to isotope partitioning and decay, followed by a survey of different isotope systems and how they are used to study surface processes, element cycling, climate, and planetary science. Graduate/Undergraduate Equivalency: EEPS 618. Recommended Prerequisite(s): ESCI 322 or EEPS 322. Mutually Exclusive: Cannot register for EEPS 418 if student has credit for EEPS 618/ESCI 433/ESCI 633.**EEPS 420 - ORGANIC GEOCHEMISTRY****Short Title:** ORGANIC GEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course covers the organic geochemistry of the natural environment. Topics include: production, transport, decomposition, and storage of organic matter in the marine and terrestrial environments, use of isotopes to track biogeochemical processes and natural and perturbed carbon cycle issues, including past and recent climate shifts. Graduate/Undergraduate Equivalency: EEPS 620. Mutually Exclusive: Cannot register for EEPS 420 if student has credit for EEPS 620/ESCI 425/ESCI 625.**EEPS 425 - PLANETARY SURFACE PROCESSES****Short Title:** PLANETARY SURFACE PROCESSES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course is designed to expand understanding of geologic processes by considering how common or distinctive different geologic processes are on Earth compared to other bodies throughout the solar system. Students will leave the course with an appreciation for the types of surface processes that dominate different bodies throughout the solar system. How does the surface of Earth compared to the surfaces of other bodies in our solar system? How can we best extrapolate our understanding of Earth to other bodies? What do we learn about Earth from such comparisons? Graduate/Undergraduate Equivalency: EEPS 625. Mutually Exclusive: Cannot register for EEPS 425 if student has credit for EEPS 625.**EEPS 426 - GEOMORPHOLOGY****Short Title:** GEOMORPHOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 321 or EEPS 321**Description:** This course will investigate physical, chemical, and biological processes that contribute to the development and shaping of Earth's surface across a continuum of subaerial and subaqueous environments. Mandatory 4-day field trip is associated with this class. Graduate/Undergraduate Equivalency: EEPS 626. Mutually Exclusive: Cannot register for EEPS 426 if student has credit for EEPS 626/ESCI 431/ESCI 631. Repeatable for Credit.**EEPS 427 - MECHANICS OF SEDIMENT TRANSPORT****Short Title:** MECHANICS-SEDIMENT TRANSPORT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Evaluation of sedimentary transport dynamics: physical interaction between fluid flow and sediment mobility, from grain to bedform scale; exploration of environments including rivers, estuaries, deltas, coastlines, and deserts. Examination of sediment transport for geology, environmental, and engineering applications; formation of diagnostic sedimentary features recognized in the stratigraphic record. Graduate/Undergraduate Equivalency: EEPS 627. Mutually Exclusive: Cannot register for EEPS 427 if student has credit for EEPS 627/ESCI 435/ESCI 635.**EEPS 428 - ANTARCTIC MARINE GEOLOGY****Short Title:** ANTARCTIC MARINE GEOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** The study of marine geologic principles and processes using examples from the Southern Oceans. Graduate/Undergraduate Equivalency: EEPS 628. Recommended Prerequisite(s): ESCI 321 or EEPS 321. Mutually Exclusive: Cannot register for EEPS 428 if student has credit for EEPS 628/ESCI 423/ESCI 623.

EEPS 429 - PALEOCEANOGRAPHY**Short Title:** PALEOCEANOGRAPHY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 321 or EEPS 321**Description:** The evolution of the ocean, climate and the global carbon cycle over the last 100 million years as recorded by the biology, chemistry and composition of deep-sea sediment. Graduate/Undergraduate Equivalency: EEPS 629. Recommended Prerequisite(s): ESCI 109 or EEPS 109. Mutually Exclusive: Cannot register for EEPS 429 if student has credit for EEPS 629/ESCI 421/ESCI 621.**EEPS 430 - APPLIED STRATIGRAPHIC METHODS****Short Title:** APPLIED STRATIGRAPHIC METHODS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 321 or EEPS 321**Description:** This course will introduce students to the concepts of sequence stratigraphy and the power behind this correlation technique. The course is divided between classic sequence stratigraphy using cores, well-logs, and outcrop examples and seismic sequence stratigraphy. Graduate/Undergraduate Equivalency: EEPS 630. Mutually Exclusive: Cannot register for EEPS 430 if student has credit for EEPS 630/ESCI 427/ESCI 627.**EEPS 432 - FLUID FLOW IN FRACTURED ROCKS****Short Title:** FLUID FLOW IN FRACTURED ROCKS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Advanced course that will provide a quantitative overview of fluid flow through fractured rock. Emphasis will be on fundamental concepts of fluid mechanics related to flow through fractures. Potential areas of application for the material covered include: subsurface storage of carbon and hydrogen for the energy transition; water resources; geothermal energy; hydrocarbon production; as well as magma and hydrothermal systems. Graduate/Undergraduate Equivalency: EEPS 632. Recommended Prerequisite(s): Calculus and basic familiarity with differential equations. Mutually Exclusive: Cannot register for EEPS 432 if student has credit for EEPS 632/ESCI 418/ESCI 618.**EEPS 433 - CLIMATE DYNAMICS****Short Title:** CLIMATE DYNAMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 101 or ESCI 107 or ESCI 109 or ESCI 115 or ESCI 201 or ESCI 301 or ESCI 321 or ESCI 340 or EEPS 101 or EEPS 109 or EEPS 107 or EEPS 321 or EEPS 340**Description:** Earth's climate is a chaotic system, characterized by nonlinear interactions between the ocean, atmosphere, and land surfaces. This course will focus on the dynamics of the ocean and atmosphere, including the drivers of large-scale circulation, heat transport, and modes of natural variability. We will also explore projections of future climate change scenarios and records of historical climate change. Students will learn to post-process climate model output, analyze, and map these data using Python. Graduate/Undergraduate Equivalency: EEPS 633. Mutually Exclusive: Cannot register for EEPS 433 if student has credit for EEPS 633.**EEPS 434 - CLIMATE OF THE COMMON ERA****Short Title:** CLIMATE OF THE COMMON ERA**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** EEPS 101 or ESCI 101 or ENST 101 or EEPS 107 or ESCI 201 or ENST 201 or EEPS 109 or ESCI 109 or EEPS 321 or ESCI 321 or EEPS 340 or ESCI 340 or EEPS 448 or ESCI 442**Description:** This course explores climate variability and change over the past two thousand years to contextualize current rates and magnitudes of anthropogenic climate change on Earth. This reading and discussion-focused seminar course will cover paleoclimate archives such as corals, tree rings, and ice cores, as well as climate reconstruction methods, detection and attribution. Students will be provided with an overview of methods and key findings in paleoclimatology and paleoceanography, using high-resolution archives to explore past changes in global climate. Students will read 3-4 scientific papers each week, provide summaries and volunteer to lead discussions surrounding topics of their choosing. Graduate/Undergraduate Equivalency: EEPS 634. Mutually Exclusive: Cannot register for EEPS 434 if student has credit for EEPS 634.**EEPS 435 - REMOTE SENSING****Short Title:** REMOTE SENSING**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to electromagnetic remote sensing of the earth and other planets using passive and active methods. The course includes a computer lab component involving processing and interpretation of remote sensing imagery, and an individual project. Graduate/Undergraduate Equivalency: EEPS 635. Mutually Exclusive: Cannot register for EEPS 435 if student has credit for EEPS 635.

EEPS 436 - GIS FOR SCIENTISTS AND ENGINEERS**Short Title:** GIS FOR SCIENTISTS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Basic principles of Geographic Information Systems, with a focus on effectively applying the technology to the geosciences. Main platform of the class will be ESRI's ArcGIS, but a wide array of other tools will also be introduced. Material will be delivered via a blend of lecture and hands-on exercises. Graduate/Undergraduate Equivalency: EEPS 636. Mutually Exclusive: Cannot register for EEPS 436 if student has credit for EEPS 636.**EEPS 437 - EARTH'S NATURAL RESOURCES FOR THE ENERGY TRANSITION****Short Title:** EARTH'S NATURAL RESOURCES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Modern society depends strongly on the resources extracted from the earth. As the world advances technologically and as the human population continues to grow, that demand will only become stronger. In this course, we will investigate where the resources necessary for a modern functioning society comes from, the geology of those areas, extraction techniques, and the geopolitics surrounding those resources. Some resources we will consider will be metal ore deposits (gold, copper, etc.), battery deposits (lithium, cobalt, rare earth elements), hydrocarbons, and water. We will also discuss the climate impacts associated with extraction. Graduate/Undergraduate Equivalency: EEPS 637. Recommended Prerequisite(s): EEPS 101 or EEPS 103**EEPS 438 - THE SCIENCE OF NATURE-BASED CARBON SEQUESTRATION****Short Title:** NATURE-BASED CARBON SEQUESTRATION**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** EEPS 107 or EEPS 109 or EEPS 110 or EEPS 111 or EEPS 321 or EEPS 307 or CEVE 307**Description:** This course introduces nature-based solutions to climate change, reviewing existing and proposed nature-based solutions and covering the role of nature-based solutions in an overall greenhouse-gas reduction portfolio. Students will build the scientific background to evaluate new proposed nature-based solutions through a series of lectures and case studies, building a strong understanding of the global carbon, nitrogen, and water cycles. Graduate/Undergraduate Equivalency: EEPS 638.**EEPS 439 - GEOMICROBIOLOGY****Short Title:** GEOMICROBIOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** BIOS 201 or BIOC 201**Description:** This course will introduce geomicrobiology from an Earth system context, exploring how microbes fundamentally shape the Earth. Concepts covered will include the diversity of microbial metabolisms and the impacts of these metabolisms on the environment, applications of new microbial methods to Earth system questions, and the geomicrobiology of soils, oceans, the deep subsurface, as well as engineered environments (e.g. wastewater). Graduate/Undergraduate Equivalency: EEPS 639. Mutually Exclusive: Cannot register for EEPS 439 if student has credit for EEPS 639.**EEPS 445 - EARTH AND PLANETARY INTERIORS****Short Title:** EARTH AND PLANETARY INTERIORS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (ESCI 101 or EEPS 101 or ESCI 107 or ESCI 108 or EEPS 108 or ESCI 110 or EEPS 110 or ESCI 111 or EEPS 111 or ESCI 115 or ESCI 301) and (ESCI 323 or EEPS 323) and MATH 211 and (PHYS 101 or PHYS 111 or PHYS 102 or PHYS 112)**Description:** Formation and differentiation of Earth and Planetary systems. Structural seismology and the composition of the Earth and our solar system's planetary interiors. Earth's gravity, geoid, density, and moment of inertia. Heat flow and Earth energetics. Earth's core and magnetic field. Mantle convection and plate tectonics. Oceanic and continental lithosphere. Graduate/Undergraduate Equivalency: EEPS 645. Recommended Prerequisite(s): MATH 212 Mutually Exclusive: Cannot register for EEPS 445 if student has credit for EEPS 645.**EEPS 446 - SEISMOLOGY I****Short Title:** SEISMOLOGY I**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Principles of elastic wave propagation, the determination of Earth structure, and the understanding of earthquake physics. Graduate/Undergraduate Equivalency: EEPS 646. Mutually Exclusive: Cannot register for EEPS 446 if student has credit for EEPS 646/ESCI 461/ESCI 661.

EEPS 448 - EXPLORATION GEOPHYSICS**Short Title:** EXPLORATION GEOPHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 101 and (PHYS 101 or PHYS 102 or PHYS 111 or PHYS 112)**Description:** Study of the principles and procedures involved in geophysical exploration. Includes acquisition, processing, and interpretation of seismic, ground-penetrating radar, gravity, magnetic, and electrical data. Graduate/Undergraduate Equivalency: EEPS 648. Mutually Exclusive: Cannot register for EEPS 448 if student has credit for EEPS 648/ESCI 442/ESCI 642.**EEPS 450 - GEOPHYSICAL DATA ANALYSIS: DIGITAL SIGNAL PROCESSING****Short Title:** GEOPHYSICAL DATA ANALYSIS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 101 and MATH 102**Description:** Data sampling, aliasing, discrete Fourier transform, digital filter design techniques, z-transform, and discrete Hilbert transform are introduced. Deconvolution, velocity filters, polarization filter, stacking, beam forming and migration techniques will be taught together with their application in geophysical studies. Graduate/Undergraduate Equivalency: EEPS 650. Mutually Exclusive: Cannot register for EEPS 450 if student has credit for EEPS 650/ESCI 440/ESCI 640.**EEPS 451 - GEOPHYSICAL DATA ANALYSIS: INVERSE METHODS****Short Title:** GEOPHYSICAL DATA ANALYSIS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 211**Description:** Review of linear algebra and probability. Data fitting, model parameter estimation, inverse theory, linear and nonlinear methods, and global optimization. Graduate/Undergraduate Equivalency: EEPS 651. Mutually Exclusive: Cannot register for EEPS 451 if student has credit for EEPS 651.**EEPS 454 - INTRODUCTION TO SEISMIC INTERPRETATION: STRUCTURAL STYLES AND SEISMIC STRATIGRAPHY****Short Title:** 2D SEISMIC STRUCTURE AND STRAT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 442 (may be taken concurrently) or EEPS 448 (may be taken concurrently)**Description:** This course will introduce students to analysis of sub-regional structural and stratigraphic frameworks. We will utilize the interpretation of 2D seismic profiles to reconstruct basin history and discuss implications for petroleum systems. Students will gain an understanding of a variety of structural and stratigraphic styles, as expressed on seismic data. Graduate/Undergraduate Equivalency: EEPS 654. Mutually Exclusive: Cannot register for EEPS 454 if student has credit for EEPS 654.**EEPS 455 - REFLECTION SEISMIC DATA PROCESSING****Short Title:** REFLEC SEISMIC DATA PROCESSING**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 442 or EEPS 448**Description:** Experience with processing reflection seismic data. Includes seismic data organization, velocity analysis, stacking, filtering, deconvolution, migration, and display, using the Center for Computational Geophysics facility's seismic processing system(s).**EEPS 456 - 3D SEISMIC REFLECTION DATA INTERPRETATION****Short Title:** 3D SEISMIC INTERPRETATION**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Course Level:** Undergraduate Upper-Level**Description:** Workstation-based geologic interpretation of 3D seismic reflection data. The course will focus on interpreting horizons and faults tying interpretation to well data, analyzing seismic attributes, and other relevant topics. Emphasis will be placed on workflows utilized in hydrocarbon exploration. Mutually Exclusive: Cannot register for EEPS 456 if student has credit for ESCI 428.

EEPS 458 - ENVIRONMENTAL & APPLIED ROCK PHYSICS**Short Title:** APPLIED ROCK PHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 101 or MATH 102) and (PHYS 101 or PHYS 102 or PHYS 111) and (CAAM 210 or CMOR 220)**Description:** Rock physics, the study of the impact of rock microstructure, mineralogy, fluids, stress state, and diagenetic features on wave propagation in porous media. Understanding the use of such relationships for quantitative analysis of seismic datasets. Applications to geologic carbon storage, permafrost characterization, geothermal systems, and hydrogeology. Graduate/Undergraduate Equivalency: EEPS 658. Recommended Prerequisite(s): Knowledge of applied geophysics, seismology, continuum mechanics, differential equations, and petrology will expand the value of the material. Mutually Exclusive: Cannot register for EEPS 458 if student has credit for EEPS 658.**EEPS 459 - WELL LOGGING AND PETROPHYSICS****Short Title:** WELL LOGGING AND PETROPHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Basics of wireline logging and logging while drilling including borehole environment, resistivity, radiation, thermal, and elastic wave measurements and measuring tools. Building from this introduction, basic interpretation of logging data and formation evaluation will be studied. Graduate/Undergraduate Equivalency: EEPS 659. Mutually Exclusive: Cannot register for EEPS 459 if student has credit for EEPS 659.**EEPS 460 - GLOBAL TECTONICS****Short Title:** GLOBAL TECTONICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Geometrical aspects of plate tectonics, the 3 traditional types of plate boundaries, instantaneous plate motions, earthquakes and faulting, space geodesy, geomagnetic reversals, paleomagnetic poles, hotspots, "absolute" plate motion, true polar wander, driving forces, diffuse plate boundaries, plate nonrigidity, and rheology of the lithosphere. Graduate/Undergraduate Equivalency: EEPS 660. Mutually Exclusive: Cannot register for EEPS 460 if student has credit for EEPS 660.**EEPS 461 - STRUCTURE AND EVOLUTION OF TECTONIC SYSTEMS****Short Title:** TECTONIC SYSTEMS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** ESCI 323 or EEPS 323**Description:** The distribution, origin, and evolution of various tectonic systems, and characterization of their structural and geophysical signatures, emphasizing crustal and lithospheric processes associated with tectonic deformation. Review of representative global examples of convergent and collisional margins, divergent and passive margins, and transform margins. Graduate/Undergraduate Equivalency: EEPS 661. Mutually Exclusive: Cannot register for EEPS 461 if student has credit for EEPS 661.**EEPS 462 - TECTONOPHYSICS****Short Title:** TECTONOPHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 102 or MATH 106 or PHYS 102 or PHYS 112**Description:** Applications of continuum physics to the deformation, flexure, heat transfer, and gravity field of the lithosphere. Graduate/Undergraduate Equivalency: EEPS 662. Recommended Prerequisite(s): MATH 212. Mutually Exclusive: Cannot register for EEPS 462 if student has credit for EEPS 662.**EEPS 463 - THE PHYSICS OF FAULTING AND EARTHQUAKES****Short Title:** EARTHQUAKE PHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** PHYS 101**Description:** In this class students will learn about the physics of earthquakes and earthquake hazards. This course will describe faults, the structures on which most earthquakes occur, and their locations on Earth. Students will learn about the physics behind faulting and how this leads to earthquakes and controls earthquake size. In addition, students will learn to relate different faulting characteristics to earthquake hazards through an understanding of earthquake energy budget. This course requires no previous coursework in Earth, Environmental, and Planetary Sciences. Graduate/Undergraduate Equivalency: EEPS 663.

EEPS 464 - HEAT AND MASS TRANSPORT ON EARTH AND PLANETS**Short Title:** GEODYNAMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to the use of continuum mechanics to solve fundamental problems related to mass and energy transport problems arising in the study of the Earth, planets and moons. Topics include: heat conduction, convective heat transfer, planetary thermal evolution, geological fluid dynamics, flow through porous media, and rheology of planetary materials. Graduate/Undergraduate Equivalency: EEPS 664. Mutually Exclusive: Cannot register for EEPS 464 if student has credit for EEPS 664.**EEPS 465 - ROCK DEFORMATION AND RHEOLOGY****Short Title:** ROCK DEFORMATION AND RHEOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** The mechanisms of deformation and rheology of Earth's crust and mantle. Graduate/Undergraduate Equivalency: EEPS 665. Recommended Prerequisite(s): ESCI 323**EEPS 467 - GEOMECHANICS****Short Title:** GEOMECHANICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** An examination of deformation and failure processes within the Earth's shallow crust, with a focus on rock and sediment mechanics, and associated fluid processes. Emphasis will be on geologic applications, including sediment consolidation, slope stability, fault mechanics, and earthquake nucleation and rupture. Graduate/Undergraduate Equivalency: EEPS 667. Mutually Exclusive: Cannot register for EEPS 467 if student has credit for EEPS 667.**EEPS 468 - VOLCANOES****Short Title:** VOLCANOES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Introduction to volcanoes and associated physical processes. Conceptual and quantitative discussion of topics related to magma transport, magma storage, and volcanic eruptions. The course includes a 4-6 day field trip to California and Oregon. Graduate/Undergraduate Equivalency: EEPS 668. Mutually Exclusive: Cannot register for EEPS 468 if student has credit for EEPS 668.**EEPS 469 - PLANETARY VOLCANISM****Short Title:** PLANETARY VOLCANISM**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This seminar will cover the broad range of volcanic phenomena in the solar system, via weekly readings of, and student presentations on, classic and recent papers. Topics include: Composition (basaltic, silicic, unusual, carbonatite), cryovolcanism, structure (caldera, rift zones, volcanic spreading radiating dike systems, magma chambers, and sill complexes), and dynamics (eruption mechanism, effusive vs. explosive, volatiles and atmospheres/oceans). The planetary settings to be considered include Earth, Venus, Mars, Mercury, Moon, large asteroids and outer planet satellites. Graduate/Undergraduate Equivalency: EEPS 669. Mutually Exclusive: Cannot register for EEPS 469 if student has credit for EEPS 669.**EEPS 471 - EARTH SYSTEMS MODELING I: PHILOSOPHY AND FUNDAMENTALS****Short Title:** EARTH SYSTEMS MODELING I**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 111 or CHEM 121 or PHYS 101 or PHYS 102**Description:** A model is a simplified representation of something. Scientific models range from conceptual to physical to mathematical. In Earth and planetary science, one is often concerned with modeling interactions between physical, chemical, and biological components, i.e., with modeling systems. This class will cover the fundamentals of scientific modeling with a focus on Earth systems. Graduate/Undergraduate Equivalency: EEPS 671. Recommended Prerequisite(s): MATH 211. Mutually Exclusive: Cannot register for EEPS 471 if student has credit for EEPS 671. Repeatable for Credit.**EEPS 472 - EARTH SYSTEMS MODELING: NUMERICAL TECHNIQUES AND APPLICATIONS****Short Title:** NUMERICAL METHODS EARTH SYSTEM**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 111 or CHEM 121 or PHYS 101 or PHYS 102**Description:** Introduction to numerical methods with applications in Earth Science using Matlab and COMSOL. Much of the class is spent in the computer lab learning Matlab and COMSOL, followed by hands-on exercises. Graduate/Undergraduate Equivalency: EEPS 672. Recommended Prerequisite(s): MATH 211. Mutually Exclusive: Cannot register for EEPS 472 if student has credit for EEPS 672.

EEPS 473 - FORMATION AND EVOLUTION OF PLANETARY SYSTEMS**Short Title:** PLANETARY FORMATION**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 101 and MATH 102 and MATH 211**Description:** This course introduces students to the state-of-the-art knowledge about the processes underlying the formation and evolution of planetary systems. This course will review basic ideas of orbital planetary dynamics and the different stages of planet formation. The course aims at developing important quantitative and qualitative skills to analyze and understand the main physical processes that operate in young planetary systems. The course will be guided by modern planet formation models using different tools and constraints from planetary physics, celestial mechanics, astronomical-observations, geochemistry, and cosmochemistry. Graduate/Undergraduate Equivalency: EEPS 673. Mutually Exclusive: Cannot register for EEPS 473 if student has credit for EEPS 673.**EEPS 477 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Independent Study, Seminar, Internship/Practicum, Laboratory, Lecture, Lecture/Laboratory**Credit Hours:** 1-4**Course Level:** Undergraduate Upper-Level**Description:** Topics and credit hours vary each semester. Contact the department for current semester's topic(s). Repeatable for Credit.**EEPS 480 - ENERGY TRANSITION SEMINAR****Short Title:** ENERGY TRANSITION SEMINAR**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This seminar course will provide an introduction to the energy transition broadly defined, but focusing primarily on its impact and importance in the earth sciences. Once a week an invited expert will give a 50-minute lecture on topics that may include: carbon capture and sequestration, carbon markets, geothermal energy, climate change, hydrogen, energy storage, critical minerals, ecological impacts of resource extraction, hydrocarbon sustainability, water resources, energy systems and sustainable development, energy transition policy, and energy transition economics. Topics and speakers will change each year. There are no prerequisites for this course and undergraduate and graduate students do not have to have an earth science background. Graduate/Undergraduate Equivalency: EEPS 680. Mutually Exclusive: Cannot register for EEPS 480 if student has credit for EEPS 680. Repeatable for Credit.**EEPS 481 - UNDERGRADUATE RESEARCH IN EARTH, ENVIRONMENTAL AND PLANETARY SCIENCES****Short Title:** UNDERGRAD RESEARCH IN EEPS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Advanced activities adapted to the needs of the individual undergraduate student research. Instructor Permission Required. Repeatable for Credit.**EEPS 484 - DECISION MAKING AND ECONOMICS IN THE ENERGY INDUSTRY****Short Title:** DECISION MAKING AND ECONOMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course will provide students with an understanding of how energy projects are evaluated. Topics include resource-size determination, geologic and economic risk, discounted cash-flow economics, and other common methods used in decision making. Emphasis will be placed on working in teams to understand basic concepts and sensitivities. Graduate/Undergraduate Equivalency: EEPS 684. Recommended Prerequisite(s): (EEPS 321 or ESCI 321) and (EEPS 323 or ESCI 323). Mutually Exclusive: Cannot register for EEPS 484 if student has credit for EEPS 684.**EEPS 486 - PETROLEUM INDUSTRY ECONOMICS AND MANAGEMENT****Short Title:** PETROLEUM IND ECONOMICS MGMT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Topics covered include resource size determination; geologic risk analysis; establishing minimum economic thresholds; economic chance factors; the concepts of present worth, investment efficiency, rates of return. Price forecasting, cost inflation are discussed. Graduate/Undergraduate Equivalency: EEPS 686. Recommended Prerequisite(s): ESCI 415 or EEPS 484 Mutually Exclusive: Cannot register for EEPS 486 if student has credit for EEPS 686.

EEPS 488 - ECONOMIC GEOLOGY MINERAL DEPOSITS**Short Title:** ECON GEOL MINERAL DEPOSITS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** An overview of metallic and nonmetallic mineral deposits, theories of their origin, and classification. The impact of government regulation, economics, production practices, and exploration will be considered. Graduate/Undergraduate Equivalency: EEPS 688. Mutually Exclusive: Cannot register for EEPS 488 if student has credit for EEPS 688.**EEPS 491 - SPECIAL STUDIES FOR UNDERGRADUATES****Short Title:** SPECIAL STUDY FOR UNDERGRADS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Activities in Earth, Environmental or Planetary sciences adapted to the needs of individual undergraduate study. Instructor Permission Required. Repeatable for Credit.**EEPS 495 - SEMINAR: TOPICS IN ENVIRONMENTAL SCIENCE****Short Title:** TOPICS: ENVIRONMENTAL SCIENCE**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course provides an integration of interdisciplinary topics that span environmental sciences. Topics will vary depending upon the interests and needs of both students and faculty. Cross-list: BIOS 495. Mutually Exclusive: Cannot register for EEPS 495 if student has credit for EEPS 699.**EEPS 499 - GRAPHIC AND VISUAL DESIGN FOR SCIENTISTS****Short Title:** GRAPHIC AND VISUAL DESIGN**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** A significant portion of a scientist's time is spent solving visual design problems (graphics for papers, visual layouts for seminars, posters, teaching). Effective communication of scientific information is part of a scientist's skill set. This class is designed to enhance that skill set in terms of presenting visual information clearly, simply, and effectively. Graduate/Undergraduate Equivalency: EEPS 699. Mutually Exclusive: Cannot register for EEPS 499 if student has credit for EEPS 699. Repeatable for Credit.**EEPS 501 - SPECIAL STUDIES FOR GRADUATE STUDENTS****Short Title:** SPECIAL STUDIES GRAD STUDENTS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Independent Study**Credit Hours:** 1-15**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Advanced work in Earth science adapted to the needs of individual graduate students. Instructor Permission Required. Repeatable for Credit.**EEPS 510 - ADVANCED BIOGEOCHEMISTRY****Short Title:** ADVANCED BIOGEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will explore carbon, nitrogen, and water cycling at the advanced level. Repeatable for Credit.**EEPS 511 - ADVANCED TOPICS IN GEOCHEMISTRY****Short Title:** ADVANCED TOPICS IN GEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar Topics will vary.**EEPS 514 - SEMINAR: SPECIAL TOPICS IN HIGH TEMPERATURE GEOCHEMISTRY****Short Title:** SEM:SPEC TOPICS HIGH TEMP**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 516 - FIELD TRIP FOR ADVANCED GEOLOGY****Short Title:** FIELD TRIP FOR ADV GEOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A field trip course centered on weekly readings and several mapping projects carried out over the course of 1 week. The course will focus on western North American geology with emphasis on igneous and metamorphic petrology and structural geology in the context of regional tectonics. Field studies will be accompanied by quantitative data collection and analysis. Each student will be responsible for a small field-based project. Recommended Prerequisite(s): EEPS 322 and EEPS 323 Repeatable for Credit.

EEPS 525 - APPLIED SEDIMENTOLOGY I**Short Title:** APPLIED SEDIMENTOLOGY I**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics will vary.**EEPS 526 - APPLIED SEDIMENTOLOGY II****Short Title:** APPLIED SEDIMENTOLOGY II**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** ESCI 505**Description:** Advanced field studies in sedimentary geology. This course is intended to provide graduate students with experience working in sedimentary rocks by working on projects of their own design.**EEPS 527 - CARBONATE SEDIMENTS: DEPOSITIONAL SYSTEMS AND PROCESSES****Short Title:** CARBONATE SEDIMENTS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** ESCI 321 or EEPS 321**Description:** Characterization of modern and ancient, shallow and deep sedimentary environments and facies. Includes examination of different depositional models in relation both to climate and to hydrographic and geographic settings, as well as three field trips. Meeting times will be determined after registration.**EEPS 528 - TOPICS ON CARBONATES****Short Title:** TOPICS ON CARBONATES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topics may vary. 7-day field trip is required. Recommended**Prerequisite(s):** MATH 211. Repeatable for Credit.**EEPS 530 - SILICICLASTIC SEDIMENTS: DEPOSITIONAL SYSTEMS AND PROCESSES****Short Title:** SILICICLASTIC SEDIMENTS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Study of modern and ancient sedimentary environments with emphasis on field work. Depositional models examined in relation to climatic, oceanographic, and tectonic influences.**EEPS 531 - ADVANCED TOPICS IN BASIN SEDIMENTOLOGY AND STRATIGRAPHY****Short Title:** ADV TOPICS: BASIN SEDIM & STRAT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will investigate the processes that lead to the development of sedimentary stratigraphy across a continuum of depositional environments, including: fluvial, deltaic, coastal near-shore, continental shelf and slope and abyssal settings. Material will include transport linkages based on studies from modern settings, and will also cover the unique stratigraphic signatures preserved in ancient depositional systems.**EEPS 532 - ADVANCED TOPICS IN FLUVIAL-DELTAIC SEDIMENTOLOGY AND STRATIGRAPHY****Short Title:** ADV TOPICS FLUVIAL-DELTAIC**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will investigate physical and biological processes that contribute to the development of fluvial-deltaic environments. Materials will include deriving physical erosion, transport, and deposition laws, in order to evaluate modern processes that shape deltas and coastlines. The course will also focus on sedimentary deposits of fluvial-deltaic systems and preservation potential of the stratigraphy, by examining ancient depositional systems that are preserved in the rock record. The course will explore these topics by reviewing science literature that utilizes numerical, experimental, and field studies, to further theory on the development of fluvial-deltaic systems. Repeatable for Credit.**EEPS 533 - CLASTIC DEPOSITIONAL SYSTEMS FIELD TRIP****Short Title:** FIELD TRIP CLASTIC DEP SYSTEMS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This is a five day trip that takes place in northwestern New Mexico. The trip is intended for students with strong interests in sedimentology and stratigraphy and focuses on field methods in interpretation of clastic sedimentary deposits in terms of their depositional environment, sequence stratigraphic occurrence and reservoir and source rock potential. The field area includes four different basins, which provides further opportunity for discussion of sedimentary basin evolution. The course also includes reading assignments and class presentations on topics related to the trip. Repeatable for Credit.

EEPS 535 - FIELD TRIP FOR STRATIGRAPHY AND STRUCTURAL GEOLOGY**Short Title:** FIELD TRIP. STRAT AND STRUCTU**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This field trip will traverse regional geologic domains, interpreting the stratigraphy, structure, geomorphology, and paleoclimate from outcrop and subsurface data. Students will document and interpret the tectonic history, palogeography, controls on depositional systems, and related processes, leading to an understanding of the regional geology, and associated structural, stratigraphic, and petrologic framework. Class readings and discussions will provide the necessary background prior to the scheduled field trip. Repeatable for Credit.

EEPS 537 - SEMINAR: TOPICS IN SEDIMENTOLOGY AND PLANETARY TOPICS**Short Title:** SEM:TOPICS-SED AND PLANETARY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 538 - SEMINAR: CARIBBEAN****Short Title:** SEM: CARIBBEAN**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 540 - CRYOSPHERE****Short Title:** CRYOSPHERE**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** ESCI 321 or EEPS 321

Description: The growth and decay of glaciers play a large role in modulating Earth's climate system. This course focuses on physical glaciology, glacial geomorphology, the geologic record of glaciation, and glacier-climate interactions in the past, present, and future.

EEPS 541 - MOUNTAINS, CLIMATE AND GLOBAL CARBON CYCLING**Short Title:** CARBON CYCLE**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The purpose of this course is to discuss the origins of high elevations, such as mountains and epeirogenic uplifts, and their impacts of climate, global carbon cycling, and sedimentary processes. We will discuss the physics and chemistry of building mountains by magmatism and tectonic thickening as well as destroying them by erosion, chemical weathering, and delamination. We will explore perspectives from the deep Earth to the atmosphere. The seminar will meet once a week for two hours with the first hour being a thematic overview given by faculty or students and the second hour devoted to discussion of assigned papers. Recommended Prerequisite(s): (ESCI 321 or EEPS 321) and (ESCI 322 or EEPS 322) Repeatable for Credit.

EEPS 542 - MARINE GEOLOGY SYSTEMS**Short Title:** MARINE GEOLOGY SYSTEMS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course examines areas of the seafloor recently targeted by large-scale science projects, such as the ocean drilling program. The purpose is to understand current ocean geoscience problems, the research being conducted to address these problems, and preliminary results.

EEPS 543 - EARTH'S ATMOSPHERE**Short Title:** EARTH'S ATMOSPHERE**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: How and why has Earth's atmosphere evolved over time? We will begin with an understanding of the atmosphere today - its physics, chemistry, and dynamics - work backwards in time to frontiers that are comparatively data-poor. We focus on empirical/observational constraints that drive theories of atmospheric evolution on Earth and other planets. Recommended Prerequisite(s): MATH 211 Repeatable for Credit.

EEPS 544 - SEMINAR: ADVANCED TOPICS IN HYDROGEOLOGY**Short Title:** SEM:ADV TOPICS HYDROGEOLOGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.

EEPS 545 - THEORETICAL GLOBAL SEISMOLOGY I**Short Title:** THEORETICAL GLBL SEISMOLOGY I**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The course provides a path through theoretical seismology from a comprehensive analysis perspective. It consists of five parts: (i) The introduction of Earth's elastic-gravitational deformations through the calculus of variations, and the introduction of fluid-solid boundaries involving Earth's core using an action integral. (ii) The variational linearized or weak formulation of Earth's elastic-gravitational deformations. (iii) Energy estimates and well-posedness under appropriate conditions (that, for example, constrain the shapes of the major boundaries) of the system of elastic-gravitational equations describing the oscillations of the earth, and a Volterra equation justifying the extraction of the system describing acousto-elastic waves. (iv) The characterization of the spectrum of the earth, seismic normal modes and the essential spectrum associated with internal or gravity modes and embedded eigenfrequencies. The "asymptotic" resolution of the identity or seismic normal mode summation. In radial models such as PREM, a discussion of the Einstein-Brioullin-Keller quantization, trace formula and length spectrum. (v) Incorporation of dynamic ruptures, using rate- and state-dependent friction laws, generating seismic waves through an iterative coupling scheme and viscosity solutions. All parts will be illustrated with computational simulations using numerical formulations closely related to the analysis.

EEPS 546 - SEISMOLOGY II**Short Title:** SEISMOLOGY II**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Review of elastodynamics. Calculation of synthetic seismograms using asymptotic and finite-difference methods, wave propagation in layered and random media. Seismic migration and inversion using finite-difference. Kirchoff, and frequency-wave number methods.

EEPS 548 - 3D SEISMIC REFLECTION DATA INTERPRETATION**Short Title:** 3D SEISMIC REFLECTION DATA**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Prerequisite(s): ESCI 442 or ESCI 642 (may be taken concurrently) or EEPS 448 or EEPS 648 (may be taken concurrently)

Description: Workstation-based geologic interpretation of 3D seismic reflection data. The course will focus on interpreting horizons and faults tying interpretation to well data, analyzing seismic attributes, and other relevant topics. Emphasis will be placed on workflows utilized in hydrocarbon exploration. Mutually Exclusive: Cannot register for EEPS 548 if student has credit for ESCI 558.

EEPS 550 - ADVANCED TOPICS IN THE SOLID EARTH I**Short Title:** ADV TOPICS - SOLID EARTH I**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary.**EEPS 551 - ADVANCED TOPICS IN THE SOLID EARTH II****Short Title:** ADV TOPICS - SOLID EARTH II**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 552 - ADVANCED TOPICS IN GEOPHYSICS****Short Title:** ADV TOPICS IN GEOPHYSICS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 555 - SEMINAR: SEISMOLOGY****Short Title:** SEM: SEISMOLOGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 556 - SEMINAR: SEISMIC MODELING AND INVERSE METHODS****Short Title:** SEM:SEISMICMODEL&INVERSEMETHOD**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 557 - SEMINAR: GLOBAL SEISMOLOGY****Short Title:** SEM:GLOBAL SEISMOLOGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.

EEPS 560 - ADVANCED TECTONOPHYSICS/GLOBAL TECTONICS**Short Title:** ADV TECTONOPHY/GLOBL TECTONICS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 561 - TOPICS IN PLANETARY DYNAMICS AND MAGMATIC PROCESSES****Short Title:** TOPICS IN PLANETARY DYNAMICS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 563 - THE PLANET MARS: FORMATION, DIFFERENTIATION, STRUCTURE AND EVOLUTION****Short Title:** PLANET MARS: FORM, STRUCT, EVO**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This seminar addresses fundamental issues in Mars science, spanning the disciplines of geology, geophysics, geochemistry and petrology. Sources range over six decades of data from flybys and orbiting spacecraft, landed stations and rovers, and laboratory analysis of meteorites and experiments. Readings will be supplemented by presentations from active Mars researchers.**EEPS 564 - THE MOON: ORIGIN AND EVOLUTION OF EARTH'S COMPANION****Short Title:** THE MOON: ORIGIN & EVOLUTION**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This seminar course addresses fundamental issues in the origin and evolution of the Moon, spanning the disciplines of geology, geophysics, geochemistry and petrology. Sources range from classic studies to recent results from orbiting spacecraft and laboratory analysis. Readings will be supplemented by guest presentations from active researchers in the field.**EEPS 567 - SEMINAR: ADVANCED TOPICS IN EARTH STRUCTURE AND DEFORMATION****Short Title:** SEM:ADV TOPICS EARTH STRUCTURE**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Please contact the department for more details. Repeatable for Credit.**EEPS 568 - SEMINAR: DEVELOPMENTS IN STRUCTURAL GEOLOGY****Short Title:** SEM: DEV STRUCTURAL GEOLOGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 569 - SEMINAR: TECTONICS OF CONTINENTAL MARGINS****Short Title:** SEM:TECTONICS-CONTINEN-MARGINS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.**EEPS 571 - SEMINAR: TOPICS IN VOLCANOLOGY, MAGMATIC, AND HYDROTHERMAL PROCESSES****Short Title:** SEM: PHYSICAL VOLCANOLOGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Reading and discussions about current topics related to magma generation, migration, accumulation and eruption, as well as hydrothermal systems. Repeatable for Credit.**EEPS 572 - SEMINAR: ADVANCED TOPICS IN GEOFLUIDS, GEOTHERMICS, AND PLANETARY EVOLUTION****Short Title:** SEM:GEOFLUIDS/THERMICS, PLANET**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary.**EEPS 578 - HYDROCARBON EXPLORATION****Short Title:** HYDROCARBON EXPLORATION**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A student team will analyze and assess petroleum prospects in a sedimentary basin. Using a dataset of industry well/seismic data, the team will analyze data, identify/prioritize exploration targets, and prepare a formal presentation. Team will review their findings to industry judges for AAPG Imperial Barrel Award competition.

EEPS 579 - APPLIED SUBSURFACE SYSTEMS: ANALYTICAL METHODS FOR ENERGY AND SUSTAINABILITY

Short Title: APPLIED SUBSURFACE SYSTEMS

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture/Laboratory

Credit Hours: 4

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: This course has lecture, lab, and field components. Students will learn about the components of the hydrocarbon system and how to rank areas of a basin for prospectively. Activities will be organized on a class and small group basis. Recommended Prerequisite(s): ESCI 323 or EEPS 323 or ESCI 427 or EEPS 430 or ESCI 627 or EEPS 630

EEPS 580 - SEMINAR: QUANTITATIVE PETROLEUM SYSTEMS ANALYSIS

Short Title: QUANT PETROLEUM SYS ANALYSIS

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Seminar

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: Seminar topics may vary. Course taught at the University of Houston. Repeatable for Credit.

EEPS 581 - MODERN EXPLORATION TECHNOLOGY

Short Title: MODERN EXPLORATION TECHNOLOGY

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Prerequisite(s): ESCI 442 or ESCI 642 or EEPS 448 or EEPS 648

Corequisite: EEPS 455

Description: Modern petroleum exploration techniques using geology, geophysics, and information technology methods. As new techniques emerge, the course will change to ensure that the course material mirrors the exploration industry.

EEPS 582 - GEOSCIENCES FOR THE ENERGY TRANSITION

Short Title: ENERGY TRANSITION GEOSCIENCES

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: A broad introduction to the intersection between the energy transition and geoscience. The focus will be on subsurface technologies relevant to carbon mitigation, low carbon power, energy storage, and critical materials, while also introducing the climate and resource drivers for this transition. The course will introduce fundamental concepts, applications to subsurface systems, and their impact on the future of energy production and utilization. Recommended Prerequisite(s): MATH 101/102 or equivalent; PHYS 101/102 or equivalent; competence in a structured programming language.

EEPS 583 - DATA MANAGEMENT AND DATA GOVERNANCE

Short Title: DATA MANAGEMENT

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: An organization's data is recognized as the most vital asset of an enterprise, yet far too many fail to appreciate the legal and fiscal responsibilities and liabilities associated with it. This course covers the foundations, principles and methodology of data management and data governance to ensure such high quality data.

EEPS 584 - DATA SCIENCE ENVIRONMENTAL AND GEOSCIENCES

Short Title: DATA SCIENCE GEO-HYDRO-ENV APP

Department: Earth/Environment/Planetary Sci

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: This course focuses on practical applications of common data science techniques to extract information from environmental, hydrologic and geological data. Lectures cover theories and examples with biweekly course work assignments. Students are required to complete a group project and presentation at the end of the course.

EEPS 585 - COMPUTATIONAL AND DATA SCIENCE IN THE ENERGY INDUSTRY**Short Title:** COMP&DATA SCI ENERGY INDUSTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will be dedicated to problems and topics occurring in the energy industry, both in R&D and in operations. It has three main components: 1. Computational Geophysics 2. Reservoir Simulation Fundamentals 3. Machine Learning The first two components will be taught together in the first 10 weeks by dedicating half of the class-time to each subject. The Machine Learning component will, in part, build on the first two fundamental components and will be taught using the full class time. Computational Geophysics The participants in this geophysics part of the course are expected to be interested to learn how to use modern seismic data to image the subsurface with awareness of the computational costs of the techniques involved. The main focus will be given to current seismic imaging tools including cutting-edge Machine Learning (ML) applications. As the result of the successful completion of this course part, the course participants should be able to: (1) Understand the context and value of imaging tools for the hydrocarbon exploration business. (2) Relate the imaging tools with their computational costs for modern computer resources. (3) Properly use wave-based geophysical imaging and ML-based tools and (4) Understand main seismic processing and interpretation decisions. Applied Reservoir Simulation This component of the course will introduce participants to the practice of reservoir simulation. This class will be an applied course on reservoir simulation. Theoretical descriptions will be provided as warranted but will be kept to minimum. Class participants will learn about the fundamentals of applied reservoir simulation, use of a reservoir simulator, and how to select the proper model for a simulation study. This course will also cover data preparation, grid design, calibration of the reservoir model, forecasting of future performance, and interpretation of simulation results. Participants will also be introduced to the role of simulation in reservoir management, limitations of reservoir simulation, and the structural aspects of the models. Upscaling and recent advances simulation techniques will also be discussed. A realistic open-source reservoir simulation software will be used during the tutorials and computer projects. Machine Learning for Oil & Gas This part of the course will introduce the fundamentals of statistical learning, present a few of the popular learning paradigms and algorithms, and culminate in a small student project applying them to an oil reservoir data set using the R programming language (solutions to class problems will be accepted in any programming language or system). Much of the material presented here is also known under the names "Big Data", "Data Analytics", "Artificial Intelligence", "Data Mining", "Petroleum Data Driven Analytics" and other terms. Weeks 11 and 12 are theory only, weeks 13-15 will have small hands-on exercises incorporated and week 16 and 17 are dedicated to solving a simple oil reservoir problem using machine learning.

EEPS 586 - DATA SCIENCE METHODS AND DATA MANAGEMENT**Short Title:** METHODS DATA SCIENCE/MGMT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Data has become a critical asset for enabling organizations to be competitive, make better decisions and support diverse stakeholders. In recent years, new methods, tools and techniques for data management and processing have been developed. In this vein, ensuring that users have the knowledge and skills to profit from this wealth of information is critical. In this course, participants will learn a holistic overview about infrastructure, data life cycles, metadata standards, policies and techniques for successfully managing and using data for decision-making. The emphasis of the course will be from the perspective of the Oil & Gas and Energy Industries. Recommended Prerequisite(s): Basic programming, introductory statistics

EEPS 587 - SEM: PETROLEUM GEOCHEMISTRY - PRINCIPALS AND PRACTICE**Short Title:** SEM: PETROLEUM GEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Seminar topics may vary. Course taught at the University of Houston. Repeatable for Credit.

EEPS 589 - TOPICS IN GEOMATHEMATICS**Short Title:** TOPICS IN GEOMATHEMATICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Content varies from year to year. Recommended Prerequisite(s): CAAM 335 and CAAM 336

EEPS 590 - SEMINAR: DEPARTMENT TYPE-LOCALE FIELD TRIPS**Short Title:** SEM:DEPT-LOCALE-FIELD TRIPS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Seminar topics may vary. Repeatable for Credit.

EEPS 591 - SEMINAR: DEPARTMENT TYPE - LOCALE FIELD TRIP**Short Title:** SEM: LOCALE FIELD TRIP**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics vary depending on location of field trip. This is a Seminar/Trip type course combination. Undergraduates are required to take prerequisites to register for this course. Prerequisites do not apply for graduate students. Prerequisites may be taken concurrently. Additional fee may be required for this course. Instructor Permission Required. Repeatable for Credit.**EEPS 592 - SPECIAL TOPICS IN EARTH, ENVIRONMENTAL & PLANETARY SCIENCES****Short Title:** SPECIAL TOPICS IN EEPS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 1-2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course deals with miscellaneous special topics not covered in other courses. Please contact the Earth Science department for the specific topics. Topics change each semester. Repeatable for Credit.**EEPS 593 - INTRODUCTION TO GEOTHERMAL ENERGY SYSTEMS****Short Title:** GEOTHERMAL ENERGY**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will provide a broad overview and introduction to geothermal energy systems and how they fit into the future energy source mix. Students will gain an understanding of the advantages, disadvantages, and challenges of using the earth's internal heat as a low-carbon, resilient energy source. We will cover the technical aspects of finding, developing, and producing energy from the earth; we will also cover some of the non-technical ESG-related challenges. Each student will undertake a self-paced evaluation of a geothermal opportunity using the tools and techniques covered in the course and will make a final presentation of that evaluation to the class. The course will include an optional 2–3-day field trip to an active geothermal site to see field operations in action. Although there are no prerequisites for this course, students should have a general knowledge of Earth Science.**EEPS 594 - PRACTICAL METHODS OF EARTH SCIENCE COMMUNICATION****Short Title:** EARTH SCIENCE COMMUNICATION**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will introduce students to the methods of communicating earth science to the public, by exposing them to professionals and researchers from various communication careers. It will teach students to convey science to the lay audience through several methods, such as media reporting, museum programming, website development, blogging, and general public outreach.**EEPS 595 - PITCHING YOUR SCIENCE****Short Title:** PITCHING YOUR SCIENCE**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course is designed for senior level graduate students who will be facing high-stakes professional speaking opportunities, such as impromptu job conversations, formal academic and professional presentations, conversations with journalists, and/or industrial job interviews. Students will construct and practice 90-second, 5-minute, and 15-minute presentations. Most assignments will take place in-class, with limited work occurring outside of the classroom. Requirement: Participation in the Rice University 90-second thesis competition. Instructor Permission Required.**EEPS 597 - GEOPHYSICAL FIELD WORK FOR EDUCATORS****Short Title:** GEOPHYS FLD WK FOR EDUCATORS**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course consists of 2 weeks of geophysical field work and is designated for in-service K-12 teachers. Instructor Permission Required. Repeatable for Credit.**EEPS 598 - PUTTING EARTH SCIENCE INTO ACTION****Short Title:** SEM: EARTH SCIENCE INTO ACTION**Department:** Earth/Environmnt/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Seminar topics may vary. Repeatable for Credit.

EEPS 603 - SEMINAR: DEPARTMENT RESEARCH**Short Title:** SEMINAR: DEPARTMENT RESEARCH**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Introduction to current research in the Earth, Environmental and Planetary Sciences department. Students will learn how to give a presentation and will get experience presenting their research. Graduate/Undergraduate Equivalency: EEPS 403. Mutually Exclusive: Cannot register for EEPS 603 if student has credit for EEPS 403. Repeatable for Credit.**EEPS 604 - SEMINAR: DEPARTMENT RESEARCH****Short Title:** SEMINAR: DEPARTMENT RESEARCH**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Introduction to current research in the Earth, Environmental and Planetary Sciences department. Students will learn how to give a presentation and will get experience presenting their research. Graduate/Undergraduate Equivalency: EEPS 404. Mutually Exclusive: Cannot register for EEPS 604 if student has credit for EEPS 404. Repeatable for Credit.**EEPS 605 - SEMINAR: CURRENT RESEARCH IN EARTH, ENVIRONMENTAL AND PLANETARY SCIENCES****Short Title:** SEM:CURRENT RESEARCH IN EEPS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A series of lectures and paper discussions in various areas of Earth, Environmental and Planetary sciences. Graduate/Undergraduate Equivalency: EEPS 405. Mutually Exclusive: Cannot register for EEPS 605 if student has credit for EEPS 405. Repeatable for Credit.**EEPS 606 - SEMINAR: CURRENT RESEARCH IN EARTH, ENVIRONMENTAL AND PLANETARY SCIENCES****Short Title:** SEM:CURRENT RESEARCH IN EEPS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A series of lectures and paper discussions in various areas of Earth, Environmental and Planetary sciences. Graduate/Undergraduate Equivalency: EEPS 406. Mutually Exclusive: Cannot register for EEPS 606 if student has credit for EEPS 406. Repeatable for Credit.**EEPS 610 - OPTICAL MINERALOGY AND PETROGRAPHY****Short Title:** OPTICAL MINERALOGY & PETROGRPH**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This is a lab course focused on the identification of minerals with petrographic microscopy. Principles of crystallography, mineral optics, and mineral chemistry will be covered in the first third of the course. The second third of the course will focus on the identification of minerals in igneous, metamorphic, and sedimentary rocks with emphasis on petrogenetic interpretation. The last third of the course will involve each student working on specific petrologic themes in the context of regional tectonics or magmatic processes. Taught every other Fall. Graduate/Undergraduate Equivalency: EEPS 410. Mutually Exclusive: Cannot register for EEPS 610 if student has credit for EEPS 410/ESCI 410/ESCI 610.**EEPS 611 - CHARACTERIZATION OF EARTH, ENVIRONMENTAL, AND PLANETARY MATERIALS****Short Title:** MATERIALS CHARACTERIZATION**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will provide an overview of various characterization methods used in geological, chemical, material science and other natural science and engineering research. The techniques that will be discussed include but not limited to electron beam methods (imaging and spectroscopy), X-ray methods, ion-beam analysis, vibrational spectroscopies, and Synchrotron-based techniques. Graduate/Undergraduate Equivalency: EEPS 411. Mutually Exclusive: Cannot register for EEPS 611 if student has credit for EEPS 411/ESCI 419/ESCI 619.**EEPS 612 - ADVANCED PETROLOGY****Short Title:** ADVANCED PETROLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Evaluation of the evolution of igneous rocks in the Earth's crust and mantle. Topics will include phase equilibria, experimental studies, and geochemistry. Labs will stress thin section petrography. Graduate/Undergraduate Equivalency: EEPS 412. Mutually Exclusive: Cannot register for EEPS 612 if student has credit for EEPS 412. Repeatable for Credit.

EEPS 613 - ADVANCED PETROLOGY II**Short Title:** ADVANCED PETROLOGY II**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will bring together constraints from field geology, petrography, petrology, geochemistry, and geodynamics to tackle advanced A87 research questions of whole Earth processes that are relevant in the 21st century. The topics that may be covered include, but are not limited to, interplay between magmatic and tectonic processes, magma generation, migration, extraction, and dynamic stability in various settings, magmatic differentiation, volatiles and fluids exchange between various reservoirs and effects on long-term climate, ore genesis, and formation and modification of continents. Graduate/Undergraduate Equivalency: EEPS 413. Mutually Exclusive: Cannot register for EEPS 613 if student has credit for EEPS 413.

EEPS 615 - GEOCHEMISTRY OF EARTH'S SURFACE**Short Title:** GEOCHEM EARTH'S SURFACE**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will cover concepts in aqueous geochemistry in the context of chemical weathering and Earth's major biogeochemical cycles. Central to this course will be weekly student-led discussions of scientific literature. Students will also learn basic numerical modeling and data analysis techniques using MATLAB, field methods, and basic analytical chemistry. Graduate/Undergraduate Equivalency: EEPS 415. Mutually Exclusive: Cannot register for EEPS 615 if student has credit for EEPS 415/ESCI 407/ESCI 607.

EEPS 617 - TRACE-ELEMENT AND ISOTOPE GEOCHEMISTRY FOR EARTH AND ENVIRONMENTAL SCIENCE**Short Title:** TRACE-ELEMENT& ISOTOPE GEOCHEM**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Introduction to the principles of trace-element and isotope geochemistry and their applications to high and low temperature processes in the earth. Topics to be covered are trace-element partitioning, basic quantum physics, radiogenic isotopic systems and stable isotope fractionation. Graduate/Undergraduate Equivalency: EEPS 417. Mutually Exclusive: Cannot register for EEPS 617 if student has credit for EEPS 417/ESCI 430/ESCI 630.

EEPS 618 - TRACE ELEMENT AND ISOTOPE GEOCHEMISTRY**Short Title:** ISOTOPE GEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: An introduction to the principles and techniques of stable and radiogenic geochemistry in the geosciences. The course will begin by examining the fundamental physics relevant to isotope partitioning and decay, followed by a survey of different isotope systems and how they are used to study surface processes, element cycling, climate, and planetary science. Graduate/Undergraduate Equivalency: EEPS 418. Recommended Prerequisite(s): ESCI 322 or EEPS 322 Mutually Exclusive: Cannot register for EEPS 618 if student has credit for EEPS 418/ESCI 433/ESCI 633.

EEPS 620 - ORGANIC GEOCHEMISTRY**Short Title:** ORGANIC GEOCHEMISTRY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course covers the organic geochemistry of the natural environment. Topics include: production, transport, decomposition, and storage of organic matter in the marine and terrestrial environments, use of isotopes to track biogeochemical processes and natural and perturbed carbon cycle issues, including past and recent climate shifts. Graduate/Undergraduate Equivalency: EEPS 420. Mutually Exclusive: Cannot register for EEPS 620 if student has credit for EEPS 420/ESCI 425/ESCI 625.

EEPS 625 - PLANETARY SURFACE PROCESSES**Short Title:** PLANETARY SURFACE PROCESSES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course is designed to expand understanding of geologic processes by considering how common or distinctive different geologic processes are on Earth compared to other bodies throughout the solar system. Students will leave the course with an appreciation for the types of surface processes that dominate different bodies throughout the solar system. How does the surface of Earth compare to the surfaces of other bodies in our solar system? How can we best extrapolate our understanding of Earth to other bodies? What do we learn about Earth from such comparisons? Graduate/Undergraduate Equivalency: EEPS 425. Mutually Exclusive: Cannot register for EEPS 625 if student has credit for EEPS 425.

EEPS 626 - GEOMORPHOLOGY**Short Title:** GEOMORPHOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will investigate physical, chemical, and biological processes that contribute to the development and shaping of Earth's surface across a continuum of subaerial and subaqueous environments. Mandatory 4-day field trip is associated with this class. Graduate students will be assigned exercises more challenging than those assigned to undergraduate students. Graduate/Undergraduate Equivalency: EEPS 426. Mutually Exclusive: Cannot register for EEPS 626 if student has credit for EEPS 426/ESCI 431/ESCI 631. Repeatable for Credit.

EEPS 627 - MECHANICS OF SEDIMENT TRANSPORT**Short Title:** MECHANICS-SEDIMENT TRANSPORT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Evaluation of sedimentary transport dynamics: physical interaction between fluid flow and sediment mobility, from grain to bedform scale; exploration of environments including rivers, estuaries, deltas, coastlines, and deserts. Examination of sediment transport for geology, environmental, and engineering applications; formation of diagnostic sedimentary features recognized in the stratigraphic record. Graduate/Undergraduate Equivalency: EEPS 427. Mutually Exclusive: Cannot register for EEPS 627 if student has credit for EEPS 427/ESCI 435/ESCI 635.

EEPS 628 - ANTARCTIC MARINE GEOLOGY**Short Title:** ANTARCTIC MARINE GEOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The study of marine geologic principles and processes using examples from the Southern Oceans. Graduate/Undergraduate Equivalency: EEPS 428. Mutually Exclusive: Cannot register for EEPS 628 if student has credit for EEPS 428/ESCI 423/ESCI 623.

EEPS 629 - PALEOCEANOGRAPHY**Short Title:** PALEOCEANOGRAPHY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The evolution of the ocean, climate and the global carbon cycle over the last 100 million years as recorded by the biology, chemistry and composition of deep-sea sediment. Graduate/Undergraduate Equivalency: EEPS 429. Mutually Exclusive: Cannot register for EEPS 629 if student has credit for EEPS 429/ESCI 421/ESCI 621.

EEPS 630 - SEQUENCE STRATIGRAPHY**Short Title:** SEQUENCE STRATIGRAPHY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will introduce students to the concepts of sequence stratigraphy and the power behind this correlation technique. The course is divided between classic sequence stratigraphy using cores, well-logs, and outcrop examples and seismic sequence stratigraphy. Graduate/Undergraduate Equivalency: EEPS 430. Mutually Exclusive: Cannot register for EEPS 630 if student has credit for EEPS 430/ESCI 427/ESCI 627.

EEPS 632 - QUANTITATIVE HYDROGEOLOGY**Short Title:** QUANTITATIVE HYDROGEOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Advanced course that will provide a quantitative overview of groundwater hydrology. Emphasis will be placed on mastering concepts in fluid mechanics and applying these concepts to water supply, environmental, and geological problems. Graduate/Undergraduate Equivalency: EEPS 432. Mutually Exclusive: Cannot register for EEPS 632 if student has credit for EEPS 432/ESCI 418/ESCI 618.

EEPS 633 - CLIMATE DYNAMICS**Short Title:** CLIMATE DYNAMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Earth's climate is a chaotic system, characterized by nonlinear interactions between the ocean, atmosphere, and land surfaces. This course will focus on the dynamics of the ocean and atmosphere, including the drivers of large-scale circulation, heat transport, and modes of natural variability. We will also explore projections of future climate change scenarios and records of historical climate change. Students will learn to post-process climate model output, analyze, and map these data using Python. Graduate/Undergraduate Equivalency: EEPS 433. Mutually Exclusive: Cannot register for EEPS 633 if student has credit for EEPS 433.

EEPS 634 - CLIMATE OF THE COMMON ERA

Short Title: CLIMATE OF THE COMMON ERA
Department: Earth/Environment/Planetary Sci
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: This course explores climate variability and change over the past two thousand years to contextualize current rates and magnitudes of anthropogenic climate change on Earth. This reading and discussion-focused seminar course will cover paleoclimate archives such as corals, tree rings, and ice cores, as well as climate reconstruction methods, detection and attribution. Students will be provided with an overview of methods and key findings in paleoclimatology and paleoceanography, using high-resolution archives to explore past changes in global climate. Students will read 3-4 scientific papers each week, provide summaries and volunteer to lead discussions surrounding topics of their choosing. Graduate/Undergraduate Equivalency: EEPS 434. Mutually Exclusive: Cannot register for EEPS 634 if student has credit for EEPS 434.

EEPS 635 - REMOTE SENSING

Short Title: REMOTE SENSING
Department: Earth/Environment/Planetary Sci
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: Introduction to electromagnetic remote sensing of the Earth and other planets using passive and active methods. The course includes a computer lab component involving processing and interpretation of remote sensing imagery, and an individual project. Graduate/Undergraduate Equivalency: EEPS 435. Mutually Exclusive: Cannot register for EEPS 635 if student has credit for EEPS 435.

EEPS 636 - GIS FOR SCIENTISTS AND ENGINEERS

Short Title: GIS FOR SCIENTISTS
Department: Earth/Environment/Planetary Sci
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: Basic principles of Geographic Information Systems, with a focus on effectively applying the technology to the geosciences. Main platform of the class will be ESRI's ArcGIS, but a wide array of other tools will also be introduced. Material will be delivered via a blend of lecture and hands-on exercises. Graduate/Undergraduate Equivalency: EEPS 436. Mutually Exclusive: Cannot register for EEPS 636 if student has credit for EEPS 436.

EEPS 637 - EARTH'S NATURAL RESOURCES FOR THE ENERGY TRANSITION

Short Title: EARTH'S NATURAL RESOURCES
Department: Earth/Environment/Planetary Sci
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: Modern society depends strongly on the resources extracted from the earth. As the world advances technologically and as the human population continues to grow, that demand will only become stronger. In this course, we will investigate where the resources necessary for a modern functioning society comes from, the geology of those areas, extraction techniques, and the geopolitics surrounding those resources. Some resources we will consider will be metal ore deposits (gold, copper, etc.), battery deposits (lithium, cobalt, rare earth elements), hydrocarbons, and water. We will also discuss the climate impacts associated with extraction. Graduate/Undergraduate Equivalency: EEPS 437.

EEPS 638 - THE SCIENCE OF NATURE-BASED CARBON SEQUESTRATION

Short Title: NATURE-BASED CARBON SEQUESTRATION
Department: Earth/Environment/Planetary Sci
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: This course introduces nature-based solutions to climate change, reviewing existing and proposed nature-based solutions and covering the role of nature-based solutions in an overall greenhouse-gas reduction portfolio. Students will build the scientific background to evaluate new proposed nature-based solutions through a series of lectures and case studies, building a strong understanding of the global carbon, nitrogen, and water cycles. Graduate/Undergraduate Equivalency: EEPS 438. Recommended Prerequisite(s): The equivalent of one semester of Earth surface processes or introduction to climate change at the undergraduate level.

EEPS 639 - GEOMICROBIOLOGY

Short Title: GEOMICROBIOLOGY
Department: Earth/Environment/Planetary Sci
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: This course will introduce geomicrobiology from an Earth system context, exploring how microbes fundamentally shape the Earth. Concepts covered will include the diversity of microbial metabolisms and the impacts of these metabolisms on the environment, applications of new microbial methods to Earth system questions, and the geomicrobiology of soils, oceans, the deep subsurface, as well as engineered environments (e.g. wastewater). Graduate/Undergraduate Equivalency: EEPS 439. Mutually Exclusive: Cannot register for EEPS 639 if student has credit for EEPS 439.

EEPS 645 - EARTH AND PLANETARY INTERIORS**Short Title:** EARTH AND PLANETARY INTERIORS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Formation and differentiation of Earth and Planetary systems. Structural seismology and the composition of the Earth and our solar system's planetary interiors. Earth's gravity, geoid, density, and moment of inertia. Heat flow and Earth energetics. Earth's core and magnetic field. Mantle convection and plate tectonics. Oceanic and continental lithosphere. Graduate/Undergraduate Equivalency: EEPS 445. Mutually Exclusive: Cannot register for EEPS 645 if student has credit for EEPS 445.**EEPS 646 - SEISMOLOGY I****Short Title:** SEISMOLOGY I**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Principles of elastic wave propagation, the determination of Earth structure, and the understanding of earthquake physics. Graduate/Undergraduate Equivalency: EEPS 446. Mutually Exclusive: Cannot register for EEPS 646 if student has credit for EEPS 446/ESCI 461/ESCI 661.**EEPS 648 - EXPLORATION GEOPHYSICS****Short Title:** EXPLORATION GEOPHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Study of the principles and procedures involved in geophysical exploration. Includes acquisition, processing, and interpretation of seismic, ground-penetrating radar, gravity, magnetic, and electrical data. Graduate/Undergraduate Equivalency: EEPS 448. Mutually Exclusive: Cannot register for EEPS 648 if student has credit for EEPS 448/ESCI 442/ESCI 642.**EEPS 650 - GEOPHYSICAL DATA ANALYSIS: DIGITAL SIGNAL PROCESSING****Short Title:** GEOPHYSICAL DATA ANALYSIS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Data sampling, aliasing, discrete Fourier transform, digital filter design techniques, z-transform, and discrete Hilbert transform are introduced. Deconvolution, velocity filters, polarization filter, stacking, beam forming and migration techniques will be taught together with their application in geophysical studies. Graduate/Undergraduate Equivalency: EEPS 450. Mutually Exclusive: Cannot register for EEPS 650 if student has credit for EEPS 450/ESCI 440/ESCI 640.**EEPS 651 - GEOPHYSICAL DATA ANALYSIS: INVERSE METHODS****Short Title:** GEOPHYSICAL DATA ANALYSIS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Review of linear algebra and probability. Data fitting, model parameter estimation, inverse theory, linear and nonlinear methods, and global optimization. Graduate/Undergraduate Equivalency: EEPS 451. Mutually Exclusive: Cannot register for EEPS 651 if student has credit for EEPS 451.**EEPS 654 - INTRODUCTION TO SEISMIC INTERPRETATION: STRUCTURAL STYLES AND SEISMIC STRATIGRAPHY****Short Title:** 2D SEISMIC STRUCTURE AND STRAT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** ESCI 642 or EEPS 648 (may be taken concurrently)**Description:** This course will introduce students to analysis of sub-regional structural and stratigraphic frameworks. We will utilize the interpretation of 2D seismic profiles to reconstruct basin history and discuss implications for petroleum systems. Students will gain an understanding of a variety of structural and stratigraphic styles, as expressed on seismic data. Graduate/Undergraduate Equivalency: EEPS 454. Mutually Exclusive: Cannot register for EEPS 654 if student has credit for EEPS 454.**EEPS 658 - ENVIRONMENTAL & APPLIED ROCK PHYSICS****Short Title:** APPLIED ROCK PHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Rock physics, the study of the impact of rock microstructure, mineralogy, fluids, stress state, and diagenetic features on wave propagation in porous media. Understanding the use of such relationships for quantitative analysis of seismic datasets. Applications to geologic carbon storage, permafrost characterization, geothermal systems, and hydrogeology. Graduate/Undergraduate Equivalency: EEPS 458. Mutually Exclusive: Cannot register for EEPS 658 if student has credit for EEPS 458.

EEPS 659 - WELL LOGGING AND PETROPHYSICS**Short Title:** WELL LOGGING AND PETROPHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Basics of wireline logging and logging while drilling including borehole environment, resistivity, radiation, thermal, and elastic wave measurements and measuring tools. Building from this introduction, basic interpretation of logging data and formation evaluation will be studied. Graduate/Undergraduate Equivalency: EEPS 459. Mutually Exclusive: Cannot register for EEPS 659 if student has credit for EEPS 459.

EEPS 660 - GLOBAL TECTONICS**Short Title:** GLOBAL TECTONICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Geometrical aspects of plate tectonics, the 3 traditional types of plate boundaries, instantaneous plate motions, earthquakes and faulting, space geodesy, geomagnetic reversals, paleomagnetic poles, hotspots, "absolute" plate motion, true polar wander, driving forces, diffuse plate boundaries, plate nonrigidity, and rheology of the lithosphere. Graduate/Undergraduate Equivalency: EEPS 460. Mutually Exclusive: Cannot register for EEPS 660 if student has credit for EEPS 460.

EEPS 661 - STRUCTURE AND EVOLUTION OF TECTONIC SYSTEMS**Short Title:** TECTONIC SYSTEMS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The distribution, origin, and evolution of various tectonic systems, and characterization of their structural and geophysical signatures, emphasizing crustal and lithospheric processes associated with tectonic deformation. Review of representative global examples of convergent and collisional margins, divergent and passive margins, and transform margins. Graduate/Undergraduate Equivalency: EEPS 461. Mutually Exclusive: Cannot register for EEPS 661 if student has credit for EEPS 461.

EEPS 662 - TECTONOPHYSICS**Short Title:** TECTONOPHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Applications of continuum physics to the deformation, flexure, heat transfer, and gravity field of the lithosphere. Graduate/Undergraduate Equivalency: EEPS 462. Mutually Exclusive: Cannot register for EEPS 662 if student has credit for EEPS 462.

EEPS 663 - THE PHYSICS OF FAULTING AND EARTHQUAKES**Short Title:** EARTHQUAKE PHYSICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: In this class students will learn about the physics of earthquakes and earthquake hazards. This course will describe faults, the structures on which most earthquakes occur, and their locations on Earth. Students will learn about the physics behind faulting and how this leads to earthquakes and controls earthquake size. In addition, students will learn to relate different faulting characteristics to earthquake hazards through an understanding of earthquake energy budget. This course requires no previous coursework in Earth, Environmental, and Planetary Sciences. Graduate/Undergraduate Equivalency: EEPS 463.

EEPS 664 - HEAT, AND MASS TRANSPORT ON EARTH AND PLANETS**Short Title:** GEODYNAMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Introduction to the use of continuum mechanics to solve fundamental problems related to mass and energy transport problems arising in the study of solid Earth, planets and moons. Topics include: heat conduction, convective heat transfer, planetary thermal evolution, geological fluid dynamics, flow through porous media, rheology of planetary materials. Graduate/Undergraduate Equivalency: EEPS 464. Mutually Exclusive: Cannot register for EEPS 664 if student has credit for EEPS 464.

EEPS 665 - ROCK DEFORMATION AND RHEOLOGY**Short Title:** ROCK DEFORMATION AND RHEOLOGY**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Advanced course in the foundations of fluid mechanics and its application to Earth science. Aspects of continuum mechanics, heat and mass transfer, and the rheologic behavior of materials will be covered in developing the fundamental laws that describe fluid motion. Applications include atmospheric dynamics, mantle and lithospheric dynamics, and hydrogeology. Graduate/Undergraduate Equivalency: EEPS 465.

EEPS 667 - GEOMECHANICS**Short Title:** GEOMECHANICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** An examination of deformation and failure processes within the Earth's shallow crust, with a focus on rock and sediment mechanics, and associated fluid processes. Emphasis will be on geologic applications, including sediment consolidation, slope stability, fault mechanics, and earthquake nucleation and rupture. Graduate/Undergraduate Equivalency: EEPS 467. Mutually Exclusive: Cannot register for EEPS 667 if student has credit for EEPS 467.**EEPS 668 - VOLCANOES****Short Title:** VOLCANOES**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Introduction to volcanoes and associated physical processes. Conceptual and quantitative discussion of topics related to magma transport, magma storage, and volcanic eruptions. The course includes a 4-6 day field trip to California and Oregon. Graduate/Undergraduate Equivalency: EEPS 468. Mutually Exclusive: Cannot register for EEPS 668 if student has credit for EEPS 468.**EEPS 669 - PLANETARY VOLCANISM****Short Title:** PLANETARY VOLCANISM**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This seminar will cover the broad range of volcanic phenomena in the solar system, via weekly readings of, and student presentations on, classic and recent papers. Topics include: Composition (basaltic, silicic, unusual, carbonatite), cryovolcanism, structure (caldera, rift zones, volcanic spreading radiating dike systems, magma chambers, and sill complexes), and dynamics (eruption mechanism, effusive vs. explosive, volatiles and atmospheres/oceans). The planetary settings to be considered include Earth, Venus, Mars, Mercury, Moon, large asteroids and outer planet satellites. Graduate/Undergraduate Equivalency: EEPS 469. Mutually Exclusive: Cannot register for EEPS 669 if student has credit for EEPS 469.**EEPS 671 - EARTH SYSTEMS MODELING I: PHILOSOPHY AND FUNDAMENTALS****Short Title:** EARTH SYSTEMS MODELING I**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A model is a simplified representation of something. Scientific models range from conceptual to physical to mathematical. In Earth and planetary science, one is often concerned with modeling interactions between physical, chemical, and biological components, i.e., with modeling systems. This class will cover the fundamentals of scientific modeling with a focus on Earth systems. Graduate/Undergraduate Equivalency: EEPS 471. Mutually Exclusive: Cannot register for EEPS 671 if student has credit for EEPS 471. Repeatable for Credit.**EEPS 672 - EARTH SYSTEMS MODELING: NUMERICAL TECHNIQUES AND APPLICATIONS****Short Title:** NUMERICAL METHODS EARTH SYSTEM**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Introduction to numerical methods with applications in Earth Science using Matlab and COMSOL. Much of the class is spent in the computer lab learning Matlab and COMSOL, followed by hands-on exercises. Graduate/Undergraduate Equivalency: EEPS 472. Mutually Exclusive: Cannot register for EEPS 672 if student has credit for EEPS 472. Repeatable for Credit.**EEPS 673 - FORMATION AND EVOLUTION OF PLANETARY SYSTEMS****Short Title:** PLANETARY FORMATION**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course introduces students to the state-of-the-art knowledge about the processes underlying the formation and evolution of planetary systems. This course will review basic ideas of orbital planetary dynamics and the different stages of planet formation. The course aims at developing important quantitative and qualitative skills to analyze and understand the main physical processes that operate in young planetary systems. The course will be guided by modern planet formation models using different tools and constraints from planetary physics, celestial mechanics, astronomical-observations, geochemistry, and cosmochemistry. Graduate/Undergraduate Equivalency: EEPS 473. Recommended Prerequisite(s): MATH 101 and MATH 102 and MATH 211 or equivalents Mutually Exclusive: Cannot register for EEPS 673 if student has credit for EEPS 473.

EEPS 677 - SPECIAL TOPICS**Short Title:** SPECIAL TOPICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar, Independent Study, Internship/Practicum, Laboratory, Lecture, Lecture/Laboratory**Credit Hours:** 1-4**Course Level:** Graduate**Description:** Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**EEPS 680 - ENERGY TRANSITION SEMINAR****Short Title:** ENERGY TRANSITION SEMINAR**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Course Level:** Graduate**Description:** This seminar course will provide an introduction to the energy transition broadly defined, but focusing primarily on its impact and importance in the earth sciences. Once a week an invited expert will give a 50-minute lecture on topics that may include: carbon capture and sequestration, carbon markets, geothermal energy, climate change, hydrogen, energy storage, critical minerals, ecological impacts of resource extraction, hydrocarbon sustainability, water resources, energy systems and sustainable development, energy transition policy, and energy transition economics. Topics and speakers will change each year. There are no prerequisites for this course and undergraduate and graduate students do not have to have an earth science background. Cross-list: CHBE 680. Graduate/Undergraduate Equivalency: EEPS 480. Mutually Exclusive: Cannot register for EEPS 680 if student has credit for EEPS 480. Repeatable for Credit.**EEPS 684 - DECISION MAKING AND ECONOMICS IN THE ENERGY INDUSTRY****Short Title:** DECISION MAKING AND ECONOMICS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** This course will provide students with an understanding of how energy projects are evaluated. Topics include resource-size determination, geologic and economic risk, discounted cash-flow economics, and other common methods used in decision making. Emphasis will be placed on working in teams to understand basic concepts and sensitivities. Graduate/Undergraduate Equivalency: EEPS 484. Mutually Exclusive: Cannot register for EEPS 684 if student has credit for EEPS 484.**EEPS 686 - PETROLEUM INDUSTRY ECONOMICS AND MANAGEMENT****Short Title:** PETROLEUM IND ECONOMICS MGMT**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Topics covered include resource size determination; geologic risk analysis; establishing minimum economic thresholds; economic chance factors; the concepts of present worth, investment efficiency, rates of return. Price forecasting, cost inflation are discussed. Graduate/Undergraduate Equivalency: EEPS 486. Mutually Exclusive: Cannot register for EEPS 686 if student has credit for EEPS 486.**EEPS 688 - ECONOMIC GEOLOGY MINERAL DEPOSITS****Short Title:** ECON GEOL MINERAL DEPOSITS**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** An overview of metallic and nonmetallic mineral deposits, theories of their origin, and classification. The impact of government regulation, economics, production practices, and exploration will be considered. Graduate/Undergraduate Equivalency: EEPS 488. Mutually Exclusive: Cannot register for EEPS 688 if student has credit for EEPS 488.**EEPS 699 - GRAPHIC AND VISUAL DESIGN FOR SCIENTISTS****Short Title:** GRAPHIC AND VISUAL DESIGN**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A significant portion of a scientist's time is spent solving visual design problems (graphics for papers, visual layouts for seminars, posters, teaching). Effective communication of scientific information is part of a scientist's skill set. This class is designed to enhance that skill set in terms of presenting visual information clearly, simply, and effectively. Graduate/Undergraduate Equivalency: EEPS 499. Mutually Exclusive: Cannot register for EEPS 699 if student has credit for EEPS 495/EEPS 499. Repeatable for Credit.**EEPS 800 - THESIS RESEARCH****Short Title:** THESIS RESEARCH**Department:** Earth/Environment/Planetary Sci**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Research**Credit Hours:** 1-15**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** Thesis research. Recommended Prerequisite(s): Students must pass the preliminary exam before taking this course. Repeatable for Credit.

Description and Code Legend

Note: Internally, the university uses the following descriptions, codes, and abbreviations for this academic program. The following is a quick reference:

Course Catalog/Schedule

- Course offerings/subject code: EEPS

Department Description and Code

- Earth, Environmental, and Planetary Sciences: EEPS

Undergraduate Degree Descriptions and Codes

- Bachelor of Arts degree: BA
- Bachelor of Science degree: BS

Undergraduate Major Description and Code

- Major in Earth, Environmental and Planetary Sciences (for both the BA and BS degrees): EEPS

Undergraduate Minor Description and Code

- Minor in Earth, Environmental and Planetary Sciences: EEPM

Graduate Degree Descriptions and Codes

- Master of Science degree: MS
- Doctor of Philosophy degree: PhD

Graduate Degree Program Description and Code

- Degree Program in Earth, Environmental and Planetary Sciences: EEPS

CIP Code and Description ¹

- **EEPS** Major/Program: CIP Code/Title: *40.0601 - Geology/Earth Science, General*
- **EEPM** Minor: CIP Code/Title: *40.0601 - Geology/Earth Science, General*

¹ Classification of Instructional Programs (CIP) 2020 Codes and Descriptions from the National Center for Education Statistics: <https://nces.ed.gov/ipeds/cipcode/>