DEPARTMENT OF EARTH SCIENCES

College of Sciences and Humanities
Department of Earth Sciences
221 McGilvrey Hall
Kent Campus
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geology@kent.edu
www.kent.edu/earth-sciences

Undergraduate Programs
Minors
Graduate Programs
Department of Earth Sciences Faculty

- Clement, Susanne M. (1995), Professor, Ph.D., Kent State University, 2005
- Gallagher, Timothy M. (2020), Assistant Professor, Ph.D., University of Michigan, 2016
- Hacker, David B. (1989), Professor, Ph.D., Kent State University, 1998
- Holm, Daniel K. (1992), Professor, Ph.D., Harvard University, 1992
- Ortiz, Joseph D. (2001), Professor, Ph.D., Oregon State University, 1995
- Schweitzer, Carrie E. (1994), Professor, Ph.D., Kent State University, 2000
- Singer, David M. (2012), Associate Professor, Ph.D., Stanford University, 2008
- Singh, Kuldeep (2017), Assistant Professor, Ph.D., University of Texas at Austin, 2013
- Smith, Alison J. (1990), Professor, Ph.D., Brown University, 1991
- Taylor, Eric S. (2012), Professor, Ph.D., The Ohio State University, 2012
- Tessin, Allyson (2020), Assistant Professor, Ph.D, University of Michigan-Ann Arbor, 2016
- Wagner, Courtney L. (2024), Assistant Professor, Ph.D., University Of Utah, 2021
- Wells, Neil A. (1984), Professor, Ph.D., University of Michigan-Ann Arbor, 1984

Earth Science (ESCI)

ESCI 11040 HOW THE EARTH WORKS (KBS) 3 Credit Hours
Explores processes that shape Earth's landscapes (e.g., volcanism, flooding, landslides, sea-level rise, mountain building) and that are of vital interest to humans (e.g., earthquakes, groundwater, energy and mineral resources, climate change).
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, TAG Science, Transfer Module Natural Sciences

ESCI 11041 HOW THE EARTH WORKS LABORATORY (KBS) (KLAB) 1 Credit Hour
Students study earth materials (e.g., mineral crystals, common and unusual rock specimens) and Google Earth images. Students conduct experiments demonstrating processes at earth's surface such as groundwater pollution, flooding and earthquakes.
Pre/corequisite: ESCI 11040.
Schedule Type: Laboratory
Contact Hours: 2 lab
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Kent Core Basic Sciences Lab, TAG Science, Transfer Module Natural Sciences, TAG Natural Science Lab

ESCI 11042 EARTH AND LIFE THROUGH TIME (KBS) 3 Credit Hours
Explores major events in the history of Earth, including mass extinctions, Snowball Earth hypothesis, birth and death of oceans, growth of continents, explosion of life, dinosaurs and the inter-relatedness of earth and life processes.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, TAG Science, Transfer Module Natural Sciences

ESCI 11043 EARTH AND LIFE THROUGH TIME LABORATORY (KBS) (KLAB) 1 Credit Hour
Students conduct lab experiments involving fossils, rocks and sedimentary features, a river process simulator and the concept of deep time.
Pre/corequisite: ESCI 11042.
Schedule Type: Laboratory
Contact Hours: 2 lab
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Kent Core Basic Sciences Lab, TAG Science, Transfer Module Natural Sciences, TAG Natural Science Lab

ESCI 21062 ENVIRONMENTAL EARTH SCIENCE (KBS) 3 Credit Hours
Application of Earth science to environmental problems, including natural resource extraction, water supply, pollution, waste disposal, landslides, floods and land use planning.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Transfer Module Natural Sciences

ESCI 21080 ALL ABOUT THE OCEANS (KBS) 3 Credit Hours
Explores the many fascinating (and some still little known) features and processes of the Earth's oceans, including mid-ocean ridges, hydrothermal vents, tsunamis, tides, rogue waves, marine life and the role of the ocean in climate change.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
Attributes: Kent Core Basic Sciences, Transfer Module Natural Sciences

ESCI 22000 DEGREE AND CAREER PATHS IN EARTH SCIENCES (ELR) 1 Credit Hour
Provides students with an overview of career paths and opportunities in the Geology and Earth Science majors. Components of the course include a journal club; informational presentations by geoscientists in industry, government and academia; and skills training needed for the majors. Required overnight field trip.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 1 lecture
Grade Mode: Standard Letter
Attributes: Experiential Learning Requirement

ESCI 23063 EARTH MATERIALS I 4 Credit Hours
Occurrence, associations, characteristics, crystallography and crystal chemistry of common minerals. Laboratory identification emphasizing physical properties. Required field trip.
Prerequisite: ESCI 11041 or ESCI 11043.
Pre/corequisite: CHEM 10058 or CHEM 10060.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter
Attributes: TAG Science

ESCI 31070 EARTH MATERIALS II (WIC) 4 Credit Hours
Occurrence and origin of igneous, sedimentary and metamorphic rocks. Laboratory identification, description and classification of hand specimens. Required field trip.
Prerequisite: ESCI 23063.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter
Attributes: Writing Intensive Course

ESCI 31080 STRUCTURAL GEOLOGY 4 Credit Hours
Mechanical principles of rock deformation. Structures in sedimentary igneous and metamorphic rocks. Required field trip.
Prerequisite: ESCI 11041 or ESCI 11043.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 32066 GEOMORPHOLOGY 4 Credit Hours
Earth's surface features as functions of geological structures, processes and time. Landform analysis using topographic maps and some stereographic aerial photos. Trigonometry recommended.
Prerequisite: ESCI 11041 or ESCI 11043.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 33025 WATER AND THE ENVIRONMENT 3 Credit Hours
How water moves on the surface and in the subsurface, with an emphasis on societal issues such as pollution, the conservation and management of water resources, and the impacts of environmental change.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 34061 PRINCIPLES OF PALEONTOLOGY 4 Credit Hours
Concepts applied to study of commonly preserved invertebrate organisms; identification of common North American fossils. Required field trip.
Prerequisite: BSCI 10002 or BSCI 10110 or ESCI 11043.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 40095 SELECTED TOPICS IN EARTH SCIENCES 1-3 Credit Hours
(Slashed with ESCI 50095 and ESCI 70095)(Repeatable for credit) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

ESCI 40096 INDIVIDUAL INVESTIGATION IN EARTH SCIENCES 1-3 Credit Hours
(Repeatable for credit) Directed field, laboratory and/or library research. Written report required. Maximum 3 credit hours applied toward bachelor's degree.
Prerequisite: Special approval.
Schedule Type: Individual Investigation
Contact Hours: 1-3 other
Grade Mode: Standard Letter-IP

ESCI 40380 BIOGEOCHEMISTRY 3 Credit Hours
(Cross-listed with BSCI 40380)(Slashed with BSCI 50380, BSCI 70380 and ESCI 50380) This course explores the chemical, physical, geological and biological processes and reactions that shape the world around us, and provides tools for understanding human alterations to global systems. Throughout this course, students explore elemental cycles of diverse terrestrial and aquatic ecosystems, as well as assess how humans have drastically altered these elemental cycles on a global scale and the implications of these changes for biological systems.
Prerequisite: Minimum C grade in the following courses: (BSCI 10110 and BSCI 10120) or (ESCI 11041 or ESCI 11043); and (CHEM 10058 or CHEM 10060) and CHEM 10062.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 41073 GEOLOGY OF OHIO 3 Credit Hours
(Slashed with ESCI 51073) Minerals, rocks, fossils, structural geology, physiography, environmental geology and geologic resources. Required field trips. Does not count toward the Geology major.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 41077 GEOLOGY OF THE NATIONAL PARKS 3 Credit Hours
(Slashed with ESCI 51077) Introduction to the geology of selected major national parks, emphasizing basic geological principles and the processes that have produced the spectacular scenery, rocks and fossils in each park. Does not count toward the Geology major.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 41079 ALL ABOUT DINOSAURS 3 Credit Hours
Dinosaurs (and some relatives) and their world, emphasizing how to interpret evidence concerning their history, biology and evolutionary relationships. Does not count toward the Geology major.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 41080 TECTONICS AND OROGENY 3 Credit Hours
(Slashed with ESCI 51080 and ESCI 71080) This course examines the forces that drive plate motions and mountain building; techniques for reconstructing those motions over a range of time scales; and how the lithosphere deforms and drives rock creation and destruction at plate boundaries, particularly in the Western United States and Appalachians. Required field trip to the Appalachians.
Prerequisite: ESCI 31080.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 41085 MASS EXTINCTIONS: CAUSES AND CONSEQUENCES 3 Credit Hours
(Slashed with ESCI 51085 and ESCI 71085) Investigation of the causes and consequences of extinction in marine and terrestrial ecosystems using paleontological, geochemical, sedimentological and stratigraphical information; emphasizing an Earth system science approach to the Big Five mass extinctions, as well as the possible sixth extinction occurring now.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 42030 REMOTE SENSING 3 Credit Hours
(Cross-listed with GEOG 49230, GEOG 59230, GEOG 79230) (Slashed with ESCI 52030, ESCI 72030) Computer analysis of multispectral satellite datasets. Applications in terrestrial earth science are emphasized.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 42035 DATA ANALYSIS IN THE EARTH SCIENCES 3 Credit Hours
(Slashed with ESCI 52035 and ESCI 72035) Application of scientific methods to geologic data in the field and laboratory, including methods for collection, analysis, modeling and presentation of data, within the framework of formulation and testing of scientific hypotheses. Provides the background necessary for upper-division earth science courses.
Prerequisite: None.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 2 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 42036 PHYSICAL HYDROGEOLOGY LABORATORY 1 Credit Hour
(Slashed with ESCI 52036 and ESCI 72036) Laboratory course offering fundamental training for professional hydrogeologists in field, laboratory and analytical techniques. Required weekend field trip.
Prerequisite: Junior standing.
Pre/corequisite: ESCI 42066.
Schedule Type: Laboratory
Contact Hours: 2 lab
Grade Mode: Standard Letter

ESCI 42060 EARTH OBSERVING 3 Credit Hours
(Slashed with ESCI 52060 and ESCI 72060) Students are introduced to visible, thermal and LiDAR remote sensing methods. Visible and near infrared multispectral and hyperspectral data sets are used for a wide variety of research including land use change, water quality research and agricultural remote and proximal sensing. Thermal remote sensing can be used to characterize surface temperature changes, earth materials and thermal stresses on plants. LiDAR provides the ability to measure variations in surface topography and can "see" through clouds and jungle canopy and even penetrate aquatic environments to measure algal biomass and suspended sediment. Remote sensing is the use of instrumentation to obtain spectral and spatial information about an object or surface without direct contact. All matter interacts with electromagnetic energy through thermal emittance, absorption, transmittance, reflectance and/or scattering. Different materials have distinct electromagnetic signatures depending on their composition, structure and the nature of the energy with which the material is interacting. This course focuses primarily on multispectral and hyperspectral visible remote sensing, but the field of remote sensing makes use of information throughout the electromagnetic spectrum to sense the environment around us. Note that most of the data sets that are examined and analyzed in this course are multispectral Landsat images. Students are encouraged to explore various topics or geographic regions for their class project. It is recommended that students take an introductory GIS class prior to enrollment.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 42065 WATERSHED HYDROLOGY 3 Credit Hours
(Slashed with ESCI 52065 and ESCI 72065) Watershed hydrology is the study of water movement, storage and transformation across landscapes. Course covers such basic questions like "Where does water go when it rains?" and "What pathways do water take to the stream channel?". Students examine the processes of precipitation, evapotranspiration, infiltration, streamflow generation and streamflow and learn how they are measured; how to analyze the data; and how these hydrologic processes are regulated by landscape characteristics, human activities and climate dynamics.
Prerequisite: MATH 11022; and junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 42066 PHYSICAL HYDROGEOLOGY 3 Credit Hours
(Slashed with ESCI 52066 and ESCI 72066) Principles of water flow in hydrologic cycle, soil and aquifer hydraulic properties, groundwater flow, surface water-groundwater interactions and geochemical evolution of groundwater. Application of principles for evaluation of water resources, emphasizing utilization, conservation and management of groundwater resources in a changing environment.
Prerequisite: MATH 11022 or any higher-level MATH course.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 42068 CONTAMINANT HYDROLOGY AND HYDROGEOLOGY 3 Credit Hours
(Slashed with ESCI 52068 and ESCI 72068) An introduction to the basic principles of chemical and physical behavior of contaminants introduced by humans into the environment. Students are expected to understand concepts and work practical quantitative problems.
Prerequisite: MATH 11022 or any higher level MATH course.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 43042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours
(Slashed with ESCI 53042 and ESCI 73042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.
Prerequisite: CHEM 10058 or CHEM 10060.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 43043 ENVIRONMENTAL MINERALOGY 3 Credit Hours
(Slashed with ESCI 53043 and ESCI 73043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and potential role of remediation.
Prerequisite: ESCI 23063.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 43044 ENVIRONMENTAL ISOTOPES 3 Credit Hours
(Slashed with ESCI 53044 and ESCI 73044) Stable isotope geochemistry can be used as a tool to explore a wide array of processes across the Earth and environmental sciences. The course begins by focusing on traditional applications of oxygen, hydrogen, carbon and sulfur stable isotopes to understand the water and carbon cycles. Subsequently, students are introduced to emerging stable isotope techniques and non-traditional stable isotope systems. Lectures are supplemented with exercises that incorporate real data and discussions based on recent scientific literature.
Prerequisite: CHEM 10058 or CHEM 10060.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 43092 FIELD GEOLOGY (ELR) 3 Credit Hours
Course devoted to geological field skills and solving structural and stratigraphic problems in the Black Hills of South Dakota or other suitable field location.
Prerequisite: ESCI 31070 and ESCI 31080.
Schedule Type: Practical Experience
Contact Hours: 9 other
Grade Mode: Standard Letter
Attributes: Experiential Learning Requirement

ESCI 43500 ENVIRONMENTAL SOIL SCIENCE 3 Credit Hours
(Slashed with ESCI 53500 and ESCI 73500) Soil is a critical natural resource that sustains human life. During this course, students explore the geochemical composition of soils and physical, biological and chemical processes involved with rock weathering, soil formation and the environmental transport of nutrients and toxic elements.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 44025 GEOLOGIC HAZARDS AND DISASTERS 3 Credit Hours
(Slashed with ESCI 54025 and ESCI 74025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geologic risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks, and the communication of accurate, relevant, actionable information about these risks to the public and authorities.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 44040 EARTH'S ENERGY TRANSITION 3 Credit Hours
(Slashed with ESCI 54040 and ESCI 74040) Society is faced with a growing climate crisis but has most of the tools and technological knowhow needed to address the problems. This class explores mitigation and adaptation approaches necessary for a successful energy transformation by assessing Earth energy sources from a systems perspective.
Prerequisite: None.
Schedule Type: Seminar
Contact Hours: 3 other
Grade Mode: Standard Letter

ESCI 44070 SEDIMENTOLOGY AND STRATIGRAPHY 4 Credit Hours
(Slashed with ESCI 54070 and ESCI 74070) Course explores the processes that control the production, transport, deposition and alteration of sediments. Students learn how to reconstruct past environments, ranging from mountain streams to the deep ocean, based on the physical and geochemical characteristics of sedimentary rocks. Techniques to document and interpret spatial patterns in sediment deposition are covered and tied into various modern-day challenges, such as climate and sea level change. Lectures are integrated with in-class activities, examples from cutting-edge research, laboratory exercises and a field trip.
Pre/corequisite: ESCI 31070.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 44072 MARINE PROCESSES 3 Credit Hours
(Slashed with ESCI 54072 and ESCI 74072) This course is an exploration of the mechanisms (geological, physical, chemical and biological) through which the ocean operates, and how it influences climate on seasonal, inter-annual, glacial-interglacial and over deep time. Emphasis is placed on understanding the relative importance of these processes and how they have varied through time, and the potential outcomes of human-induced changes to these processes.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 44074 PALEOCEANOGRAPHY 3 Credit Hours
(Slashed with ESCI 54074 and ESCI 74074) A broad spectrum of geological approaches (including paleontology, geochemistry and stratigraphy) are employed to interpret the history of the Earth's oceans.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 45045 EARTH SYSTEM SCIENCE 3 Credit Hours
(Slashed with ESCI 55045 and ESCI 75045) Earth system science refers to a rapidly emerging transdisciplinary endeavor aimed at understanding the structure and functioning of the Earth as a complex, adaptive system. The development of this field began with the awareness that life on Earth exerts a control on the physical and chemical environment. The course begins with an overview of the history of this effort, which provides context for the state of the art understanding of the Earth system. Throughout this course, traditional disciplines that examine components of the Earth system in isolation (including geology, oceanography, biology and atmospheric science) are reviewed before building toward a unified understanding of the Earth system. The course also explores the impact of human advancements and civilizations in altering this system in an unprecedented manner. Course concepts include planetary boundaries, feedbacks and tipping points. A key focus of the course is the importance of spatial and temporal scale when investigating the Earth system. Throughout this course, students read and discuss papers exploring multiple techniques for integrating Earth system components, including observations, experiments and modeling. Ultimately, each student produces a research paper or proposal for a project that could bridge traditional disciplinary boundaries to investigate exciting linkages within the Earth system.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 50095 SELECTED TOPICS IN EARTH SCIENCES 1-3 Credit Hours
(Slashed with ESCI 40095 and ESCI 70095)(Repeatable for credit) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

ESCI 50380 BIOGEOCHEMISTRY 3 Credit Hours
(Cross-listed with BSCI 50380)(Slashed with BSCI 40380, BSCI 70380 and ESCI 40380) This course explores the chemical, physical, geological and biological processes and reactions that shape the world around us, and provides tools for understanding human alterations to global systems. Throughout this course, students explore elemental cycles of diverse terrestrial and aquatic ecosystems, as well as assess how humans have drastically altered these elemental cycles on a global scale and the implications of these changes for biological systems.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 51073 GEOLOGY OF OHIO 3 Credit Hours
(Slashed with ESCI 41073) Minerals, rocks, fossils, structural geology, physiography, environmental geology and geologic resources. Required field trips. Does not count toward the Geology major.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 51077 GEOLOGY OF THE NATIONAL PARKS 3 Credit Hours
(Slashed with ESCI 41077) Introduction to the geology of selected major national parks, emphasizing basic geological principles and the processes that have produced the spectacular scenery, rocks and fossils in each park. Does not count toward the Geology major.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 51080 TECTONICS AND OROGENY 3 Credit Hours
(Slashed with ESCI 41080 and ESCI 71080) This course examines the forces that drive plate motions and mountain building; techniques for reconstructing those motions over a range of time scales; and how the lithosphere deforms and drives rock creation and destruction at plate boundaries, particularly in the Western United States and Appalachians. Required field trip to the Appalachians.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 51085 MASS EXTINCTIONS: CAUSES AND CONSEQUENCES 3 Credit Hours
(Slashed with ESCI 41085 and ESCI 71085) Investigation of the causes and consequences of extinction in marine and terrestrial ecosystems using paleontological, geochemical, sedimentological and stratigraphical information; emphasizing an Earth system science approach to the Big Five mass extinctions, as well as the possible sixth extinction occurring now.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 52030 REMOTE SENSING 3 Credit Hours
(Cross-listed with GEOG 59230) (Slashed with ESCI 42030, ESCI 72030, GEOG 49230, GEOG 79230) Computer analysis of multispectral satellite datasets. Applications in terrestrial earth science are emphasized.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 52035 DATA ANALYSIS IN THE EARTH SCIENCES 3 Credit Hours
(Slashed with ESCI 42035 and ESCI 72035) Application of scientific methods to geologic data in the field and laboratory, including methods for collection, analysis, modeling and presentation of data, within the framework of formulation and testing of scientific hypotheses.
Prerequisite: Graduate standing.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 2 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 52036 PHYSICAL HYDROGEOLOGY LABORATORY 1 Credit Hour
(Slashed with ESCI 42036 and ESCI 72036) Laboratory course offering fundamental training for professional hydrogeologists in field, laboratory and analytical techniques. Required weekend field trip.
Prerequisite: Graduate standing.
Pre/corequisite: ESCI 52066.
Schedule Type: Laboratory
Contact Hours: 2 lab
Grade Mode: Standard Letter

ESCI 52060 EARTH OBSERVING 3 Credit Hours
(Slashed with ESCI 42060 and ESCI 72060) Students are introduced to visible, thermal and LiDAR remote sensing methods. Visible and near infrared multispectral and hyperspectral data sets are used for a wide variety of research including land use change, water quality research and agricultural remote and proximal sensing. Thermal remote sensing can be used to characterize surface temperature changes, earth materials and thermal stresses on plants. LiDAR provides the ability to measure variations in surface topography and can "see" through clouds and jungle canopy and even penetrate aquatic environments to measure algal biomass and suspended sediment. Remote sensing is the use of instrumentation to obtain spectral and spatial information about an object or surface without direct contact. All matter interacts with electromagnetic energy through thermal emittance, absorption, transmittance, reflectance and/or scattering. Different materials have distinct electromagnetic signatures depending on their composition, structure and the nature of the energy with which the material is interacting. This course focuses primarily on multispectral and hyperspectral visible remote sensing, but the field of remote sensing makes use of information throughout the electromagnetic spectrum to sense the environment around us. Note that most of the data sets that are examined and analyzed in this course are multispectral Landsat images. Students are encouraged to explore various topics or geographic regions for their class project. It is recommended that students take an introductory GIS class prior to enrollment.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 52065 WATERSHED HYDROLOGY 3 Credit Hours
(Slashed with ESCI 42065 and ESCI 72065) Watershed hydrology is the study of water movement, storage and transformation across landscapes. Course covers such basic questions like "Where does water go when it rains?" and "What pathways do water take to the stream channel?". Students examine the processes of precipitation, evapotranspiration, infiltration, streamflow generation and streamflow and learn how they are measured; how to analyze the data; and how these hydrologic processes are regulated by landscape characteristics, human activities and climate dynamics.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 52066 PHYSICAL HYDROGEOLOGY 3 Credit Hours
(Slashed with ESCI 42066 and ESCI 72066) Principles of water flow in hydrologic cycle, soil and aquifer hydraulic properties, groundwater flow, surface water-groundwater interactions and geochemical evolution of groundwater. Application of principles for evaluation of water resources, emphasizing utilization, conservation and management of groundwater resources in a changing environment.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 52068 CONTAMINANT HYDROLOGY AND HYDROGEOLOGY 3 Credit Hours
(Slashed with ESCI 42068 and ESCI 72068) An introduction to the basic principles of chemical and physical behavior of contaminants introduced by humans into the environment. Students are expected to understand concepts and work practical quantitative problems.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 53042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours
(Slashed with ESCI 43042 and ESCI 73042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 53043 ENVIRONMENTAL MINERALOGY 3 Credit Hours
(Slashed with ESCI 43043 and ESCI 73043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and potential role of remediation.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 53044 ENVIRONMENTAL ISOTOPES 3 Credit Hours
(Slashed with ESCI 43044 and ESCI 73044) Stable isotope geochemistry can be used as a tool to explore a wide array of processes across the Earth and environmental sciences. The course begins by focusing on traditional applications of oxygen, hydrogen, carbon and sulfur stable isotopes to understand the water and carbon cycles. Subsequently, students are introduced to emerging stable isotope techniques and non-traditional stable isotope systems. Lectures are supplemented with exercises that incorporate real data and discussions based on recent scientific literature.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 53092 FIELD GEOLOGY 3 Credit Hours
Course devoted to geological field skills and solving structural and stratigraphic problems in the Black Hills of South Dakota or other suitable field location.
Prerequisite: Graduate standing.
Schedule Type: Practical Experience
Contact Hours: 9 other
Grade Mode: Standard Letter

ESCI 53500 ENVIRONMENTAL SOIL SCIENCE 3 Credit Hours
(Slashed with ESCI 43500 and ESCI 73500) Soil is a critical natural resource that sustains human life. During this course, students explore the geochemical composition of soils and physical, biological and chemical processes involved with rock weathering, soil formation and the environmental transport of nutrients and toxic elements.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 54025 GEOLOGIC HAZARDS AND DISASTERS 3 Credit Hours
(Slashed with ESCI 44025 and ESCI 74025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geologic risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks, and the communication of accurate, relevant, actionable information about these risks to the public and authorities.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 54040 EARTH'S ENERGY TRANSITION 3 Credit Hours
(Slashed with ESCI 44040 and ESCI 74040) Society is faced with a growing climate crisis but has most of the tools and technological knowhow needed to address the problems. This class explores mitigation and adaptation approaches necessary for a successful energy transformation by assessing Earth energy sources from a systems perspective.
Prerequisite: Graduate standing.
Schedule Type: Seminar
Contact Hours: 3 other
Grade Mode: Standard Letter

ESCI 54070 SEDIMENTOLOGY AND STRATIGRAPHY 4 Credit Hours
(Slashed with ESCI 44070 and ESCI 74070) Course explores the processes that control the production, transport, deposition and alteration of sediments. Students learn how to reconstruct past environments, ranging from mountain streams to the deep ocean, based on the physical and geochemical characteristics of sedimentary rocks. Techniques to document and interpret spatial patterns in sediment deposition are covered and tied into various modern-day challenges, such as climate and sea level change. Lectures are integrated with in-class activities, examples from cutting-edge research, laboratory exercises and a field trip.
Prerequisite: Graduate standing.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 54072 MARINE PROCESSES 3 Credit Hours
(Slashed with ESCI 44072 and ESCI 74072) This course is an exploration of the mechanisms (geological, physical, chemical and biological) through which the ocean operates, and how it influences climate on seasonal, inter-annual, glacial-interglacial and over deep time. Emphasis is placed on understanding the relative importance of these processes and how they have varied through time, and the potential outcomes of human-induced changes to these processes.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 54074 PALEOCEANOGRAPHY 3 Credit Hours
(Slashed with ESCI 44074 and ESCI 74074) A broad spectrum of geological approaches (including paleontology, geochemistry and stratigraphy) are employed to interpret the history of the Earth's oceans.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 55045 EARTH SYSTEM SCIENCE 3 Credit Hours
(Slashed with ESCI 45045 and ESCI 75045) Earth system science refers to a rapidly emerging transdisciplinary endeavor aimed at understanding the structure and functioning of the Earth as a complex, adaptive system. The development of this field began with the awareness that life on Earth exerts a control on the physical and chemical environment. The course begins with an overview of the history of this effort, which provides context for the state of the art understanding of the Earth system. Throughout this course, traditional disciplines that examine components of the Earth system in isolation (including geology, oceanography, biology and atmospheric science) are reviewed before building toward a unified understanding of the Earth system. The course also explores the impact of human advancements and civilizations in altering this system in an unprecedented manner. Course concepts include planetary boundaries, feedbacks and tipping points. A key focus of the course is the importance of spatial and temporal scale when investigating the Earth system. Throughout this course, students read and discuss papers exploring multiple techniques for integrating Earth system components, including observations, experiments and modeling. Ultimately, each student produces a research paper or proposal for a project that could bridge traditional disciplinary boundaries to investigate exciting linkages within the Earth system.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 60084 GEOLOGY GRADUATE STUDENT ORIENTATION 1 Credit Hour
(Slashed with ESCI 70084) Introduction to departmental resources, procedures and expectations, as well as approaches to successfully conduct research at a graduate level. Training and experience in presentation of data and college teaching of applied geology, as well as a discussion forum on professional ethics and responsibilities.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 1 lecture
Grade Mode: Satisfactory/Unsatisfactory

ESCI 60086 FIELD METHODS IN THE EARTH SCIENCES 1 Credit Hour
(Slashed with ESCI 80086) This course focuses on the skills necessary for sample and data collection in the field. Additionally, it provides strategies for successfully leading safe, inclusive field work both within academia and other career sectors. The course requires a commitment to weekly readings and discussions.
Prerequisite: Graduate standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Satisfactory/Unsatisfactory

ESCI 60091 SEMINAR 1-2 Credit Hours
(Repeatable for credit)(Slashed with ESCI 70091) Topics in geology and earth science; varies per course offering.
Prerequisite: Graduate standing.
Schedule Type: Seminar
Contact Hours: 1-2 other
Grade Mode: Standard Letter

ESCI 60095 SELECTED TOPICS IN EARTH SCIENCES 1-3 Credit Hours
(Repeatable for credit) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

ESCI 60098 RESEARCH 1-15 Credit Hours
(Repeatable for credit) Research for master's level students. Credits earned may be applied toward degree if department approves.
Prerequisite: Graduate standing.
Schedule Type: Research
Contact Hours: 1-15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

ESCI 60199 THESIS I 2-6 Credit Hours
Thesis students must register for a total of 6 hours, 2 to 6 hours in a single semester distributed over several semesters if desired.
Prerequisite: Graduate standing.
Schedule Type: Masters Thesis
Contact Hours: 2-6 other
Grade Mode: Satisfactory/Unsatisfactory-IP

ESCI 60291 SEMINAR: WRITING IN THE EARTH SCIENCES 1 Credit Hour
(Slashed with ESCI 80291)(Repeatable for credit) Focuses on the strategies for achieving regular and productive academic writing and the craft of writing for scientific literature. The course is designed for students who have a major writing project that will take most or all of the semester, such as a dissertation, thesis or dissertation proposal. The course requires commitment to weekly writing progress and provides weekly opportunities for peer review and support.
Prerequisite: Graduate standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Standard Letter

ESCI 60299 THESIS II 2 Credit Hours
Thesis students must continue registration each semester until all degree requirements are met.
Prerequisite: ESCI 60199; and graduate standing.
Schedule Type: Masters Thesis
Contact Hours: 2 other
Grade Mode: Satisfactory/Unsatisfactory-IP

ESCI 60391 GEOCHEMINAR 1 Credit Hour
(Repeatable for credit) In this course, students gain understanding of advanced techniques in geochemistry by presenting information from primary literature and discussing data processing and analysis of their research.
Prerequisite: Graduate standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Standard Letter

ESCI 60591 SEMINAR: DATA ANALYSIS AND PRESENTATION 1 Credit Hour
(Slashed with ESCI 80591)(Repeatable for credit) Course focuses on the skills and issues surrounding data production and analysis for the earth sciences. It provides students the opportunity to familiarize themselves with strategies for managing and presenting data that they generate as part of their graduate studies. The course requires a commitment to regular readings and discussions.
Prerequisite: Graduate standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Standard Letter

ESCI 70084 GEOLOGY GRADUATE STUDENT ORIENTATION 1 Credit Hour
(Slashed with ESCI 60084) Introduction to departmental resources, procedures and expectations, as well as approaches to successfully conduct research at a graduate level. Training and experience in presentation of data and college teaching of applied geology, as well as discussion forum on professional ethics and responsibilities.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 1 lecture
Grade Mode: Satisfactory/Unsatisfactory

ESCI 70091 SEMINAR 1-2 Credit Hours
(Repeatable for credit)(Slashed with ESCI 60091) Topics in geology and earth science; varies per course offering.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 1-2 other
Grade Mode: Standard Letter

ESCI 70095 SELECTED TOPICS IN EARTH SCIENCES 1-3 Credit Hours
(Slashed with ESCI 40095 and ESCI 50095)(Repeatable for credit) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

ESCI 71080 TECTONICS AND OROGENY 3 Credit Hours
(Slashed with ESCI 41080 and ESCI 51080) This course examines the forces that drive plate motions and mountain building; techniques for reconstructing those motions over a range of time scales; and how the lithosphere deforms and drives rock creation and destruction at plate boundaries, particularly in the Western United States and Appalachians. Required field trip to the Appalachians.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 71085 MASS EXTINCTIONS: CAUSES AND CONSEQUENCES 3 Credit Hours
(Slashed with ESCI 41085 and ESCI 51085) Investigation of the causes and consequences of extinction in marine and terrestrial ecosystems using paleontological, geochemical, sedimentological and stratigraphical information; emphasizing an Earth system science approach to the Big Five mass extinctions, as well as the possible sixth extinction occurring now.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 72030 REMOTE SENSING 3 Credit Hours
(Cross-listed with GEOG 79230) (Slashed with ESCI 42030, ESCI 52030, GEOG 49230, GEOG 59230) Computer analysis of multispectral satellite datasets. Applications in terrestrial earth science are emphasized.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 72035 DATA ANALYSIS IN THE EARTH SCIENCES 3 Credit Hours
(Slashed with ESCI 42035 and ESCI 52035) Application of scientific methods to geologic data in the field and laboratory, including methods for collection, analysis, modeling and presentation of data, within the framework of formulation and testing of scientific hypotheses.
Prerequisite: Doctoral standing.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 2 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 72036 PHYSICAL HYDROGEOLOGY LABORATORY 1 Credit Hour
(Slashed with ESCI 42036 and ESCI 52036) Laboratory course offering fundamental training for professional hydrogeologists in field, laboratory and analytical techniques. Required weekend field trip.
Prerequisite: Doctoral standing.
Pre/corequisite: ESCI 72066.
Schedule Type: Laboratory
Contact Hours: 2 lab
Grade Mode: Standard Letter

ESCI 72060 EARTH OBSERVING 3 Credit Hours
(Slashed with ESCI 42060 and ESCI 52060) Students are introduced to visible, thermal and LiDAR remote sensing methods. Visible and near infrared multispectral and hyperspectral data sets are used for a wide variety of research including land use change, water quality research and agricultural remote and proximal sensing. Thermal remote sensing can be used to characterize surface temperature changes, earth materials and thermal stresses on plants. LiDAR provides the ability to measure variations in surface topography and can "see" through clouds and jungle canopy and even penetrate aquatic environments to measure algal biomass and suspended sediment. Remote sensing is the use of instrumentation to obtain spectral and spatial information about an object or surface without direct contact. All matter interacts with electromagnetic energy through thermal emittance, absorption, transmittance, reflectance and/or scattering. Different materials have distinct electromagnetic signatures depending on their composition, structure and the nature of the energy with which the material is interacting. This course focuses primarily on multispectral and hyperspectral visible remote sensing, but the field of remote sensing makes use of information throughout the electromagnetic spectrum to sense the environment around us. Note that most of the data sets that are examined and analyzed in this course are multispectral Landsat images. Students are encouraged to explore various topics or geographic regions for their class project. It is recommended that students take an introductory GIS class prior to enrollment.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 72065 WATERSHED HYDROLOGY 3 Credit Hours
(Slashed with ESCI 42065 and ESCI 52065) Watershed hydrology is the study of water movement, storage and transformation across landscapes. Course covers such basic questions like "Where does water go when it rains?" and "What pathways do water take to the stream channel?". Students examine the processes of precipitation, evapotranspiration, infiltration, streamflow generation and streamflow and learn how they are measured; how to analyze the data; and how these hydrologic processes are regulated by landscape characteristics, human activities and climate dynamics.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 72066 PHYSICAL HYDROGEOLOGY 3 Credit Hours
(Slashed with ESCI 42066 and ESCI 52066) Principles of water flow in hydrologic cycle, soil and aquifer hydraulic properties, groundwater flow, surface water-groundwater interactions and geochemical evolution of groundwater. Application of principles for evaluation of water resources, emphasizing utilization, conservation and management of groundwater resources in a changing environment.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 72068 CONTAMINANT HYDROLOGY AND HYDROGEOLOGY 3 Credit Hours
(Slashed with ESCI 42068 and ESCI 52068) An introduction to the basic principles of chemical and physical behavior of contaminants introduced by humans into the environment. Students are expected to understand concepts and work practical quantitative problems.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 73042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours
(Slashed with ESCI 43042 and ESCI 53042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 73043 ENVIRONMENTAL MINERALOGY 3 Credit Hours
(Slashed with ESCI 43043 and ESCI 53043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and potential role of remediation.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 73044 ENVIRONMENTAL ISOTOPES 3 Credit Hours
(Slashed with ESCI 43044 and ESCI 53044) Stable isotope geochemistry can be used as a tool to explore a wide array of processes across the Earth and environmental sciences. The course begins by focusing on traditional applications of oxygen, hydrogen, carbon and sulfur stable isotopes to understand the water and carbon cycles. Subsequently, students are introduced to emerging stable isotope techniques and non-traditional stable isotope systems. Lectures are supplemented with exercises that incorporate real data and discussions based on recent scientific literature.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 73500 ENVIRONMENTAL SOIL SCIENCE 3 Credit Hours
(Slashed with ESCI 43500 and ESCI 53500) Soil is a critical natural resource that sustains human life. During this course, students explore the geochemical composition of soils and physical, biological and chemical processes involved with rock weathering, soil formation and the environmental transport of nutrients and toxic elements.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 74025 GEOLOGIC HAZARDS AND DISASTERS 3 Credit Hours
(Slashed with ESCI 44025 and ESCI 54025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geologic risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks, and the communication of accurate, relevant, actionable information about these risks to the public and authorities.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 74040 EARTH'S ENERGY TRANSITION 3 Credit Hours
(Slashed with ESCI 44040 and ESCI 54040) Society is faced with a growing climate crisis but has most of the tools and technological knowhow needed to address the problems. This class explores mitigation and adaptation approaches necessary for a successful energy transformation by assessing Earth energy sources from a systems perspective.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 3 other
Grade Mode: Standard Letter

ESCI 74070 SEDIMENTOLOGY AND STRATIGRAPHY 4 Credit Hours
(Slashed with ESCI 44070 and ESCI 54070) Course explores the processes that control the production, transport, deposition and alteration of sediments. Students learn how to reconstruct past environments, ranging from mountain streams to the deep ocean, based on the physical and geochemical characteristics of sedimentary rocks. Techniques to document and interpret spatial patterns in sediment deposition are covered and tied into various modern-day challenges, such as climate and sea level change. Lectures are integrated with in-class activities, examples from cutting-edge research, laboratory exercises and a field trip.
Prerequisite: Doctoral standing.
Schedule Type: Laboratory, Lecture, Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

ESCI 74072 MARINE PROCESSES 3 Credit Hours
(Slashed with ESCI 44072 and ESCI 54072) This course is an exploration of the mechanisms (geological, physical, chemical and biological) through which the ocean operates, and how it influences climate on seasonal, inter-annual, glacial-interglacial and over deep time. Emphasis is placed on understanding the relative importance of these processes and how they have varied through time, and the potential outcomes of human-induced changes to these processes.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 74074 PALEOCEANOGRAPHY 3 Credit Hours
(Slashed with ESCI 44074 and ESCI 54074) A broad spectrum of geological approaches (including paleontology, geochemistry and stratigraphy) are employed to interpret the history of the Earth's oceans.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 75045 EARTH SYSTEM SCIENCE 3 Credit Hours
(Slashed with ESCI 45045 and ESCI 55045) Earth system science refers to a rapidly emerging transdisciplinary endeavor aimed at understanding the structure and functioning of the Earth as a complex, adaptive system. The development of this field began with the awareness that life on Earth exerts a control on the physical and chemical environment. The course begins with an overview of the history of this effort, which provides context for the state of the art understanding of the Earth system. Throughout this course, traditional disciplines that examine components of the Earth system in isolation (including geology, oceanography, biology and atmospheric science) are reviewed before building toward a unified understanding of the Earth system. The course also explores the impact of human advancements and civilizations in altering this system in an unprecedented manner. Course concepts include planetary boundaries, feedbacks and tipping points. A key focus of the course is the importance of spatial and temporal scale when investigating the Earth system. Throughout this course, students read and discuss papers exploring multiple techniques for integrating Earth system components, including observations, experiments and modeling. Ultimately, each student produces a research paper or proposal for a project that could bridge traditional disciplinary boundaries to investigate exciting linkages within the Earth system.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

ESCI 80086 FIELD METHODS IN THE EARTH SCIENCES 1 Credit Hour
(Slashed with ESCI 60086) This course focuses on the skills necessary for sample and data collection in the field. Additionally, it provides strategies for successfully leading safe, inclusive field work both within academia and other career sectors. The course requires a commitment to weekly readings and discussions.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Satisfactory/Unsatisfactory

ESCI 80095 ADVANCED TOPICS IN EARTH SCIENCES 1-3 Credit Hours
(Repeatable for credit) Advanced topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: Doctoral standing; and special approval.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

ESCI 80098 RESEARCH 1-15 Credit Hours
(Repeatable for credit) Research for doctoral students. Credits earned may be applied toward degree with departmental approval.
Prerequisite: Doctoral standing.
Schedule Type: Research
Contact Hours: 1-15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

ESCI 80199 DISSERTATION I 15 Credit Hours
(Repeatable for credit) Doctoral dissertation, for which registration in at least two semesters is required first of which will be semester in which dissertation work is begun and continuing until the completion of 30 hours.
Prerequisite: Admission to candidacy for doctoral degree; and doctoral standing.
Schedule Type: Dissertation
Contact Hours: 15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

ESCI 80291 SEMINAR: WRITING IN THE EARTH SCIENCES 1 Credit Hour
(Slashed with ESCI 60291)(Repeatable for credit) Focuses on the strategies for achieving regular and productive academic writing and the craft of writing for scientific literature. The course is designed for students who have a major writing project that will take most or all of the semester, such as a dissertation, thesis or dissertation proposal. The course requires commitment to weekly writing progress and provides weekly opportunities for peer review and support.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Standard Letter

ESCI 80299 DISSERTATION II 15 Credit Hours
(Repeatable for credit) Continuing registration is required of doctoral students who have completed the initial 30 hours of dissertation, continuing until all degree requirements are met.
Prerequisite: ESCI 80199; and doctoral standing.
Schedule Type: Dissertation
Contact Hours: 15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

ESCI 80591 SEMINAR: DATA ANALYSIS AND PRESENTATION 1 Credit Hour
(Slashed with ESCI 60591)(Repeatable for credit) Course focuses on the skills and issues surrounding data production and analysis for the earth sciences. It provides students the opportunity to familiarize themselves with strategies for managing and presenting data that they generate as part of their graduate studies. The course requires a commitment to regular readings and discussions.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 1 other
Grade Mode: Standard Letter