EARTH SCIENCES (ESCI)

Course numbers with the # symbol included (e.g. #400) have not been taught in the last 3 years.

ESCI 801 - Quantitative Methods in Earth Sciences
Credits: 4
Introduces quantitative tools necessary for upper level Earth Science courses. Incudes basic statistical descriptions of spatially and temporally varying data, curve fitting, and time-series analysis with emphasis on atmospheric, oceanic and terrestrial data sets. Students learn to construct simple numerical models of Earth Systems. Instruction in data and analysis and modeling in Python. One year of calculus and at least one semester of intermediate Earth Science required.
Grade Mode: Letter Grading

ESCI 805 - Principles of Hydrology
Credits: 4
Basic physical principles important in the land phase of the hydrologic cycle, including precipitation, snow melt, infiltration and soil physics, evapotranspiration, and surface and subsurface flow to streams. Problems of measurement and aspects of statistical treatment of hydrologic data. Field trips. Transportation fee. One term of calculus and one term of physics required, and statistics recommended. Lab.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI #810 - Groundwater Hydrology
Credits: 4
Principles for fluid flow in porous media with emphasis on occurrence, location, and development of groundwater, but with consideration of groundwater as a transporting medium. Major topics include well hydraulics, regional groundwater flow, exploration techniques, and groundwater modeling. Laboratory exercises involve use of fluid, electrical, and digital computer models to illustrate key concepts. One year each of calculus and physics required. Lab.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 820 - Ocean Measurements Lab
Credits: 4
Measurements of fundamental ocean processes and parameters. Emphasizes understanding typical coastal and estuarine measurements their applications, and the use of acquired data in terms of the effects on structures and processes in the ocean.
Equivalent(s): OE 810
Grade Mode: Letter Grading

ESCI 826 - Igneous and Metamorphic Petrology
Credits: 4
This course focuses on the origin and evolution of igneous and metamorphic rocks from field, petrographic mineral chemistry, experimental, and theoretical studies. Igneous systems include volcanic and plutonic suites, with emphasis on mineralogic records of magma chamber systematics. Metamorphic systems include pelitic, mafic, and calc silicate rocks, with special emphasis on closed- and open-system reactions, multi-systems, reaction space, and pressure-temperature-time paths. Intermediate courses in petrology, calculus, chemistry, and physics required. Field trips. Lab.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 834 - Global Geophysics
Credits: 4
This course focuses on the structure of the Earth and dynamic processes within it. Topics include: plate tectonics, earthquakes and seismic waves, mantle convection, rheology and ice age dynamics, Earth's gravity field and geodesy, and the geodynamo. One year of calculus, one year of college physics required. Lab.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 841 - Geochemistry
Credits: 4
Course focuses on the application of chemical principles to solve problems in the Earth sciences. Students learn the chemical tools of thermodynamics and kinetics, element partitioning, conservation of mass, and isotope geochemistry. Explore geochemical properties/processes in the deep Earth and the Earth surface, atmosphere and marine systems, and cosmo-chemistry and investigate the interactions between these components of the Earth system. Lab. One year each of calculus and chemistry required.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 845 - Isotope Geochemistry
Credits: 4
Course focuses on the application of radiogenic, radioactive and stable isotopes to improve students' knowledge about the processes and timescales relevant to the formation of the planet and solar system, the evolution of the Earth system and interactions in the hydrosphere and biosphere. Topics include geochronology, tracer applications, Earth surface applications, as well as applications in the hydrosphere and biosphere. Systems discussed include the classic radiogenic systems (K-Ar, Rb-Sr, Sm-Nd, Lu-Hf and U-Th-Pb), traditional (H, C, N, O) as well as nontraditional (e.g., Mg, Ca, Fe) stable isotope systems, and radioactive isotopes (e.g., radiocarbon). Course consists of lecture, where students are exposed to these applications, and a lab section to work through any questions on the homework assignments, discuss relevant papers from the literature, and carry out a project. Lab. One year each of calculus and chemistry required.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 847 - Aqueous Geochemistry
Credits: 4
The chemical processes that determine the composition of aquatic systems such as rivers, lakes, groundwater and the ocean. The goal is to quantitatively understand the behavior of inorganic species such as carbon dioxide, nutrients, trace metals and inorganic pollutants in natural waters. Topics include, acid-based equilibria, carbonate chemistry, reduction-oxidation reactions, organic complexation and mineral precipitation and dissolution. Lab. One year each of calculus and chemistry or geochemistry required.
Grade Mode: Letter Grading

ESCI 852 - Chemical Oceanography
Credits: 3
This course investigates the physical and biogeochemical processes that determine the composition of seawater. Topics include biological effects on chemistry, ocean nutrient cycles, air-sea gas exchange, radiogenic and stable isotopes as tracers of ocean processes, sediment and trace-metal chemistry. One year each of calculus and chemistry required.
Grade Mode: Letter Grading

ESCI 854 - Sedimentology
Credits: 4
This course focuses on modern sedimentary processes and ancient sedimentary records through the examination, identification, and interpretation of sediments and sedimentary rocks. Topics such as sediment transport mechanisms, depositional environments, and time in sedimentary records will provide a strong framework for any student studying Earth processes and sedimentary systems.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 856 - Geotectonics
Credits: 3
The geological record of plate tectonics past and present. The first part of the course focuses on modern tectonic settings with an emphasis on plate geometries, geodynamical processes, and sedimentary products. The second part of the course focuses on reconstructing ancient tectonic settings with an emphasis on methodology (paleomagnetism, basin analysis, provenance) and case studies (e.g. India-Asia collision). Field trip. Intermediate level courses in structural geology or petrology required.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 858 - Introduction to Physical Oceanography
Credits: 3
Descriptive treatment of atmosphere-ocean interaction; general wind-driven and thermo-haline ocean circulation; waves and tides; continental shelf and near-shore processes; instrumentation and methods used in ocean research. Simplified conceptual models demonstrate the important principles. Calculus-based physics and introductory oceanography required.
Grade Mode: Letter Grading

ESCI 859 - Geological Oceanography
Credits: 4
Major geological features and processes of the ocean floor; geological and geophysical methods; composition of the earth, sedimentary processes, plate tectonics and paleoceanography.
Grade Mode: Letter Grading

ESCI 860 - Paleoceanography
Credits: 3
This course introduces the basic principles of paleoceanography, such as the preservation of ocean history in sediment archives and the analysis/interpretation of paleoceanographic data. The course focuses on the capabilities and limitations of paleoceanographic techniques, and empowers students to critically assess the strengths and weaknesses of results presented in scientific journals. Topics include Milankovitch cycles, faunal assemblages, temperature and circulation proxies, linear and non-linear responses to climate forcings, abrupt climate events atmospheric teleconnections and monsoons. One year of chemistry and one course in introductory geology required.
Grade Mode: Letter Grading

ESCI #862 - Glacial Geology
Credits: 4
Course provides a survey of glacier dynamics and processes, with an emphasis on understanding the origin and significance of glacial deposits and landforms. The first half of the course examines the physics of glaciers, and the second half focuses on glacial geologic processes. Lectures discuss glaciers and ice sheets as key agents of large-scale geomorphic change, as well as their central role in the Earth's past and present climate system. Labs involve analysis of glaciological data, glacial-geologic map interpretation, and short field exercises. Course incorporates one mandatory weekend field trip that explores the glacial landscapes of New England. Lab.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 864 - Spectral Analysis of Geophysical Time Series Data
Credits: 4
This course considers basic exploratory techniques and in-depth spectral analysis for estimation with geophysical time series data, including calculations of confidence intervals and significance testing. This course prepares students for interpreting time series data with science and engineering applications. Topics include sampling theory, filtering, statistics, probability, spectral analysis, and empirical orthogonal functions. Students gain experience in code-writing for the analysis of time series data. One year of calculus required.
Equivalent(s): OE #864
Grade Mode: Letter Grading

ESCI 865 - Paleoclimatology
Credits: 3
Course reviews the study of past changes in the Earth's climate system. Main discussion topics include astronomical theories of ice ages, Quaternary dating methods, Antarctic and Greenland ice core records, greenhouse gases, marine-based climate proxies, glacial mega-floods, and linkages between ocean circulation and abrupt climate change. Emphasis on climate variability during the Quaternary period (the last approximately 1.8 million years), a time interval dominated by cycles of global glaciation. Lectures include discussion of recent and emerging scientific papers in order to keep pace with the latest findings in paleoclimatic research.
Grade Mode: Letter Grading

ESCI #866 - Volcanology
Credits: 4
Provides a comprehensive overview of volcanic processes and their influences on planetary evolution and modern-day Earth systems. Lectures discuss the generation and properties of magma, tectonic setting of volcanism, eruption styles, volcanic landforms and products, monitoring of active volcanoes, volcanic hazards, and volcanism on other planets. Laboratory topics include modeling volcanic processes, hand-sample observation, topographic map interpretation, volcanographical data analysis, and two afternoon field trips. As volcanology is a rapidly developing field of active research, the course incorporates discussions of recent and emerging scientific papers from the literature and student-led updates of ongoing volcanic activity. One year of calculus and one course in introductory geology required. Lab.
Grade Mode: Letter Grading
Special Fee: Yes

ESCI 868 - Applied Physical Oceanography for Hydrographic Surveyors
Credits: 2
This course provides a context-specific examination of physical oceanographic phenomena that impact the quality of hydrographic surveys. This includes a review of global scale ocean circulation followed by a particular focus on processes controlling the variability of coastal and continental shelf oceanography. The instruments used, and the available ocean climatological databases are emphasized. The course is designed to meet the oceanography requirement for the Category A FIG/IHO/ICA Standards of Competence for Hydrographic Surveyors.
Grade Mode: Letter Grading

ESCI 869 - Marine Geology and Geophysics for Hydrographic Surveyors
Credits: 2
This course provides an overview of the geology, physiography, and sediments of the ocean basins, continental margins, shelves and coastal zone, formation and distribution of sediments, major substrate types, and gravity and magnetic fields. It introduces the main marine geophysical techniques (seismics, gravity, magnetics) and describes their methodology and derived information content. The course is designed to meet the marine geology and geophysics requirement for the Category A FIG/IHO/ICA Standards of Competence for Hydrographic Surveyors.
Grade Mode: Letter Grading

ESCI 870 - Geodesy for Ocean Mapping
Credits: 3
Ocean mapping requires precise positioning and navigation. For this we need to precisely know Earth's shape, gravity field, and orientation in space. Data used for this purpose include satellite-based positioning, gravity measurements, and ground surveys. Reference frames can then be created allowing the integration of geometric observations for the creation of mapping products. This course will focus on this integration of measurements and the uncertainty associated to them.
Grade Mode: Letter Grading

ESCI 871 - Positioning for Ocean Mapping
Credits: 4
Ocean mapping requires precise positioning and navigation. For this we need to precisely know Earth's shape, gravity field, and orientation in space. Data used for this purpose include satellite-based positioning, gravity measurements, and ground surveys. Reference frames can then be created allowing the integration of geometric observations for the creation of mapping products. This course will focus on this integration of measurements and the uncertainty associated to them. One of OE 770, OE870, or ESCI 870, required.
Equivalent(s): OE 871
Grade Mode: Letter Grading

ESCI 872 - Applied Tools for Ocean Mapping
Credits: 2
A review course on research tools commonly used in ocean mapping. The course focuses on teaching problem solving skills, note merely the application of tools. The course consists of modules addressing the use of: IVS Fledermaus; GeoMappApp, GIS, Google Earth, Matlab as well as the effective library research and use of Wikis. One year of calculus required.
Grade Mode: Graduate Credit/Fail grading

ESCI 874 - Integrated Seabed Mapping Systems
Credits: 4
Overview of typical applications that involve mapping the sediment-water interface in the ocean and adjacent waters. Emphasis on defining the task-specific resolution and accuracy requirements. Fundamentals of acoustics relevant to seabed mapping. Progressions through typical configurations involving single beam, sidescan, phase differing and multibeam systems. Integration of asynchronous 3D position, orientation and sound speed measurements with sona-relative acoustic travel times and angles. Analysis of impact of offsets, mis-alignments and latency in all integrated sensors. Prereq: two terms each of college calculus and physics. One year each of calculus and physics required.
Prerequisite(s): MATH 831 (may be taken concurrently) with a minimum grade of B-.
Equivalent(s): OE 874
Grade Mode: Letter Grading

ESCI 875 - Advanced Topics in Ocean Mapping
Credits: 4
The second of two courses covering the principles and practices of hydrography and ocean mapping. In this course the following topics are covered: Verification and Field QA/QC, Water Levels (Tides); Mapping Standards; Survey Planning, Execution and Reporting; Terrain Analysis; Optical Remote Sensing; Data Presentation; Seafloor Characterization; Electronic Navigational Charts; Hydrography for Nautical Charting, Product Liability and contracts; and the United Nations Common Law of the Sea (UNCLOS). One year each of calculus and physics required.
Prerequisite(s): ESCI 872 with a minimum grade of B- and (ESCI 874 with a minimum grade of B- or OE 874 with a minimum grade of B-) and MATH 831 (may be taken concurrently) with a minimum grade of B-.
Equivalent(s): OE 875
Grade Mode: Letter Grading

ESCI 877 - GIS for Earth & Environmental Sciences
Credits: 4
Geospatial technologies provide insight into spatial and temporal aspects of environmental and earth systems. Students will master basic skills of a geographical information system. Weekly laboratory exercises will build upon a foundation of conceptual knowledge and data processing skills. Focus on applied research questions and projects will be addressed. The course will use the open source program QGIS. Additional work will develop programing skills using the python language. Programming background is not required but beneficial. Course in earth sciences or natural resources required.
Equivalent(s): GSS #807
Grade Mode: Letter Grading

ESCI 878 - Remote Sensing Earth & Environmental Sciences
Credits: 4
Remote sensing provides insight to spatial and temporal aspects of environmental and Earth systems. Students will examine digital image processing techniques, different sensor and platform technologies, and new trends and frontiers in remote sensing science. Weekly laboratory exercises build upon conceptual knowledge, data processing skills, and development of programming skills. Applied research questions and projects will use Google Earth Engine. Hyperspectral, lidar, and unmanned aerial systems will be presented. Course in earth sciences or natural resources required.
Equivalent(s): GSS 817
Grade Mode: Letter Grading

ESCI 895 - Topics
Credits: 1-4
Study on an individual or group basis in geologic, hydrologic, or oceanographic problems, under members of the graduate staff. Topics include: geochemistry, geomorphology, geophysics; glaciology; groundwater, structural, and regional geology; crystallography, mineralogy; petrology; thermodynamics; ore deposits; earth resource policy; paleontology; sedimentation; stratigraphy; water resources management; chemical, physical, and geological oceanography; earth systems; earth science teaching methods.
Repeat Rule: May be repeated for a maximum of 9 credits.
Grade Mode: Letter Grading

ESCI 896 - Topics
Credits: 1-4
Study on an individual or group basis in geologic, hydrologic, or oceanographic problems, under members of the graduate staff. Topics include: geochemistry, geomorphology, geophysics; glaciology; groundwater, structural, and regional geology; crystallography, mineralogy; petrology; thermodynamics; ore deposits; earth resource policy; paleontology; sedimentation; stratigraphy; water resources management; chemical, physical, and geological oceanography; earth systems; earth science teaching methods. Special fee on some topics.
Repeat Rule: May be repeated for a maximum of 9 credits.
Grade Mode: Graduate Credit/Fail grading
Special Fee: Yes

ESCI 898 - Directed Research
Credits: 2
Research project on a specified topic in the Earth Sciences, guided by a faculty member.
Grade Mode: Graduate Credit/Fail grading

ESCI 899 - Master's Thesis
Credits: 1-6
Master's Thesis.
Repeat Rule: May be repeated for a maximum of 6 credits.
Grade Mode: Graduate Credit/Fail grading

ESCI 972 - Hydrographic Field Course
Credits: 4
A lecture, lab, and field course on the methods and procedures for the acquisition and processing of hydrographic and ocean mapping data. Practical experience in planning and conducting hydrographic surveys. Includes significant time underway (day trips and possible multi-day cruises) aboard survey vessel(s).
Prerequisite(s): ESCI 871 with a minimum grade of B- and ESCI 874 with a minimum grade of B- and ESCI 875 with a minimum grade of B-.
Equivalent(s): OE 972
Grade Mode: Letter Grading

ESCI 973 - Seafloor Characterization
Credits: 3
Remote characterization of seafloor properties using acoustic (echo sounders, sub-bottom profilers, side-scan, multi-beam and interferometric sonars) and optical (video and laser linescanner) methods. Models of sound interaction with the seafloor will be explored as well as a range of possible geologic, geotechnical, morphologic, acoustic, and biologic descriptors. Upper level courses in ocean mapping and geodesy required.
Grade Mode: Letter Grading

ESCI 995 - Advanced Topics
Credits: 1-4
Advanced work on an individual or group basis.
Repeat Rule: May be repeated for a maximum of 12 credits.
Grade Mode: Letter Grading

ESCI 996 - Advanced Topics
Credits: 1-4
Advanced work on an individual or group basis.
Repeat Rule: May be repeated for a maximum of 12 credits.
Grade Mode: Letter Grading

ESCI 997 - Seminar in Earth Sciences
Credits: 1
Readings, discussion, and presentation of recent investigations in the earth sciences. Required of all M.S. students in Earth Sciences. Can not be concurrently enrolled in ESCI 993.
Grade Mode: Graduate Credit/Fail grading

ESCI 998 - Proposal Development
Credits: 1
Introduction to research in the earth sciences and development of thesis and directed research proposals. Required of all M.S. students in Earth Sciences. Can not be concurrently enrolled in ESCI 994.
Grade Mode: Letter Grading

ESCI #999 - Doctoral Research
Credits: 0
Doctoral Research.
Grade Mode: Graduate Credit/Fail grading
Special Fee: Yes