

# 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. Includes 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 Matlab. Prereq: Calculus and at least one 500 or 600 level undergraduate Earth Science course; or permission.

## ESCI 805 - Principles of Hydrology

**Credits: 4**

Physical principles important in the land phase of the hydrologic cycle, including precipitation, snow melt, infiltration and soil physics, and surface and subsurface flow to streams. Problems of measurement and aspects of statistical treatment of hydrologic data. Field trips. Transportation fee. Prereq: two semesters of calculus required; statistics recommended. Special fee. Lab.

## 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. Prereq: ESCI 654 or equivalent or permission. Special fee. Lab.

## 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. Prereq: ESCI 614; adequate calculus, chemistry, and physics. Field trips. Special fee. Lab.

## ESCI 831 - Geodynamics

**Credits: 4**

Application of quantitative methods to geologically motivated problems, focusing on lithospheric deformation, topography, and fluid flow. Students acquire geophysical and geochemical techniques used to address dynamics in the Earth system. Includes biweekly recitation sessions for working through problemsets and facilitating discussions of relevant papers from the literature. Prereq: one year each of physics, calculus, chemistry or permission.

## ESCI 834 - Geophysics

**Credits: 4**

The structure of the solid Earth, including the continental and oceanic lithosphere and the deep interior as revealed by investigations of seismic waves, the Earth's gravitational and magnetic fields, heat flow, and earthquakes. Prereq: ESCI 401; one year of calculus; one year of college physics; or permission. Special fee. Lab.

## ESCI 835 - Earthquakes and Faulting

**Credits: 4**

This course provides an introduction to the principles of brittle faulting and earthquake mechanics. We discuss classic theory and current topics in earthquake science based on observations from laboratory experiments, seismology, geodesy, and geology (exhumed faults). Prereq: Structural geology or permission.

## 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. Prereq: one year each chemistry, calculus.

## 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. Special fee. Lab. Prereq: one year each chemistry and calculus.

## 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. Prereq: 1 year of college calculus and chemistry or geochemistry.

## ESCI 850 - Biological Oceanography

**Credits: 4**

Biological processes of the oceans, including primary and secondary production, trophodynamics, plankton diversity, zooplankton ecology, ecosystems and global ocean dynamics. Field trips on R/V Gulf Challenger and to the Jackson Estuarine Laboratory. Prereq: one year of biology or permission of instructor. (Also offered as ZOOL 850, EOS 850.) Special fee. Lab. (Not offered every year.)

## 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. Prereq: one year of college chemistry and calculus or permission.

**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. Special fee.

**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. Prereq: ESCI 614 or ESCI 631 or permission. Special fee.

**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. Prereq: calculus based physics, introduction to oceanography; or permission.

**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.

**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. Special fee. Lab.

**ESCI #864 - Data Analysis in Earth System Science****Credits: 4**

Analytical and numerical methods used to understand geospatial and time series data sets encountered in Earth system science research. Students develop skills in data analysis, primarily through writing and modifying their own computer programs, focused on particular aspects of real data sets. Understanding various data types, formats, and projections, and how to handle them, are also covered. Prereq: one year calculus, one year chemistry, basic statistics;/or permission. (Also listed as EOS 864.) Special fee.

**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.

**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. Prereq: one year of calculus and one Earth Science course or permission. Special fee. Lab.

**ESCI 871 - Geodesy and Positioning for Ocean Mapping****Credits: 4**

The science and technology of acquiring, managing, and displaying geographically-referenced information; the size and shape of the earth, datums and projections; determination of precise positioning of points on the earth and the sea, including classical terrestrial-based methods and satellite-based methods; shoreline mapping, nautical charting and electronic charts. Prereq: one year of calculus and one year of college physics. (Also offered as OE 871.)

**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, not 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. Prereq: two terms of single variable calculus. Cr/F.

**ESCI 874 - Fundamentals of Ocean Mapping I****Credits: 4**

The first of two courses covering the principles and practices of hydrography and ocean mapping. Methods for the measurement and definition of the configuration of the bottoms and adjacent land areas of oceans, lakes, rivers, estuaries, harbors and other water areas, and the tides or water levels and currents that occur in those bodies of water. In this first course the following topics are covered: Cartographic principles, Geological Oceanography, Physical Oceanography, Fundamentals of acoustics, signal conditioning and filtering, echosounding: Singlebeam, Multibeam and Phase differencing echo sounders, side scan sonar, Systems Selection, Statistical Uncertainty in Ocean Mapping, Data Processing and management and Motion Sensors. Prereq: two terms each of college calculus and physics. Pre- or Coreq: MATH 896 Mathematics for mapping or equivalent material.

**ESCI 875 - Fundamentals of Ocean Mapping II****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: Ancillary Sensor Integration, System Calibration, 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). Prereq: OE 874/ESCI 874. Pre- Coreq: MATH 896 Mathematics for mapping.

**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. Prereq: permission of staff concerned. May be repeated.

**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. Prereq: permission of staff concerned. May be repeated. Special fee on some topics.

**ESCI 897 - Colloquium****Credits: 0**

Presentation of recent research in the earth sciences by guest speakers and department faculty. May be taken four times. Cr/F.

**ESCI 898 - Directed Research****Credits: 2**

Research project on a specified topic in the Earth Sciences, guided by a faculty member. Cr/F.

**ESCI 899 - Master's Thesis****Credits: 1-6**

May be repeated up to a maximum of 6 credits. Cr/F.

**ESCI 906 - Advanced Fate and Transport in the Environment****Credits: 3**

Mathematically rigorous introduction and analysis of the basic processes controlling the migration and transformation of chemicals in the environment at sub-geophysical scales, including advection, diffusion, dispersion, and retardation. Examples are drawn from surface water, groundwater, oceans, and the atmosphere, with a focus on rivers and streams. Prereq: Multidimensional calculus.

**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). Prereq: Introduction to Ocean Mapping; Geodesy and Positioning for Ocean Mapping; or permission. (Also listed as OE 972.)

**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. Prereq: permission. (Also listed as OE 973.)

**ESCI 993 - Advanced Seminar****Credits: 1**

Focused seminar in a discipline of earth sciences: earth, ocean, atmosphere, or hydrology. May be repeated up to a maximum of 4 credits.

**ESCI 994 - Advanced Seminar****Credits: 1**

Focused seminar in a discipline of earth sciences: earth, ocean, atmosphere, or hydrology. May be repeated up to a maximum of 4 credits.

**ESCI 995 - Advanced Topics****Credits: 1-4**

Advanced work on an individual or group basis. Prereq: permission. May be repeated.

**ESCI 996 - Advanced Topics****Credits: 1-4**

Advanced work on an individual or group basis. Prereq: permission. May be repeated.

**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. Cr/F.

**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.

**ESCI 999 - Doctoral Research****Credits: 0**

Cr/F.