EARTH AND PLANETARY SCIENCES (EARTH)

EARTH 300-0 Earth and Planetary Materials (1 Unit)
Mineralogy of the earth and planets from atomic to continental scales, focusing on structure, composition, identification, and physical properties of minerals as they pertain to geological and societal applications. Recommended Background: At least one course in each of chemistry, physics, and math.
Natural Sciences Distro Area

EARTH 301-0 Petrology: Evolution of Crustal and Mantle Rocks (1 Unit)
Origin, composition, and classification of igneous, metamorphic, and sedimentary rocks. Application of laboratory characterization and basic thermodynamics to interpreting observed rock textures and mineral assemblages in terms of geological processes.
Natural Sciences Distro Area

EARTH 310-0 Aqueous Geochemistry (1 Unit)
The geochemistry of rivers, groundwater, lakes, and seawater. Topics include thermodynamics, kinetics, acids and bases, pH and alkalinity, carbonate equilibria, chemical weathering, and numerical modeling. Recommended Background: At least one year of chemistry coursework.
Natural Sciences Distro Area

EARTH 312-0 Stable Isotope Geochemistry (1 Unit)
Fractionation and distribution of stable isotopes (C, H, N, O, S) in the biosphere, hydrosphere, atmosphere, and geosphere. Isotopic biogeochemistry, environmental problems, and global climate change. Recommended Background: EARTH 201-0 and EARTH 203-0, or equivalent.

EARTH 313-0 Radiogenic Isotope Geochemistry (1 Unit)
Application of radiogenic isotopes to problems in geochemistry, petrology, hydrology, oceanography, ecology, and environmental science. Includes radioactive decay, nucleosynthesis, cosmochemistry, geochronology, mixing processes, and numerical modeling. Recommended Background: At least one year of chemistry coursework.

EARTH 314-0 Organic Geochemistry (1 Unit)
The sources and fates of organic matter in the natural environment; global cycling of organic carbon; applications to the study of modern and ancient environments. Recommended Background: at least one quarter of earth or environmental science, and one quarter of chemistry. Taught with CIV_ENV 314-0; may not receive credit for both courses.
Natural Sciences Distro Area

EARTH 323-0 Seismology and Earth Structure (1 Unit)
Elastic theory, seismic waves, seismometers and seismograms, ray paths, travel times; internal structure of the earth; field seismology. Recommended Background: EARTH 202-0, calculus, ordinary differential equations, and some exposure to complex numbers. No prior earth science experience required.
Natural Sciences Distro Area

EARTH 324-0 Earthquakes and Tectonics (1 Unit)
Earthquakes: location, characteristics, origin, mechanism, and relation to plate motions; seismic hazard. Recommended Background: Calculus, ordinary differential equations, and some exposure to complex numbers. No prior earth science experience required.
Natural Sciences Distro Area

EARTH 327-0 Geophysical Time Series Analysis (1 Unit)
Analysis of seismic and other geophysical data. Sampling, windowing, discrete and fast Fourier transforms, z-transforms, deconvolution, and filtering. Recommended Background: EARTH 202-0 and calculus differential equations; or consent of instructor.

EARTH 330-0 Sedimentary Geology (1 Unit)
Sedimentary rocks; stratigraphy; local, regional, and global correlation. Ancient depositional systems; facies analysis in context of tectonic, eustatic, and climatic controls on deposition. Recommended Background: EARTH 201-0 or consent of instructor.

EARTH 331-0 Field Problems in Sedimentary Geology (1 Unit)
Field methods in stratigraphy and sedimentology; interpretation of depositional systems, facies models, and sequence stratigraphy based on field observations. Includes 3½-week late-summer field trip to Colorado and Utah.
Prerequisite: EARTH 330-0.

EARTH 335-0 Tectonics and Structural Geology (1 Unit)
Deformation of rock masses: strain, fracture, slip, stress, and rheologic regimes; rock structures; folds, faults, foliations; seismic parameters in tectonic studies; orogenic belts and their tectonic evolution. Recommended Background: EARTH 201-0, and at least one credit of physics; or consent of instructor.

EARTH 340-0 Physics of Weather & Climate (1 Unit)
An investigation of atmospheric processes and the physical laws that govern them. Topics covered include atmospheric composition and structure, radiative transfer, thermodynamics, convection, precipitation, and the general circulation of the three-dimensional atmosphere. When possible, course content will engage with contemporaneous atmospheric conditions, and provide students with a better understanding of their meteorological and climatic environments. Recommended Background: Completion of full year of calculus Math and Physics.
Natural Sciences Distro Area

EARTH 341-0 Quaternary Climate Change: Ice Ages to the Age of Oil (1 Unit)
Methods for reconstructing and dating past environmental changes, causes of natural climate change, and major climate events of the Quaternary through the present. Their relevance for understanding current climate change.
Prerequisite: At least one 200-level EARTH course; or consent of instructor.
Natural Sciences Distro Area

EARTH 342-0 Contemporary Energy and Climate Change (1 Unit)
Interdisciplinary course examining global energy use and associated challenges, including the history of energy use, the science of climate change, and technological, economic, and environmental aspects of various energy sources. Registration reserved for seniors majoring in math, science, or engineering, and graduate students in all disciplines. Taught with ISEN 410-0; may not receive credit for both courses.
Natural Sciences Distro Area

EARTH 343-0 Earth System Modeling (1 Unit)
Introduction to the art and science of reducing Earth's complex systems into simple numerical models to build a better understanding of how components interact and evolve. Recommended Background: At least one 200-level course in Earth or Environmental Science, one course in each of calculus and physics.
Natural Sciences Distro Area

EARTH 350-0 Physics of the Earth for ISP (1 Unit)
Solid-earth geophysics: the earth's gravity field, the earth's magnetic field, interior of the earth, heat flow, elementary wave propagation, plate tectonics.

Prerequisites: second-year standing in ISP; or comparable background in mathematics and physics and consent of both instructor and ISP director.

EARTH 352-0 Global Tectonics (1 Unit)
Kinematics of plate tectonics. Geometry, determination, and description of plate motions. Paleomagnetism, marine magnetism, and hot spots. History of ocean basins and mountain-building processes. Recommended Background: EARTH 202-0, and completion of first-year calculus and physics.

EARTH 353-0 Mathematical Inverse Methods in Earth and Environmental Sciences (1 Unit)
Theory and application of inverse methods to gravity, magnetotelluric, seismic, and other data. Nonlinear, linearized, underdetermined, and mixed-determined problems and solution methods, including regularized least-squares and neighborhood algorithms. Recommended Background: Linear algebra and differential calculus of multivariable functions.

EARTH 360-0 Instrumentation and Field Methods (1 Unit)
Theory and practicum on electronic instrumentation for monitoring and measurement in earth sciences, including data loggers, conceptual design and construction of electronic sensors, signal processing, data management, and network design. Recommended Background: 3 EARTH courses.

EARTH 361-0 Scientific Programming in Python (1 Unit)
Introduction to coding, scientific computing, and visualization for analyzing data in the physical sciences. Emphasis on Python, but Unix, shell scripting, and Generic Mapping Tools are also introduced. Students undertake a significant final coding project individually or in pairs.
Formal Studies Distro Area

EARTH 362-0 Data Analysis for Earth and Planetary Sciences (1 Unit)
Types and characteristics of earth science data, development and applications of model types, observational and systematic sources of uncertainties and their characterization, spatial and temporal predictions. Recommended Background: EARTH 201-0 and EARTH 202-0, or equivalent.
Formal Studies Distro Area

EARTH 370-0 Geobiology (1 Unit)
A technical overview of the major topics of geo(micro)biology highlighting the fossil record, biogeochemical cycling, biomineralization, key tools of the field, historical geobiology, and astrobiology. Recommended Background: EARTH 201-0 (concurrent enrollment acceptable) and first-year chemistry.
Natural Sciences Distro Area

EARTH 371-0 Biogeochemistry (1 Unit)
The cycling of biogenic elements (C, N, S, Fe, Mn) in surficial environments. Emphasis on microbial processes and isotopic signatures. Recommended Background: At least one course in biology, chemistry, and earth or environmental science. Taught with CIV_ENV 317-0; may not receive credit for both courses.
Natural Sciences Distro Area

EARTH 373-0 Microbial Ecology (1 Unit)
This course will provide a framework for understanding the role of microbes in natural environments in terms of cell numbers, metabolisms, and interactions with geochemical cycles. We will delve deeply into the interactions between microbial populations, higher organisms, and even our own bodies. The course will finish on a survey of microbial composition and dynamics in key settings across the planet. Recommended Background: Basic understanding of chemistry, biology, and earth science.

EARTH 390-0 Special Topics in Earth and Planetary Science (1 Unit)
Topics of current interest to students and faculty. Prerequisites vary. May be repeated for credit with different topic.

EARTH 438-0 Advanced Topics in Geophysics (1 Unit)
Topics include tectonophysics and the bodily structure of the Earth, dislocation theory in Earth motions, glaciology, geochronology, and emerging and new areas of geophysics. Intended for advanced undergraduate students and graduate students.

EARTH 440-0 Advanced Topics in Geochemistry (1 Unit)
Topics at the frontiers of geochemistry research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

EARTH 450-0 Advanced Topics (1 Unit)
Topics at the frontiers of research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

EARTH 451-0 Advanced Topics in Paleoclimate (1 Unit)
Methodology in paleoclimate: stable-isotope, paleoecological, and other methods for reconstructing the past climate. Fundamental principles of climate change on the time scale of thousands to millions of years. Climate reconstructions from the Cretaceous to the present. Intended for advanced undergraduate students and graduate students.

EARTH 462-0 Advanced Topics in Seismology (1 Unit)
Topics at the frontiers of seismology research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

EARTH 499-0 Independent Study (1-4 Units)
Study of special problems under the direct supervision of one or more members of the teaching staff. A comprehensive report and/or a comprehensive examination is required. May be repeated for credit.

EARTH 519-0 Responsible Conduct of Research Training (0 Unit)
All Earth and Planetary Sciences Graduate Students and Post Doctoral Fellows must complete the Responsible Conduct of Research (RCR) Training in their first year of the program.

EARTH 590-0 Research (1-4 Units)
Independent investigation of selected problems pertaining to thesis or dissertation. May be repeated for credit.