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 320-0 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 321-0 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 322-0 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 323-0 Seismology and Earth Structure (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 324-0 Earthquakes and Tectonics (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.

EARTH 325-0 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 326-0 Contemporary Energy and Climate Change (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 327-0 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)**

**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 Distrito 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 Distrito Area

**EARTH 370-0 Geobiology (1 Unit)**
A technical overview of the major topics of geo(micro)biology highlighting the fossil record, biogeochemical cycling, biominalization, key tools of the field, historical geobiology, and astrobiology. Recommended Background: EARTH 201-0 (concurrent enrollment acceptable) and first-year chemistry. Natural Sciences Distrito 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 Distrito 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 374-0 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 forefronts 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 forefronts 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)**
Topics at the forefronts of research taught by visiting or department faculty. Intended for advanced undergraduate students and graduate students.

**EARTH 452-0 Advanced Topics in Seismology (1 Unit)**
Topics at the forefronts 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.