GEO

GEO 500: Geosciences Research Seminar
Meetings in which first-year graduate students and undergraduates with senior standing learn about the research activities of the Geosciences faculty.
Fall, S/U grading

GEO 502: GIS for Geologists
A practical introduction to geographic information system software. Participants learn to use direct measurement and mathematical techniques to compute the location of features and gain practical experience in rendering imagery and tabular geographic data as layers on maps. The course consists of two three-hour sessions per week for the first five weeks of semester, which include fieldwork, lectures, demonstrations and software-based analysis of data.
This course meets with GEO 588 (Geological Field Methods for Earth Science Teachers) for the first five weeks of the semester. Students may not take GEO 502 and GEO 588 for credit.
Fall, 1 credit, Letter graded (A, A-, B+, etc.)

GEO 503: Mineral Equilibria
Covers the basics of the application of the principles of chemical thermodynamics to the resolution of geochemical and petrological problems. Begins with the first law and continues through phase transitions, properties of fluids, definitions of fugacity and activity of major and trace elements in fluids and molten solutions; configurational entropies; models quantifying nonideal mixing in solid solutions. Additional topics include interpretation of calorimetric studies and/or solubilities of minerals in aqueous solutions.
Prerequisites: Physical chemistry and thermodynamics, or permission of instructor
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 504: Geology of the Turkana Basin
Students are introduced to the current perspectives on the origins and evolution of the Turkana Basin, Kenya. Students learn how to apply fundamental geological concepts to the sediments and rock units to provide a foundation for the chronology and context for recorded events in human evolution. Emphasis is given to sedimentation, stratigraphy, volcanism, and tectonics, as they apply to local geology, including training in field methods. Modern terrestrial processes and landscape evolution are examined using features present in the Turkana Basin. Consideration is also given to broader geologic events spanning the Oligocene to present. Geologic concepts are linked to modern and ancient environments, archaeology, and paleoanthropology in northern Kenya. It is a field-based course involving visits to important geological and fossil sites. Graded work includes fieldwork and lab assignments, independent research assignments, quizzes and a final exam. Semesters offered-Fall and Spring. Components- laboratory, lecture, and recitation.
3 credits, Letter graded (A, A-, B+, etc.)

GEO 505: Experimental Petrology Laboratory
The course is designed to give the student experience in some or all of the following techniques of experimental petrology: evacuated silica-glass tube experiments, one-atmosphere quenching experiments (with and without controlled atmospheres), 1- to 5-kbar hydrothermal systems (using oxygen buffers where necessary), gas-media experiments up to 7 kbar, and solid-media, piston-cylinder experiments.
Requirements: Completion of a project involving several of the above techniques; written report
Spring, alternate years, 1 credit, Letter graded (A, A-, B+, etc.)

GEO 506: Theoretical Petrology
Theory of phase diagrams, Schreinemakers rules, heterogeneous equilibria, experimental systems of petrologic interest, and properties of solutions.
Prerequisites: Metamorphic and igneous petrology and physical chemistry or thermodynamics; or permission of instructor
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 507: Petrogenesis
Discussion of the origin and evolutionary history of selected types of igneous and metamorphic rocks by integrating the principles of heterogeneous phase equilibria, trace-element and isotopic geochemistry, crystal chemistry, and geologic occurrence.
Fall, 4 credits, Letter graded (A, A-, B+, etc.)

GEO 508: The Rock-Forming Minerals
Study of the crystal chemistry, intracrystalline cation distribution (homogeneous equilibria) stability, and paragenesis of the rock-forming minerals. Special emphasis is placed on amphiboles, feldspars, micas, and pyroxenes.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 510: Dimensions of Global Change
This course is designed to be an intense study in global climate change science. The emphasis will be on modern climate change however, by studying the contributions of paleoclimatology we can gain insight into how the climate system operates. To understand modern climate change and predictions, it is necessary to develop an understanding of natural climate forcing, natural variability and feedbacks in the climate systems. Adding to natural variation are the impacts of anthropogenic forcing. The course will examine the measured and predicted consequences of these anthropogenic forcing.
Offered Fall and Summer, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 511: Computer Programming for the Geosciences
An introduction to object-oriented programming in Java for geoscience students. Participants are required to develop interactive programs to serve as educational or research tools pertaining to topics within the geosciences. These programs, or applets, include a graphical user interface that enables users to control parameters and observe results. The applets are posted on the World Wide Web.
Prerequisite: Geosciences graduate standing
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 512: Structure and Properties of Materials
An introductory course that will explore materials from the viewpoint of their structure and chemistry and how these affect applications. Different states of matter (crystals, quasicrystals, glasses, liquids) will be discussed and their similarities and differences, focusing on the crystalline state. Nanomaterials and their peculiarities in terms of structure and properties will also be considered. Particular attention will be paid to (1) Materials for energy and environment applications, (2) materials for technological applications, and (3) Earth and planet-forming materials.
3 credits, Letter graded (A, A-, B+, etc.)

GEO 513: GIS Fundamentals I
This course provides the basic concepts underlying modern geographic information science and technology. Emphasis is placed on the principles of GIS for collecting, storing, characterizing, and maintaining data and...
computer-based techniques for processing and analyzing spatial data. The course includes three hours of lecture, in class exercises and homework projects each week. This is a computer-based class with the majority of students working involving GIS computer software. Prerequisite: working knowledge of spreadsheet software.

3 credits, Letter graded (A, A-, B+, etc.)
May be repeated 1 times FOR credit.

**GEO 514: Introduction to Physical Hydrogeology**


Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 515: Geohydrology**


Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 517: Crystal Chemistry**

The structure/property/composition relationships in solids. An introduction to the common structure types and how they illustrate principles useful in understanding more complex solid-state materials. Applications of modern scattering techniques to the study of solids, particularly Earth materials, are also included.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 518: Carbonate Sediments**

An intensive study of the formation, deposition, lithification, and diagenesis of carbonate sediments. Lectures and seminars emphasize principles of carbonate deposition, facies relationships, and chemistry. Laboratories emphasize binocular and petrographic analysis of recent and ancient carbonates.

Spring, alternate years, 4 credits, Letter graded (A, A-, B+, etc.)

**GEO 519: Geochemistry of Natural Waters**

A comprehensive quantitative treatment of the processes controlling the chemistry of polluted and unpolluted surface and groundwaters. Topics covered include thermodynamics and kinetics of water-rock interaction; mineral solubility; chemical speciation; redox reactions; adsorptions; carbonate chemistry; and speciation, mobility, and toxicity of metal ions. Based on a knowledge of these processes, the chemical composition of a wide variety of surface and groundwaters is interpreted. Water-quality criteria and their application are also discussed.

Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 520: Glacial Geology**

History of glaciation on earth, formation and dynamics of glaciers and ice sheets; processes of glacial erosion and deposition; and the nature of glacial sediments and landforms particularly relating to the development of Long Island.

Prerequisite: Physical Geology
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 521: Isotope and Trace Element Geology**

Application of radiogenic isotopes and trace elements to the petrogenesis of igneous, metamorphic, and sedimentary systems including water-rock interaction in diagenetic and hydrothermal systems. Evaluation of radiogenic techniques for determining the ages of rocks and minerals.

Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 522: Planetary Sciences**

The chemical, physical, and petrologic properties of meteorites are reviewed. These data and data for the moon and the terrestrial planets are used to form a picture of the origin, chemical evolution, and accretion of planetary material.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 523: Geodatabase and Design**

Concepts of geodatabase design and management in geographic information systems (GIS). SQL statements, geographic data types and functions, data entry, and techniques of geographic information structure applications.

3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 524: Organic Contaminant Hydrology**

There are a host of chemical, biological, and physical processes that affect the transport and fate of organic chemicals in natural waters. This course concerns understanding these processes and the structure-activity relationships available for predicting their rates. The major focus of this class is on contaminant hydrology of soil and aquifer environments, and includes the principles behind remediation and containment technologies. This course is offered as both MAR 524 and GEO 524.

Prerequisite: GEO 526 or MAR 503 or permission of instructor
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 525: GIS Fundamentals II**

GIS Fundamentals II will introduce the applied use of Geographic Information Systems (GIS) which is now used extensively in analytical studies. The course emphasizes the applications of GIS in solving real-world problems. Students are expected to gain an understanding of GIS theory, methodology and most importantly application. Students are also expected to demonstrate abilities of spatial thinking, spatial analysis, and be able to solve practical spatial problems utilizing a GIS.

3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 526: Low-Temperature Geochemistry**

Fundamental principles of chemical thermodynamics and kinetics, including isotope effects, as they pertain to geochemical processes occurring in surface and near-surface environments. Consideration is also given to mass transfer process and reaction pathways.

Fall, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 528: Carbonate Geochemistry**

Examination of the mineralogical and chemical characteristics of the rock-forming carbonates with emphasis on stabilities in the geological environments. Includes study of phase relations; trace and minor element chemistries; and mechanisms of growth, dissolution, and replacement. Use of current research techniques as applied to carbonate minerals.

Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 530: The Geology of Mars**

Overview of Mars as a planetary system. Evolution of the planet and its atmosphere through time. Detailed discussion of processes that have shaped the martian surface, including erosion, sedimentation, volcanism, impact cratering, physical and chemical weathering. Comparison of geologic processes on Mars and Earth. Discussion of past and future spacecraft missions to Mars. Three hours of lecture per week.

3 credits, Letter graded (A, A-, B+, etc.)
GEO 531: Crystalline Solids
Principles of symmetry, single-crystal, and powder X-ray diffraction techniques and elements of crystal structure determination are considered. Use of crystallographic data in the study of mineral systems. Laboratory in diffraction techniques includes extensive use of digital computers.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 532: Solid-State Geochemistry
The application of crystallographic techniques to problems in mineral chemistry. Concepts of the crystalline state, order-disorder, atom radii, chemical bonding, atom coordination, solid solutions, and physical properties of minerals. Emphasis on silicate and sulfide crystal structures.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 533: Geochemistry of the Terrestrial Planets
A brief overview of basic principles of geochemistry, including origin of the elements, geochemical and cosmochemical classification of the elements, and a geochemical perspective of the periodic table. This is followed by an examination of the compositions and chemical interactions among the major geochemical reservoirs of the terrestrial planets, including their cores, mantles, crusts, and where relevant, sedimentary shells.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 535: Regional Structure and Tectonics
Formation and development of continental crust in Phanerozoic mountain belts. The structure and origin of ocean crust, magmatic arcs, and continental margin sequences are studied using geophysical, geochemical, and geologic data from ancient and modern examples.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 540: Solid Earth Geophysics
An overview of solid earth geophysics. Topics include earthquake and exploratory seismology, gravity, magnetics, geochronology, and heat flow. There is an emphasis on how all of these techniques shed light on the nature of the Earth’s interior and dynamics.
Prerequisite: Physical geology, undergraduate physics and calculus
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 542: Inverse Theory
Introduction to the basic concepts of inverse theory and its application to the study of the internal structure of the Earth and related problems.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 543: Stratigraphy
The history and practice of defining units layered rocks and interpreting their spatial relationships. Topics include the basis for the geologic time scale, lithostratigraphic versus chronostratigraphic units, biostratigraphy, magnetostratigraphy, facies patterns and Walther’s law, subsurface stratigraphy, and the application of stratigraphy to geological problems. One three-hour laboratory per week. Laboratory work emphasizes practical techniques in stratigraphy.
Prerequisite: GEO 546 or undergraduate mineralogy and petrology
Fall, 4 credits, Letter graded (A, A-, B+, etc.)

GEO 546: Mineralogy and Petrology
An introduction to mineralogy and petrology, including crystallography, crystal chemistry, mineral identification, and the processes that govern the formation of igneous and metamorphic rocks. Two three-hour laboratories per week.
Prerequisite: Undergraduate physical geology and one year of undergraduate chemistry
Spring, 4 credits, Letter graded (A, A-, B+, etc.)

GEO 547: Remote Sensing in Geosciences
Comprehensive study of commonly used image analysis methods in earth, environmental and planetary sciences. Discussion of physical principles that are the basis for remote sensing techniques. Participants gain practical experience in geologic and environmental problem-solving using satellite imagery.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 549: Structural Geology
Principles of structural geology, including the recognition and the mechanics crustal structural features. Topics include folding and faulting, stress and strain, and the nature of brittle and ductile lineations and foliations in the crust. One three-hour laboratory per week.
Prerequisite: Undergraduate physical geology
Spring, 4 credits, Letter graded (A, A-, B+, etc.)

GEO 550: Global Tectonics
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 551: Physics of the Earth I
Study of the internal structure and properties of the Earth as revealed by field and laboratory investigations. Topics include the rotation and figure of the Earth, gravity anomalies, solid-earth tides, geomagnetism and paleomagnetism, electromagnetic induction, and heat flow and the Earth’s present and past thermal states. May be taken independently of GEO 552.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 552: Physics of the Earth II
Study of the Earth’s structure and properties based on evidence from seismology and high-pressure geophysics. Topics include fundamental principles of elastic wave theory, body and surface wave propagation in layered media, earthquake source mechanisms, free oscillations of the Earth, and rheological properties of the Earth’s interior. May be taken independently of GEO 551.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 556: Solid-State Geophysics
Application of lattice dynamics and equations of state of solids to studies in high-pressure, high-temperature geophysics. Reviews experimental data from physical acoustics, static and shock wave compression, and theoretical results from finite strain and atomistic models.
Prerequisites: GEO 551 and 552, or permission of instructor
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

GEO 562: Early Diagenesis of Marine Sediments
The course treats qualitative and quantitative aspects of the early diagenesis of sediments. Topics include diffusion and adsorption of dissolved species; organic matter decomposition and storage; and diagenesis of clay materials, sulfur compounds, and calcium carbonates. The effects of bioturbation on sediment diagenesis are also discussed. This course is offered as both MAR 562 and GEO 562.
Prerequisite: Permission of instructor
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 564: Numerical Hydrology**
Numerical solution methods for the equations of incompressible flow in porous media with special emphasis on groundwater flow. Finite difference and finite element methods for steady-state and transient flows-boundary conditions, range of validity and stability of the numerical schemes, and numerical artifacts. The approach is hands on, with example problems being computed. This course is offered as both GEO 564 and AMS 562.
Prerequisite: AMS 526 or permission of instructor
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 567: Sedimentary Rocks and Crustal Evolution**
An examination of major and trace elements and isotopic composition of terrigenous sedimentary rocks within a framework of tracing the composition and evolution of the continental crust. Emphasis is placed on interpreting sedimentary compositions in terms of provenance and sedimentary history (e.g., weathering, diagenesis, recycling). Relationships between sediment composition and tectonic setting is also examined.
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 570: Earthquake Mechanics**
A survey of fundamental mechanics aspects of earthquake rupture; reviews concepts of fracture mechanics, elastodynamics, and experimental rock mechanics. Topics include state of stress in the lithosphere, theoretical models of earthquake instability, energetics of faulting, representation of dynamic elastic field generated by earthquakes, and relation of seismic signals to the kinematics and dynamics of seismic source.
Prerequisite: GEO 552 or permission of instructor
Spring, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 571: Mechanics of Geologic Materials**
Elastic, thermal, and anelastic properties of geological materials. The course emphasizes a thermodynamic characterization of these properties including irreversible thermodynamics and nonhydrostatic thermodynamics. Specific applications to the Earth's environment are discussed.
Prerequisites: GEO 551, 552, or permission of instructor
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 572: Advanced Seismology**
Course is intended to expose the student to topics that are at the forefront of current seismological research. Examples include wave propagation in heterogeneous media, earthquake source studies, tsunami generation, and seismic network data analysis.
Prerequisite: GEO 552
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 573: Physics of Rocks**
Fundamentals of the physical properties of rock in relation to seismology, hydrogeology, geophysical prospecting and geotechnical engineering. Topics include: composition, pore structure and fabric of rocks; elasticity, anelasticity and plasticity; seismic velocity and anisotropy; poreelasticity; electrical, magnetic and hydraulic transport properties.
Fall, alternate years, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 578: Geological Field Methods for Earth Science Teachers**
Geologic mapping techniques, geochemical analytical approach, and hydrological methodologies applied in the field to examples on Long Island. These approaches are designed for developing research projects for secondary students in earth science.
Prerequisite: Permission of instructor
Summer, 3 credits, Letter graded (A, A-, B+, etc.)

**GEO 580: Research for Earth Science Teachers**
This course is intended to provide earth science teachers or students in the M.A.T. in Earth Science program an opportunity to obtain research experience. A written report is required.
Prerequisite: Permission of instructor
Summer, 1-3 credits, Letter graded (A, A-, B+, etc.)

**GEO 590: Research Project**
Independent research
Fall, Spring,
Summer, 1-12 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 599: Research**
Independent research for those students established in a research group.
1-12 credits, S/U grading
May be repeated for credit.

**GEO 600: Practicum in Teaching**
Fall and Spring, 0-3 credits, S/U grading
May be repeated for credit.

**GEO 603: Topics in Petrology**
Fall and Spring, 1-3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 604: Topics in Planetary Science**
May be repeated for credit.

**GEO 605: Topics in Sedimentary Geology-Paleontology**
Fall and Spring, 1-3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 606: Topics in Geophysics**
Fall and Spring, 1-3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 609: Topics in Mineralogy and Crystallography**
Fall and Spring, 1-3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

**GEO 696: Geoscience Colloquium**
A weekly series of research seminars presented by visiting scientists as well as by the faculty.
Required every semester of all geoscience graduate students.

GEO 697: Geoscience Seminar
Presentation of preliminary research results and current research problems by students and faculty. Required every semester of all geoscience graduate students.

GEO 698: Geoscience Special Seminar
A weekly series of specialized seminars in which graduate students and faculty discuss specific topics within the subgroups of geology. Research is reviewed, and theses are discussed.

GEO 699: Dissertation Research on Campus
Independent research for Ph.D. degree. Open only to candidates for the Ph.D. who have passed the preliminary examination.

GEO 700: Dissertation Research off Campus - Domestic
Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place off-campus, but in the United States and/or U.S. provinces. Please note, Brookhaven National Labs and the Cold Spring Harbor Lab are considered on-campus. All international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor.

GEO 701: Dissertation Research off Campus - International
Prerequisite: Must be advanced to candidacy (G5). Major portion of research will take place outside of the United States and/or U.S. provinces. Domestic students have the option of the health plan and may also enroll in MEDEX. International students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed. International students who are not in their home country are charged for the mandatory health insurance. If they are to be covered by another insurance plan they must file a waiver by second week of classes. The charge will only be removed if other plan is deemed comparable.

GEO 800: SUMMER RESEARCH
May be repeated for credit.