

# GEOP - GEOPHYSICS

## GEOP 611 Geomechanics

**Credits 3. 3 Lecture Hours.** Development of continuum mechanics and its application to rock deformation; stress, strain, stress equilibrium, constitutive relations; governing equations for elastic solids and viscous fluids formulated and used to solve elementary boundary-value problems which have application to structural geology and solid-state geophysics. **Prerequisite:** MATH 221 or equivalent.

## GEOP 615 Experimental Rock Deformation

**Credits 4. 3 Lecture Hours. 3 Lab Hours.** Results of laboratory testing of mechanical properties of rocks at high pressure and temperature; interaction of theoretical, experimental, petrofabric and field studies of rock deformations as applied to problems in structural geology, seismology and engineering; philosophy of experimentation, apparatus design, data interpretation and extrapolation. **Prerequisite:** GEOP 611 or GEOL 665 or approval of instructor.

## GEOP 618 Numerical Methods for the Geosciences

**Credits 3. 3 Lecture Hours.** Mathematical theory and numerical techniques for modeling physical systems and processes in the Geosciences; discretization of continuum equations for solids and fluids; finite difference methods, convergence, consistency, and stability; finite element and spectral methods in fluid dynamics and seismology; iterative solvers; implicit and explicit methods for diffusion and advection. **Prerequisite:** Graduate classification or approval of instructor. **Cross Listing:** ATMO 618 and OCN 618.

## GEOP 619 Finite Element Methods in Geophysics

**Credits 3. 3 Lecture Hours.** Fundamental concepts of finite element methods, formulation of two and three-dimensional boundary-value problems in geophysics, including heat conduction, elasticity, seismic wave propagation and gravity and magnetic modeling; emphasis on the Galerkin method and isoparametric concept; data processing and programming techniques such as MPI-based parallel computing.

## GEOP 620 Geophysical Inverse Theory

**Credits 3. 3 Lecture Hours.** Inferences about Earth structure from geophysical data; explicit treatment of sparse and noisy observations; construction of smooth Earth models; linear inversion of marine magnetic anomalies from seafloor magnetization; smooth inversion of DC sounding data from electrical structure; seismic tomography and geodetic fault-plane reconstructions; advanced methods for nonlinear deterministic inversion. **Prerequisite:** Graduate classification.

## GEOP 622 Petroleum Seismology II

**Credits 4. 3 Lecture Hours. 2 Lab Hours.** Sampling (wavefield sampling); F-K analysis (applications to dip filtering and migration); deconvolution (deterministic and predictive); velocity estimation and tomography (travel time inversion); imaging in time and depth (migration); Zoeppritz equations and AVO analysis. **Prerequisite:** GEOP 421 or approval of instructor.

## GEOP 628 Basin Architecture

**Credits 3. 3 Lecture Hours.** Tectonic classification of basins; tectonic mechanisms responsible for basin formation: mechanical behavior of the lithosphere; subsidence; geophysical signatures of sedimentary basins; tectonic controls on sedimentation and basin filling; petroleum systems and basin-scale hydrologic systems. **Prerequisite:** Approval of instructor.

## GEOP 629 Seismic Interpretation

**Credits 4. 3 Lecture Hours. 3 Lab Hours.** Introduces the problem of converting seismic properties of reflection time, velocity, impedance, amplitude and phase to geologic parameters of lithology, structures and stratigraphy using both models and real data. **Prerequisite:** Approval of instructor.

## GEOP 631 Seismic Data Processing

**Credits 4. 3 Lecture Hours. 3 Lab Hours.** Methods used to image the Earth using seismic reflection data, including deconvolution, f-k filtering, velocity analysis and migration; processing software; emphasis on field data. **Prerequisite:** Graduate classification or approval of instructor.

## GEOP 635 Methods of Geophysical Exploration

**Credits 3. 3 Lecture Hours.** Introduction to theory of gravity, magnetic, electrical and seismic exploration methods; physical properties of earth materials and their influence on geophysical measurements; limitations of geophysical data in the interpretation of subsurface structure. **Prerequisite:** Graduate classification.

## GEOP 651 Theoretical Seismology

**Credits 3. 3 Lecture Hours.** Wave propagation in unbounded and bounded elastic media; seismic reciprocity and the elastodynamic representation theorem; radiation patterns from earthquake sources; body waves, Rayleigh waves, Stoneley waves, Love waves and Lamb waves; characteristic equation for surface waves in a layered half-space; dispersion and phase and group velocities; methods of stationary phase and steepest descents; Cagniard-deHoop technique; ray theory in an inhomogeneous earth; inversion of travel times; viscoelastic wave propagation; normal modes of vibration of the earth. **Prerequisite:** GEOP 652 or approval of the instructor. (Offered in alternate years.)

## GEOP 652 Earthquake Seismology

**Credits 3. 3 Lecture Hours.** Seismometry and earthquake precursors; mathematical theory of elasticity and its application to earthquake studies; dissipation of elastic energy; seismic sources; earthquake risk; free modes of the earth; discrimination between underground nuclear explosions and earthquakes. **Prerequisite:** GEOP 421 or approval of instructor.

## GEOP 660 Physics of the Earth's Interior

**Credits 3. 2 Lecture Hours. 3 Lab Hours.** Physics of the Earth's Interior. Structure, composition and physical state of the Earth's interior; constraints on models of the Earth imposed by seismic, gravity, heat flow, and electrical conductivity; thermodynamics and high pressure mineral physics; Earth's motion and deformation; rheology. **Prerequisite:** Graduate classification.

## **GEOP 661 Reservoir Rock Physics**

**Credits 4. 3 Lecture Hours. 2 Lab Hours.** Poroelasticity and electrostatics of porous media; Biot Theory, Gassman fluid substitution and advanced rock physics models; relationships between seismic/electromagnetic properties and multiphase reservoir properties such as porosity, saturation, permeability, wettability, connectivity and other pore-structure parameters; computer-based rock physics modeling; application to reservoir characterization; time-lapse reservoir monitoring. **Prerequisite:** Approval of instructor. (Spring, alternate years.)

## **GEOP 662 Advanced Reservoir Rock Physics**

**Credits 3. 3 Lecture Hours.** Continuation of GEOP 661; topological characterization of fractured porous media and Riemannian manifold, balance laws of an effective medium, balance laws of interacting fields, compatibility equations and structural evolution, equations of relative motion, thermodynamics and constitutive relations, wave phenomena and fluid flow in fractured porous media. **Prerequisites:** GEOP 661 and approval of instructor.

## **GEOP 666 Principles of Geodynamics**

**Credits 4. 4 Lecture Hours.** Geological and geophysical methods and phenomena pertinent to geodynamics; plate tectonics; seismicity and seismology; magnetics; gravity; heat flow; igneous, metamorphic and sedimentary petrology; paleontology; and rock mechanics. **Prerequisite:** Approval of instructor.

## **GEOP 681 Seminar**

**Credit 1. 1 Lecture Hour.** Discussion of subjects of current importance. **Prerequisite:** Graduate classification.

## **GEOP 685 Directed Studies**

**Credits 1 to 6. 1 to 6 Other Hours.** For graduate students to undertake limited investigations not within their thesis or dissertation research and not covered in established curricula. **Prerequisites:** Graduate classification and approval of department head.

## **GEOP 689 Special Topics in...**

**Credits 1 to 4. 1 to 4 Lecture Hours.** Selected topics in an identified area of geophysics. May be repeated for credit. **Prerequisites:** Graduate classification and approval of instructor.

## **GEOP 691 Research**

**Credits 1 to 23. 1 to 23 Other Hours.** Research toward thesis or dissertation.