GEOL 610 Field Methods in Hydrogeology
Credits 3. 1 Lecture Hour. 6 Lab Hours.
Field methods in hydrogeology; including ground water drilling technology and law; investigation and planning of well sites; installation of ground water wells; field testing of aquifer properties and analysis of field data. Field trips may be required for which departmental fees may be assessed to cover costs.
Prerequisite: GEOL 410 or approval of instructor.

GEOL 612 Structural Geology
Credits 3. 3 Lecture Hours.
Mechanical principles important to structural geology and experimental results relating to rock deformation followed by applications to natural deformation; mechanisms, rather than geometries. Primarily for students not concentrating in structural geology but who desire an advanced general course.
Prerequisite: Approval of instructor.

GEOL 614 Advanced Hydrogeology
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Geologic conditions determining the distribution and movement of ground water and their effect on the hydrologic properties of aquifers.
Prerequisites: MATH 151 and MATH 152, or equivalent.

GEOL 616 Petroleum Systems Analysis and Basin Modeling
Credits 3. 3 Lecture Hours.
Geological processes in sedimentary basins; petroleum system elements and modeling; hydrocarbon generation, expulsion, migration, accumulation; fluid analysis; multi-disciplinary data integration; basin modeling software and simulation.

GEOL 617 Introduction to the Petroleum Industry
Credits 3. 3 Lecture Hours.
Introduction to the petroleum industry and geoscience issues associated with the full petroleum cycle from resource discovery to marketing of refined petroleum products; focuses on the role of geoscientists in all facets of the business.
Prerequisite: Graduate classification or approval of instructor.

GEOL 619 Petroleum Geology
Credits 3. 3 Lecture Hours.
Properties of reservoir rocks; origin, migration and accumulation of petroleum; geologic interpretation of borehole logs and fluid-pressure measurements and the role of hydrostatic and hydrodynamic pressures in oil accumulation.
Prerequisite: Graduate classification.

GEOL 621 Contaminant Hydrogeology
Credits 3. 3 Lecture Hours.
Physical concepts of mass transport; dispersion; diffusion; advection; geochemical processes including surface reaction; hydrolysis; biodegradation; aspects of modeling; process and parameter; and remediation.
Prerequisite: GEOL 410 or equivalent or approval of instructor.
GEOL 632 Geofluids  
Credits 3. 2 Lecture Hours. 2 Lab Hours.  
Fundamentals of how fluids drive geologic processes in sedimentary basins; stresses and pressures, compression models, origin of overpressure, trapping of hydrocarbons, formation of mud volcanoes, generation of submarine landslides; exercises and laboratory experiments that build theoretical understanding and illustrate the use of data.  
Prerequisite: Approval of instructor.

GEOL 633 River Restoration  
Credits 3. 3 Lecture Hours.  
Geologic, geomorphic and geomechanical principles applied to the investigation, design, construction, and maintenance of river restoration projects.  
Prerequisite: GEOL 631 or GEOG 626 or approval of instructor.

GEOL 635 Engineering Geology  
Credits 3. 3 Lecture Hours.  
Geological principles applied to the investigation design, construction and maintenance of engineering projects; history, development and role of engineering geologic practice as applied to dams, waste disposal, surface and ground water, tunneling, quarrying and construction materials.

GEOL 640/WMHS 640 Geochemistry of Natural Fresh Waters  
Credits 3. 3 Lecture Hours.  
Chemistry of aqueous solutions; weathering/redox reactions and controls on fresh waters; natural and anthropogenic factors affecting major, minor, and trace elements in fresh waters; evaluation of fresh water composition; application of water-quality measurements to quantitative hydrology.  
Cross Listing: WMHS 640/GEOL 640.

GEOL 641 Environmental Geochemistry  
Credits 3. 3 Lecture Hours.  
Geochemical processes affecting the fate and transport of inorganic and organic pollutants in terrestrial systems; equilibrium and kinetic modeling.  
Prerequisite: GEOL 451 or approval of instructor.

GEOL 643 Introduction to Electron Microprobe Analysis  
Credits 2. 1 Lecture Hour. 3 Lab Hours.  
Digital imaging and qualitative and quantitative chemical analysis of geological and material science samples using the electron microprobe; emphasis on quantitative chemical analysis using WDS (wavelength-dispersive spectrometry) methods; use the electron microprobe and correctly interpret analytical results.  
Prerequisite: Approval of instructor.

GEOL 645 Geochronology  
Credits 3. 3 Lecture Hours.  
Earth's 4.5 billion-year history is divided into units of geologic time based on the observed changes in the rock record: the timing of those changes is quantified by numerical dating methods; this course examines both dating methods and physical and biological changes observed in the rock record.  
Prerequisite: Graduate classification or approval of instructor.

GEOL 647 Radiogenic Isotope Geology  
Credits 3. 3 Lecture Hours.  
Use of radiogenic isotopes in addressing problems in high- and low-temperature geochemistry; their use as tracers for past and present-day processes at the surface and interior of the Earth.  
Prerequisite: Approval of instructor.

GEOL 648 Stable Isotope Geology  
Credits 3. 2 Lecture Hours. 3 Lab Hours.  
Stable isotopes of oxygen, carbon, sulfur and hydrogen applied to problems in paleontology and paleoecology, carbonate diagenesis, petroleum exploration, and igneous and metamorphic petrology; isotopic paleotemperatures; analytical methods; theory of isotopic fractionation.  
Prerequisite: GEOL 451 or approval of instructor.

GEOL 650 Paleoecology  
Credits 3. 2 Lecture Hours. 3 Lab Hours.  
Interrelationships of organisms and environment in the fossil record; methods and criteria available for interpreting ancient environments; critical review of classical studies and current research in paleoecology.  
Prerequisite: Approval of instructor.

GEOL 651 Paleoecological Community Analysis  
Credits 3. 3 Lecture Hours.  
Quantitative analysis of multivariate paleoecological community data; measurement of diversity; cluster analysis; gradient analysis by standard and canonical ordination techniques.  
Prerequisite: A basic course in statistics or approval of instructor.

GEOL 654 Evolutionary Patterns and Theory  
Credits 3. 3 Lecture Hours.  
Evolutionary patterns in the fossil record and application of evolutionary theory to understanding these patterns; comparisons of neo-Darwinian and punctuational hypotheses; events and processes pertaining to microevolutionary and macroevolutionary change; and methods of determine phylogenies of organisms.  
Prerequisite: Graduate classification in geological or biological sciences.

GEOL 658 Earth Systems Through Deep Time: Global Change, Paleoclimate and Life  
Credits 3. 3 Lecture Hours.  
History and cause of global change in the earth system, Archean to Holocene; Impact of biotic change on the earth system; influence of tectonics on paleochemistry and climate change; influence of climate on tectonics; methods and models for evaluating global change.  
Prerequisite: Graduate classification.

GEOL 661 Metamorphic Petrology and Phase Equilibria  
Credits 3. 3 Lecture Hours.  
Origin and evolution of metamorphic rocks via the application of thermodynamics and phase equilibria; geothermobarometry, fluid-rock interaction, and relations between metamorphic and tectonic processes; application of phase equilibria to real data sets to constrain important variables such as pressure, temperature, and fluid fugacities.  
Prerequisite: Approval of instructor.

GEOL 665 Structural Petrology  
Credits 4. 3 Lecture Hours. 3 Lab Hours.  
Mechanisms of rock deformation from single crystal to mountain range: techniques for mapping stresses and strains and for inferring physical conditions and mechanical behavior at time of deformation; laboratory assignments on descriptive techniques include petrographic microscope-universal stage methods, field procedures and data analysis.  
Prerequisite: Approval of instructor.

GEOL 668 Clastic Sedimentology and Sedimentary Petrology  
Credits 4. 3 Lecture Hours. 3 Lab Hours.  
Detailed analyses of clastic sedimentary rocks; relationships of facies and depositional environments with emphasis on continental, coastal and shallow shelf clastic sediments; petrography and diagenesis of modern and ancient clastic sediments.  
Prerequisites: Optical mineralogy course and sedimentology (undergraduate); graduate classification.
GEOL 670 Geological Data Analysis
Credits 3. 3 Lecture Hours.
Scientific programming and statistical methods commonly used in
geology and paleontology; applying univariate and multivariate statistical
analyses to geological data and writing short programming scripts for
R; practical expertise in evaluating statistical approaches and solving
methodological obstacles.

GEOL 678 Earth Science Modeling
Credits 4. 3 Lecture Hours. 3 Lab Hours.
Techniques for building, solving and analyzing numerical models applied
to a wide variety of problems in geology, geochemistry, geobiology
and geophysics; derivation and scaling of conservation laws; finite
difference and finite element techniques and error analysis; programming
in MATLAB or a high-level language.

GEOL 681 Seminar
Credit 1. 1 Lecture Hour.
Reports and discussions of current research and selected topics from
geologic literature.
Prerequisite: Graduate classification.

GEOL 685 Directed Studies
Credits 1 to 12. 1 to 12 Other Hours.
Enables 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 instructor.

GEOL 689 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours. 1 to 7 Lab Hours.
Selected topics in an identified area of geology. May be repeated for
credit.
Prerequisite: Approval of instructor.

GEOL 691 Research
Credits 1 to 23. 1 to 23 Other Hours.
Original research on problems in various phases of geology. Research for
thesis or dissertation.