Earth and Environmental Sciences

Undergraduate Degrees

- Bachelor of Science in Geology - Professional Option (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#bachelorstext)
- Bachelor Science in Geology - Environmental Science Option (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#bachelorstext)
- Bachelor of Science in Geology - Engineering Geology Option (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#bachelorstext)
- Bachelor of Science in Environmental Science (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#bachelorstext)
- Bachelor of Arts in Geology - General Option (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#bachelorstext)
- Bachelor of Arts in Geology - Composite Science Teacher Certification Option (UTeach) (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#bachelorstext)

Minors

- Minor in Geology (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#minortext)
- Minor in Data Science (for Majors in Earth and Environmental Sciences) (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#minortext)
- Minor in Biology (for Majors in Earth and Environmental Sciences) (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#minortext)

Undergraduate Certificates

- Certificate in Geographic Information Systems (http://catalog.uta.edu/archives/2023-2024/science/earth/undergraduate/#certificatestext)

Graduate Degrees

- Earth and Environmental Science M.S. (http://catalog.uta.edu/archives/2023-2024/science/earth/graduate/#masterstext)
- Earth and Environmental Science, Ph.D. (http://catalog.uta.edu/archives/2023-2024/science/earth/graduate/#doctoraltext)

COURSES

ENVR 1301. INTRODUCTION TO ENVIRONMENTAL SCIENCE. 3 Hours.
This course provides an introduction to the basic principles of environmental science. Environmental science, as a discipline, along with key chemical, physical, geological, and biological aspects and relevant societal issues will be examined.

ENVR 1330. GLOBAL WARMING. 3 Hours.
Global environmental challenges confronting humanity such as pollution, depletion of natural resources, ecosystem deterioration, food production, and population growth. Offered as ENVR 1330 and GEOL 1330. Credit will not be given for both.

ENVR 2314. THE GLOBAL ENVIRONMENT AND HUMAN HEALTH. 3 Hours.
This course will assess the impact on human health of: 1) population growth and available resources; 2) exposure to man-made harmful substances; and 3) environmental degradation.

ENVR 2316. CONSERVATION OF NATURAL RESOURCES. 3 Hours.
During this course the students will explore natural resources, with special emphasis on new solutions to problems of resource scarcity and conservation. During this course the students will learn about energy, water, air, and food resources conservation. Students will work on developing proposals for addressing water conservation issues. Prerequisite: ENVR 1301, or consult instructor.

ENVR 3317. ENVIRONMENTAL HYDROLOGY. 3 Hours.
An introduction to environmental hydrology topics including basic principles of the processes and measurements of precipitation, interception, infiltration, evaporation, evapotranspiration, interflow, overland flow, stream flow, and groundwater flow. Introduction to quantification of watershed metrics such as water budgets, hydrographs, discharge-concentration relationships, and flood routing. Examples and case studies will cover a broad spectrum of modern environmental scenarios (in a changing climate) across urban, agricultural, mining, and natural landscapes and biomes. Prerequisite: MATH 1426, or consent of instructor.

ENVR 3387. ENVIRONMENTAL SCIENCE FIELD METHODS. 3 Hours.
Measurement and analysis of environmental data collected in the field. Special fee covers cost of transportation and equipment. Prerequisite: CHEM 1442.

ENVR 3454. STATISTICS FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of statistics and helps students apply statistics to analyze data and interpret results from the perspective of Earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in Earth and environmental sciences. Offered as ENVR 3454 and GEOL 3454, credit will not be given for both. Prerequisite: GEOL 3454: MATH 1426.

ENVR 3457. ENVIRONMENTAL ANALYTICAL CHEMISTRY. 4 Hours.
This course offers an introduction to chemical and biochemical phenomena that occur in water, air, terrestrial and living environments, and the effects of human activity on them. Environmental chemistry can broaden as much as atmospheric chemistry, aquatic chemistry, chemistry of soil/geosphere, toxicological chemistry and industrial ecology. In this course, mainly chemical substances in diverse environmental compartments and interactions and exposure impact to human and wildlife receptors will be focus based on analytical chemistry principles and perspective. Prerequisite: CHEM 1442.

ENVR 4189. RESEARCH IN ENVIRONMENTAL SCIENCE. 1 Hour.
Supervised undergraduate research in some aspect of environmental science. Prerequisite: Permission from Instructor.

ENVR 4190. ENVIRONMENTAL SCIENCE INTERNSHIP. 1 Hour.
Work in environmental sciences for a commercial concern at least 20 hours per week for three months. Requirements include: writing a resume, learning how to interview and function on the job, and a report describing the work.

ENVR 4199. TECHNICAL SESSIONS. 1 Hour.
Forum for presentation of results of undergraduate and graduate students and faculty research. Offered as ENVR 4199 and GEOL 4199. Credit will not be given for both. Prerequisite: For ENVR: ENVR 1301 or equivalent. For GEOL: GEOL 1301 or equivalent.

ENVR 4289. RESEARCH IN ENVIRONMENTAL SCIENCES. 2 Hours.
Supervised undergraduate research in any one of the various fields of environmental sciences. May be repeated but will not meet Environmental Science degree requirements. Prerequisite: permission from instructor.

ENVR 4303. TOPICS IN SUSTAINABILITY. 3 Hours.
Governmental and regulatory issues as they relate to sustainability. Course offered as SUST 5303 and EVSE 5303. Credit will be granted only once.

ENVR 4305. SELECTED TOPICS IN ENVIRONMENTAL SCIENCES. 3 Hours.
Environmental science topics not treated in the regular curriculum. Topic, format, and prerequisites to be determined by the instructor. May be repeated for Environmental Science elective credit as different topics are offered. Prerequisite: Determined by instructor.

ENVR 4308. ENVIRONMENTAL GEOCHEMISTRY. 3 Hours.
The geochemistry of natural waters with emphasis on processes that control solute concentrations including complexation reactions, oxidation and reduction reactions, biogeochemistry, and chemical weathering reactions. Offered as ENVR 4308 and GEOL 4308. Credit will not be given for both. Prerequisite: CHEM 1442 or GEOL 2445.

ENVR 4312. ENVIRONMENTAL RISK BASED ACTION. 3 Hours.
This course offers an introduction to environmental risk-based actions including environmental laws and regulations, hazard identification, toxicology, common contaminants, chemical intake models, chemical fate and transport models, and vapor intrusions. Prerequisite: ENVR 1301 or GEOL 1301 or equivalent.

ENVR 4313. ENVIRONMENTAL REGULATION OF CHEMICAL HAZARDS. 3 Hours.
This course offers an introductory knowledge about regulations and management of environmental and life quality in relation to chemical pollution, waste disposal, energy/resources sustainability, public health threats, and food/consumer product safety. Prerequisite: CHEM 1441 or equivalent.

ENVR 4314. TOXICOLOGY FOR ENVIRONMENTAL SCIENTISTS. 3 Hours.
This course offers an introduction to environmental toxicology and methods of measuring and using data on the adverse effects of chemical substances in line with understanding chemical and biochemical phenomena that occur in water, air, terrestrial and living environments, and the impact to human population. Prerequisite: CHEM 1441 or equivalent.

ENVR 4315. INTRODUCTION TO ENVIRONMENTAL STUDIES. 3 Hours.
This course serves as an introduction to and covers broad aspects of environmental studies. It is designed to foster an increased understanding of physical, chemical and biological systems of terrestrial and aquatic environments, their complex connections and patterns, and human interactions. In this course emphasis is placed on a holistic approach to environmental studies using case studies, learning activities, and discussions to reinforce scientific principles. Students will examine the relationship between humankind and nature in order to gain a broad understanding of issues, causes, and possible solutions to the array of environmental challenges faced in today's world. Prerequisite: Junior standing, core complete.

ENVR 4323. ISSUES IN ENVIRONMENTAL HEALTH. 3 Hours.
An introduction to health issues of current concern resulting from environmental exposures. Topics include: environmental asthma, endocrine disruptors, climate change and health, emerging contaminants, nanotechnology and health, airborne particles and pediatric health. Offered as ENVR 4323 and GEOL 4323. Credit will not be given for both.

ENVR 4325. TRACER HYDROLOGY. 3 Hours.
This course is primarily focused on the applications of chemical tracers to study the interaction between precipitation, surface water, and groundwater. The first part covers the basics of water fluxes and naturally occurring and artificial tracers such as stable and radioactive isotopes, noble gases, fluorescent nanoparticles, ions, and DNA. The second part is oriented towards the assimilation of chemical tracer information to enhance hydrological metrics, conceptual model development, and numerical modeling. Prerequisite: ENVR 1301, or GEOL 1301, or cons. inst.

ENVR 4330. UNDERSTANDING GEOGRAPHIC INFORMATION SYSTEMS. 3 Hours.
A practical introduction to GIS and methods of creating, maintaining and displaying spatial data using the ArcGIS software. Prerequisite: Junior Standing.

ENVR 4389. RESEARCH IN ENVIRONMENTAL SCIENCES. 3 Hours.
Supervised undergraduate research in any one of the various fields of environmental sciences. May be repeated but will not meet Environmental Science degree requirements.

ENVR 4455. MATHEMATICAL MODELING OF ENVIRONMENTAL QUALITY SYSTEMS. 4 Hours.
This course is designed to introduce the process principles that govern contaminant transport and transformations in multimedia environments. This course will cover application of fate and transport models to evaluate pollutant interactions with the biosphere, particularly in the context of human exposure modeling and health risk assessment. Offered as ENVR 4455 and GEOL 4455. Credit will not be given for both.

ENVR 4456. ENVIRONMENTAL RISK ASSESSMENT. 4 Hours.
This course introduces the basic scientific components of environmental and occupational health risk assessment and describes the policy context in which decisions to manage environmental health risks are made. The course presents the quantitative methods used to assess the human health risks associated with exposure to toxic chemicals, focusing on the four major components of risk assessment-hazard identification, dose-response assessment, exposure assessment, and risk characterization. Offered as ENVR 4456 and GEOL 4456. Credit will not be given for both.

ENVR 4458. MACHINE LEARNING FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of machine learning and helps students apply machine learning to analyze data, predict outcomes and interpret results from the perspective of earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in earth and environmental sciences. Offered as GEOL 4458 and ENVR 4458. Credit will be not given for both. Prerequisite: GEOL 3454 or ENVR 3454 or equivalent.

COURSES

EVSE 5100. SELECTED TOPICS IN ENVIRONMENTAL SCIENCE AND ENGINEERING. 1 Hour.
May be repeated for credit when topic changes.

EVSE 5115. PROFESSIONAL EXPERIENCE. 1 Hour.
Work in environmental science for a commercial concern at least 20 hrs/wk for 3 months. Requirements include writing a resume, learning how to interview and function on the job, and a report describing the work. Prerequisite: Cons. inst.

EVSE 5120. ENVIRONMENTAL PROFESSIONAL MENTORING & BUSINESS ETHICS. 1 Hour.
Provides credit to students participating in an approved mentoring program with an experience environmental professional. May be repeated once for credit.

EVSE 5199. SEMINAR IN ENVIRONMENTAL & EARTH SCIENCES. 1 Hour.
Topics presented by faculty, students, and invited lecturers.

EVSE 5200. SELECTED TOPICS IN ENVIRONMENTAL & EARTH SCIENCES. 2 Hours.
May be repeated for credit when topic changes.

EVSE 5294. INDIVIDUAL PROBLEMS IN ENVIRONMENTAL & EARTH SCIENCES. 2 Hours.
Individual research projects supervised by a faculty member.

EVSE 5300. SELECTED TOPICS IN ENVIRONMENTAL & EARTH SCIENCE. 3 Hours.
May be repeated for credit when topic changes.

EVSE 5303. SUSTAINABILITY ISSUES SEMINAR III. 3 Hours.
Governmental and regulatory issues as they relate to sustainability.

EVSE 5309. ENVIRONMENTAL SYSTEMS-BIOLOGICAL ASPECTS. 3 Hours.
An introduction to the biological components of environmental systems. Population dynamics, species interactions, community structure, biodiversity, bioenergetics, nutrient cycling and human impacts are reviewed. Focus will be on natural processes and their engineering applications.

EVSE 5310. ENVIRONMENTAL SYSTEMS-CHEMICAL ASPECTS. 3 Hours.
An introduction to the chemistries of air at different altitudes, of water systems and of soils. Chemical and physico-chemical processes at phase boundaries, modeling for kinetics and mass transport, analytical techniques and disposal and recycling are included as well as their impact on engineering decisions.

EVSE 5311. ENVIRONMENTAL SYSTEMS-GEOLOGICAL ASPECTS. 3 Hours.
Introduction to the tectonic, volcanic, atmospheric, climatic, hydrologic and geochemical processes and natural hazards of the earth, and their interaction with political, economic and engineering decisions.

EVSE 5312. ENVIRONMENTAL RISK BASED ACTION. 3 Hours.
This course offers an introduction to environmental risk-based actions including environmental laws and regulations, hazard identification, toxicology, common contaminants, chemical intake models, chemical fate and transport models, and vapor intrusions.

EVSE 5313. ENVIRONMENTAL REGULATION OF CHEMICAL HAZARDS. 3 Hours.
This course offers an introductory knowledge about regulations and management of environmental and life quality in relation to chemical pollution, waste disposal, energy/resources sustainability, public health threats, and food/consumer product safety. Prerequisite: CHEM 1441 or equivalent.

EVSE 5314. TOXICOLOGY FOR ENVIRONMENTAL SCIENTISTS. 3 Hours.
This course offers an introduction to environmental toxicology and methods of measuring and using data on the adverse effects of chemical substances in line with understanding chemical and biochemical phenomena that occur in water, air, terrestrial and living environments, and the impact to human population. Prerequisite: CHEM 1441 or equivalent.

EVSE 5316. CONSERVATION OF NATURAL RESOURCES. 3 Hours.
During this course the students will explore natural resources, with special emphasis on new solutions to problems of resource scarcity and conservation. During this course the students will learn about energy, water, air, and food resources conservation. Students will work on developing proposals for addressing water conservation issues. Prerequisite: ENVR 1301, or equivalent, or consult instructor.

EVSE 5317. ENVIRONMENTAL HYDROLOGY. 3 Hours.
An introduction to environmental hydrology topics including basic principles of the processes and measurements of precipitation, interception, infiltration, evaporation, evapotranspiration, interflow, overland flow, stream flow, and groundwater flow. Introduction to quantification of watershed metrics such as water budgets, hydrographs, discharge-concentration relationships, and flood routing. Examples and case studies will cover a broad spectrum of modern environmental scenarios (in a changing climate) across urban, agricultural, mining, and natural landscapes and biomes. Prerequisite: MATH 1426, or consent of instructor.

EVSE 5318. CLIMATE CHANGE RISK AND RESILIENCE. 3 Hours.
Climate risk is emerging as a key risk driver for systems as diverse as critical infrastructure (e.g. water, energy, transport, communications, buildings, transportation) and the natural environment. These climate risks arising from the physical manifestation of climate change. This course will highlight the roles, responsibilities, and ethical considerations for scientists and engineers and other risk professionals in the identification, evaluation, and management of climate risk, and provide students with a suite of theories, methods, and tools to support risk assessments. Emerging concepts of system resilience will be discussed.

EVSE 5320. TOXICOLOGY. 3 Hours.
An introduction to the general principles of toxicology with an emphasis on certain classes of toxic agents, their sources and toxic effects, as well as their environmental fate. Prerequisite: CHEM 2322.

EVSE 5323. ISSUES IN ENVIRONMENTAL HEALTH. 3 Hours.
An introduction to health issues of current concern resulting from environmental exposures. Topics include: environmental asthma, endocrine disruptors, climate change and health, emerging contaminants, nanotechnology and health, airborne particles and pediatric health.

EVSE 5325. TRACER HYDROLOGY. 3 Hours.
This course is primarily focused on the applications of chemical tracers to study the interaction between precipitation, surface water, and groundwater. The first part covers the basics of water fluxes and naturally occurring and artificial tracers such as stable and radioactive isotopes, noble gases, fluorescent nanoparticles, ions, and DNA. The second part is oriented towards the assimilation of chemical tracer information to enhance hydrological metrics, conceptual model development, and numerical modeling. Prerequisite: ENVR 1301, or GEOL 1301, or cons. inst.

EVSE 5350. CONTAMINANT HYDROGEOLOGY. 3 Hours.
Sources and types of various organic and inorganic contaminants; the physical, chemical, and biological factors and processes that affect the transport and fate of contaminants in the subsurface; non-aqueous phase liquids and multiphase flow; and various remedial techniques of contaminated sites. Prerequisite: GEOL 4320 or GEOL 5328 (or concurrent enrollment).

EVSE 5351. GEOMORPHOLOGY AND QUATERNARY STRATIGRAPHY OF SEDIMENTARY SYSTEMS. 3 Hours.
This course examines those physical processes that sculpt the surface of the Earth and result in deposition of sediments. Surface systems covered include weathering, mass wasting, rivers, shorelines, eolian processes, and glaciers. The course also examines the stratigraphic techniques used to decode the recent (2 million to present) stratigraphic record of these systems. Course is designed for geologists, biologists, and other fields concerned with interpreting and/or managing modern environments.

EVSE 5357. MEDICAL GEOLOGY. 3 Hours.
Introduction to geoscience and health. Students will learn how the geologic and geochemical environment can impact health. The historic background to geoscience and health will be presented followed by discussions on the natural abundance of elements in the earth, and the nature of essential and toxic elements (dose-response). Students will then learn about health responses following exposures in specific geologic/geochemical situations.

EVSE 5394. INDIVIDUAL PROBLEMS IN ENVIRONMENTAL & EARTH SCIENCES. 3 Hours.
Individual research projects supervised by a faculty member. Prerequisite: consent of instructor.

EVSE 5395. MASTER'S PROJECT. 3 Hours.
May be used as elective for students in non-thesis program. Graded F, P.

EVSE 5398. THESIS. 3 Hours.
Graded F, R.

EVSE 5405. METEOROLOGY AND CLIMATOLOGY. 4 Hours.
A quantitative approach to the study of the structure, energy, and motions of the atmosphere.

EVSE 5454. STATISTICS FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of statistics and helps students apply statistics to analyze data and interpret results from the perspective of Earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in Earth and environmental sciences. Offered as EVSE 5454 and GEOL 5454. Credit will not be given for both.

EVSE 5455. MATHEMATICAL MODELING OF ENVIRONMENTAL QUALITY SYSTEMS. 4 Hours.
This course is designed to introduce the process principles that govern contaminant transport and transformations in multimedia environments. This course will cover application of fate and transport models to evaluate pollutant interactions with the biosphere, particularly in the context of human exposure modeling and health risk assessment. Offered as EVSE 5455 and GEOL 5455. Credit will not be given for both.

EVSE 5456. ENVIRONMENTAL RISK ASSESSMENT. 4 Hours.
This course introduces the basic scientific components of environmental and occupational health risk assessment and describes the policy context in which decisions to manage environmental health risks are made. The course presents the quantitative methods used to assess the human health risks associated with exposure to toxic chemicals, focusing on the four major components of risk assessment-hazard identification, dose-response assessment, exposure assessment, and risk characterization. Offered as EVSE 5456 and GEOL 5456, credit will not be given for both.

EVSE 5457. ENVIRONMENTAL ANALYTICAL CHEMISTRY. 4 Hours.
This course offers an introduction to chemical and biochemical phenomena that occur in water, air, terrestrial and living environments, and the effects of human activity on them. Environmental chemistry can broaden as much as atmospheric chemistry, aquatic chemistry, chemistry of soil/geosphere, toxicological chemistry and industrial ecology. In this course, mainly chemical substances in diverse environmental compartments and interactions and exposure impact to human and wildlife receptors will be focus based on analytical chemistry principles and perspective. Prerequisite: CHEM 1442 or equivalent courses.

EVSE 5458. MACHINE LEARNING FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of machine learning and helps students apply machine learning to analyze data, predict outcomes and interpret results from the perspective of earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in earth and environmental sciences. Offered as GEOL 5458 and EVSE 5458. Credit will not be given for both. Prerequisite: ENVR 3454 or GEOL 3454 or EVSE 5454 or GEOL 5454 or equivalent.

EVSE 5465. PHYSICAL OCEANOGRAPHY AND LIMNOLOGY. 4 Hours.
An introduction to physical processes in lakes and oceans. Changes in lakes and oceans influence heat, and momentum fluxes at the aquatic/oceanic and atmospheric interface. Topics include ocean/lake structure and circulation, and the impact of global climate change on lakes and oceans. Field excursions to nearby lakes combine theoretical knowledge and field measurements. Prerequisite: PHYS 1441 or PHYS 1443; and MATH 1426.

EVSE 5698. THESIS. 6 Hours.
Graded F, P, R.

EVSE 5998. THESIS. 9 Hours.
Graded F, P, R.

EVSE 6197. RESEARCH IN ENVIRONMENTAL & EARTH SCIENCES. 1 Hour.
Individually approved research projects. May be repeated for credit. Graded F, P, R.

EVSE 6297. RESEARCH IN ENVIRONMENTAL & EARTH SCIENCES. 2 Hours.
Individually approved research projects. May be repeated for credit. Graded F, P, R.

EVSE 6397. RESEARCH IN ENVIRONMENTAL AND EARTH SCIENCES. 3 Hours.
Individually approved research projects. May be repeated for credit. Graded F, P, R.

EVSE 6399. DISSERTATION. 3 Hours.
Graded F, R.

EVSE 6697. RESEARCH IN ENVIRONMENTAL & EARTH SCIENCE. 6 Hours.
Individually approved research projects. May be repeated for credit. Graded F, P, R.

EVSE 6699. DISSERTATION. 6 Hours.
Graded F, R, P, W.

EVSE 6997. RESEARCH IN ENVIRONMENTAL & EARTH SCIENCE. 9 Hours.
Individually approved research projects. May be repeated for credit. Graded F, P, R.

EVSE 6999. DISSERTATION. 9 Hours.
Graded F, P, R.

EVSE 7399. DOCTORAL DEGREE COMPLETION. 3 Hours.
This course may be taken during the semester in which a student expects to complete all requirements for the doctoral degree and graduate. Enrolling in this course meets minimum enrollment requirements for graduation, for holding fellowships awarded by The Office of Graduate Studies and for full-time GTA or GRA positions. Students should verify that enrollment in this course meets other applicable enrollment requirements. To remain eligible in their final semester of study for grants, loans or other forms of financial aid administered by the Financial Aid Office must enroll in a minimum of 5 hours as required by the Office of Financial Aid. Other funding sources may also require more than 3-hours of enrollment. Additional hours may also be required to meet to requirements set by immigration law or by the policies of the student's degree program. Students should contact the Financial Aid Office, other sources of funding, Office of International Education and/or their graduate advisor to verify enrollment requirements before registering for this course. This course may only be taken once and may not be repeated. Students who do not complete all graduation requirements while enrolled in this course must enroll in a minimum of 6 dissertation hours (6699 or 6999) in their graduation term. Graded P/F/R.

COURSES

GEOL 1301. EARTH SYSTEMS. 3 Hours.
An integrated study of the earth, emphasizing interactions between plate tectonics, the atmosphere, the oceans, the biosphere, and human activity. Formerly listed as GEOL 1425, credit will not be given for both.

GEOL 1302. EARTH HISTORY. 3 Hours.
History of the earth and evolution of life emphasizing the co-evolution of the atmosphere, oceans, and biosphere. Formerly listed as GEOL 1426, credit will not be given for both.

GEOL 1330. GLOBAL WARMING. 3 Hours.
Global environmental challenges confronting humanity such as pollution, depletion of natural resources, ecosystem deterioration, food production, and population growth. Offered as ENVR 1330 and GEOL 1330. Credit will not be given for both.

GEOL 1340. WEATHER AND CLIMATE. 3 Hours.
Nature and variability of weather and climate, including wind, temperature, clouds and precipitation, droughts and flooding. Storm systems, fronts, thunderstorms, tornadoes, hurricanes. Atmospheric chemistry and air pollution. Mean climate, seasonal variations and climatic change. Formerly listed as GEOL 2401, credit will not be given for both.

GEOL 1350. INTRODUCTION TO OCEANOGRAPHY. 3 Hours.
The study of ocean basins and their origin, ocean currents, waves and tides, properties of sea water, and marine ecosystems, emphasizing the role of the ocean in the Earth system. Discussion of weekly ocean news, and incorporation of web-delivered current oceanographic data into the course material. Formerly offered as GEOL 3301 and GEOL 3184 and GEOL 2412; credit will be granted only once. Formerly listed as GEOL 1450, credit will not be given for both.

GEOL 1360. GEOLOGIC HAZARDS. 3 Hours.
Processes producing earthquakes, floods, eruptions and landslides, and their effect on people. Formerly listed as GEOL 2404, credit will not be given for both.

GEOL 2406. NATURAL RESOURCES & SUSTAINABILITY. 4 Hours.
Energy, construction, agricultural, and hydrological resources are evaluated in terms of their production and use, including storage and disposal of waste. Emphasis is placed on the importance of preserving clean water, air and soils. The course will concentrate on what humans take from the Earth, the impacts it has on their environment, and what it takes to make the planet sustainable for human habitation.

GEOL 2445. MINERALOGY. 4 Hours. (TCCN = GEOL 2409)
Lectures discuss the physical and chemical principles governing the properties and formation of minerals. There are three major divisions of the subject matter: (a) geometric and optical crystallography; (b) crystal chemistry and properties of minerals, and (c) occurrence, origins, and pressure-temperature stabilities of the major rock-forming minerals. Laboratories are devoted to exercises in crystallography, X-ray diffraction, optical mineralogy and hand-specimen mineral identification. Prerequisite: GEOL 1301 or GEOL 3340, and CHEM 1442, or permission from instructor.

GEOL 3100. GEOSCIENCE PROFESSIONAL ORIENTATION. 1 Hour.
Review of various careers in the Geosciences, and how to prepare a resume, network, and interview. Principles to follow for on-the-job success. Class will involve field trips and guest lectures.

GEOL 3316. ASTROBIOLOGY I. 3 Hours.
This is an interdisciplinary course between astrophysics, biology and geology. Topics include properties of life, origin and evolution of life on Earth, terrestrial geology and habitability, environmental forcings, extremophiles, mass extinctions, meteorites, searches for life in the solar system. Offered as BIOL 3316, GEOL 3316 and PHYS 3316; credit will be granted only once. Prerequisite: PHYS 1441 & PHYS 1442 or equivalent and PHYS 2315 or PHYS 3315, or permission from instructor. Prerequisites for Biology majors: PHYS 1441 & PHYS 1442 or equivalent.

GEOL 3340. GEOLOGY FOR ENGINEERS. 3 Hours.
Introduction to geological materials and processes important to engineering. Includes processes forming minerals and rocks; mechanics and deformation of rocks, weathering, erosion and soils; soil hazards, land subsidence and mass movements; groundwater hydrology, geochemistry and contamination; and rivers. Labs will include introduction to geologic materials and use of GIS software to store, analyze and display geologic and engineering data. Prerequisites: PHYS 1443 and CHEM 1465 or CHEM 1442.

GEOL 3358. ASTROBIOLOGY II. 3 Hours.
This is an interdisciplinary course between astrophysics, biology and geology. Topics include basic properties of life, habitability of Earth, studies of possible life regarding Mars, Europa & Titan, space missions, exoplanets and exomoons, stellar habitable zones, multistellar systems, exoEarths, biomarkers, SETI, Fermi paradox, Drake equation, cosmology. Offered as BIOL 3358, GEOL 3358, and PHYS 3358; credit will be granted only once. Prerequisite: PHYS 1441 & PHYS 1442 or equivalent and PHYS 2315 or PHYS 3315, or permission from instructor. Prerequisites for Biology majors: PHYS 1441 & PHYS 1442 or equivalent. Note that Astrobiology I is strongly recommended to students to be taken prior to Astrobiology II, but is not a prerequisite.

GEOL 3387. FIELD GEOLOGY I. 3 Hours.
Stratigraphic and structural mapping and analysis of data collected in the field. Taught for three weeks only in the summer session. Special fee covers cost of transportation, room, and board while in the field. Prerequisite: GEOL 2445, GEOL 3442, GEOL 3443, and GEOL 3446.

GEOL 3388. FIELD GEOLOGY II. 3 Hours.
Mapping and analysis of igneous and metamorphic rock data as well as hydrologic, geochemical and mass wasting data collected in the field. Taught for three weeks after GEOL 3387 only in the summer session. Special fee covers cost of transportation, room, and board while in the field. Prerequisite: GEOL 2445, GEOL 3442, GEOL 3443, and GEOL 3387.

GEOL 3441. BIOSTRATIGRAPHY AND LIFE THROUGH TIME. 4 Hours.
Basic principles of bio- and chronostratigraphy including the classification of fossil groups, how index fossils are used to construct the geologic timescale and correlate strata. Prerequisite: GEOL 1302.

GEOL 3442. SEDIMENTOLOGY AND STRATIGRAPHY. 4 Hours.
An introduction to the description, origin, and historical interpretation of stratified rocks. Prerequisite: GEOL 2445.

GEOL 3443. STRUCTURAL GEOLOGY. 4 Hours.
The genesis, classification, and description of structural features resulting from deformation of the earth's crust. Prerequisite: GEOL 2445 and PHYS 1441 or PHYS 1443, or permission of instructor.

GEOL 3446. PETROLOGY AND GEOCHEMISTRY. 4 Hours.
Distribution, description, classification, plate-tectonic setting and origins of igneous and metamorphic rocks in the light of theoretical-experimental multicomponent phase equilibria studies; use of trace elements and radiogenic and stable isotopes as tracers in rock genesis; hand specimen and microscopic examinations of the major igneous-metamorphic rock types in the laboratory. Prerequisite: GEOL 2445.

GEOL 3454. STATISTICS FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of statistics and helps students apply statistics to analyze data and interpret results from the perspective of Earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in Earth and environmental sciences. Offered as ENVR 3454 and GEOL 3454, credit will not be given for both. Prerequisite: GEOL 3454: MATH 1426.

GEOL 4081. RESEARCH IN EARTH & ENVIRONMENTAL SCIENCES. 0 Hours.
Research problems on an individual or group basis, conducted on a selected topic under the direction of a member of the Earth & Environmental Sciences faculty. May be repeated. This is a non-credit course so cannot be used to meet degree requirements. Prerequisite: Permission of the instructor.

GEOL 4181. TOPICS IN ENERGY AND EARTH RESOURCES. 1 Hour.
Lectures will discuss the historical evolution and current status of major research thrusts in the environment, energy, and resources studies, including Superfund and groundwater remediation, carbon sequestration, tight sands and coalbed methane, petroleum production in shale gas and oil reservoirs, geological repository of high-level nuclear waste, geothermal energy exploitation, mining of critical minerals, and gas (methane) hydrate. Prerequisite: GEOL 1301 or GEOL 3340 or equivalent.

GEOL 4189. RESEARCH IN GEOLOGY. 1 Hour.
Supervised undergraduate research in any one of the various fields of geology. May be repeated but will not meet Geology degree requirements. Prerequisite: permission from instructor.

GEOL 4190. GEOSCIENCE INTERNSHIP. 1 Hour.
Work in geoscience for a commercial concern at least 20 hours per week for three months. Requirements include: writing a resume, learning how to interview and function on the job, and a report describing the work. Prerequisite: 16 hours of Geology coursework.

GEOL 4199. TECHNICAL SESSIONS. 1 Hour.
Forum for presentation of results of undergraduate and graduate students and faculty research. Offered as ENVR 4199 and GEOL 4199. Credit will not be given for both. Prerequisite: For ENVR: ENVR 1301 or equivalent. For GEOL: GEOL 1301 or equivalent.

GEOL 4289. RESEARCH IN GEOLOGY. 2 Hours.
Supervised undergraduate research in any one of the various fields of geology. May be repeated but will not meet Geology degree requirements. Prerequisite: permission from instructor.

GEOL 4302. GEODYNAMICS. 3 Hours.
A comprehensive and quantitative study of fundamental aspects of plate tectonics. Introduction to heat flow, elasticity and flexure, fluid mechanics, faulting, gravity, and flow in porous media, with a wide range of geological applications. Includes collaborative problem solving. Prerequisite: GEOL 3443 and MATH 2425.

GEOL 4304. SOLID EARTH GEOMECHANICS. 3 Hours.
Application of continuum mechanics to understanding deformation in the earth, including mechanical analysis of natural geologic structures such as faults, folds, lava flows, and dikes, as well as practical problems related to reservoir geomechanics and mining applications. Prerequisites: GEOL 3443, MATH 2425, and PHYS 1444.

GEOL 4305. SELECTED TOPICS IN GEOLOGY. 3 Hours.
Geological topics not treated in the regular curriculum. Topic, format, and prerequisites to be determined by the instructor. May be repeated for Geology elective credit as different topics are offered.

GEOL 4307. SEQUENCE STRATIGRAPHY. 3 Hours.
This course introduces sequence stratigraphy within context of all stratigraphy and history of sequence stratigraphy. Includes overview of sequence stratigraphy principles. Review of basic fundamental concepts of surface- and facies-based physical stratigraphy. Review of architectural element analysis, sequence stratigraphic in seismic, borehole expression of sequences and overview of subsurface stratigraphic techniques. Prerequisite: GEOL 3442.

GEOL 4308. ENVIRONMENTAL GEOCHEMISTRY. 3 Hours.
The geochemistry of natural waters with emphasis on processes that control solute concentrations including complexation reactions, oxidation and reduction reactions, biogeochemistry, and chemical weathering reactions. Offered as ENVR 4308 and GEOL 4308. Credit will not be given for both. Prerequisite: CHEM 1442 or GEOL 2445.

GEOL 4323. ISSUES IN ENVIRONMENTAL HEALTH. 3 Hours.
An introduction to health issues of current concern resulting from environmental exposures. Topics include: environmental asthma, endocrine disruptors, climate change and health, emerging contaminants, nanotechnology and health, airborne particles and pediatric health. Offered as ENVR 4323 and GEOL 4323. Credit will not be given for both.

GEOL 4330. UNDERSTANDING GEOGRAPHIC INFORMATION SYSTEMS. 3 Hours.
A practical introduction to GIS and methods of creating, maintaining and displaying spatial data using the ArcGIS software. This course replaces GEOL 4352; credit will not be granted for both. This course is offered as GEOL 4330 and GEOG 4330. Prerequisite: Junior standing.

GEOL 4331. ANALYSIS OF SPATIAL DATA. 3 Hours.
Analyzing spatial data using ArcGIS, Spatial Analyst, and 3-D Analyst, topological surface analysis and modeling; 3-D visualization and viewscapes; spatial statistics and data quality management. Course taught as GEOL 4331 and GEOG 4331. Credit will be granted in only one department. Prerequisite: GEOL 4330 or GEOG 4330.

GEOL 4332. GLOBAL POSITIONING SYSTEM. 3 Hours.
Review of the NAVSTAR Global Positioning System and its segments: space, operational control, and GPS receivers. Mechanics of the satellite constellation; GPS signal structure; datums and coordinate systems; precision and accuracy; error factors; absolute (point) versus relative (differential) positioning. Various positioning techniques using several types of GPS receivers; field data collection and input into GIS programs for data analysis and presentation. Course taught as GEOL 4332 and GEOG 4332. Credit will be granted in only one department. Prerequisite: GEOL 4330 or GEOG 4330.

GEOL 4333. REMOTE SENSING FUNDAMENTALS. 3 Hours.
The electromagnetic spectrum and the interaction of EM waves with matter; various types of sensing devices; spectral and spatial resolution parameters; airborne and satellite sensor platforms; aerial photographs and false-color images. The sequence of data acquisition, computer processing, and interpretation; sources of data; the integration of remote sending data with other data types in GIS. Course taught as GEOL 4333 and GEOG 4333. Credit will be granted in only one department. Prerequisite: GEOL 4330 or GEOG 4330.

GEOL 4334. GEOGRAPHIC DATA ANALYSIS. 3 Hours.
Acquisition, processing and analysis of a set of spatial data selected by the student with approval of the instructor. A written report of the results is required. Course taught as GEOL 4334 and GEOG 4334. Credit will be granted in only one department. Prerequisite: GEOL 4330 or GEOG 4330; and GEOL 4332, or GEOL 4333; or cons. inst.

GEOL 4335. TECTONICS AND ISOTOPES. 3 Hours.
Fundamentals of global tectonics, and the application of isotope geochemistry in sedimentary rocks to understanding tectonic questions. Emphasis will be given to the mechanisms of mountain formation, isotope paleoaltimetry, detrital geochronology, and thermochronology. Prerequisite: GEOL 3442, GEOL 3446.

GEOL 4342. MICROFOSSILS AND CARBONATE ROCKS. 3 Hours.
Half of this course consists of an introduction to microfossil groups occurring in sedimentary rocks: foraminifers, conodonts, coccolithophorids and others, and their usefulness in regional and global correlation of Phanerozoic strata. The biostratigraphy of these groups will be discussed along with the principles used in the correlation of sedimentary rocks. The other half of the course consists of the analysis of the lithofacies and biofacies of carbonate rocks, their genesis, depositional environments, and diagenesis. Prerequisite: GEOL 1302, or cons. inst.

GEOL 4343. RESEARCH METHODS - UTEACH. 3 Hours.
The purpose of this course is to present UTeach students with the tools scientists use to solve scientific problems. These tools enable scientists to develop new knowledge and insights, the most important of which are eventually presented in textbooks and taught in more conventional science classes. These tools include: design of experiments to answer scientific questions; use of statistics to interpret experimental results and deal with sampling errors; mathematical modeling of scientific phenomena; finding and reading articles in the current scientific literature; applying scientific arguments in matters of social importance; writing scientific papers; reviewing scientific papers; oral presentation of scientific work; use of probes and computers to gather and analyze data; ethical treatment of human subjects; laboratory safety. Research Methods is primarily a laboratory course, and most of these topics are developed in connection with four independent inquiries UTeach students design and carry out. Written inquiries will be evaluated as examples of scientific writing. Prerequisite: C or better in SCIE 1201 or SCIE 1334, or concurrent enrollment; and junior or senior standing.

GEOL 4346. BASIN ANALYSIS. 3 Hours.
The classification and characteristics of of sedimentary basins and the mechanisms forming them; and the tectonic, climatic, and eustatic controls on basin subsidence and the basin fill. Applications include the influence of basin evolution on petroleum generation, migration, and accumulation. Prerequisite: GEOL 3442 and MATH 1426.

GEOL 4350. STABLE ISOTOPE GEOCHEMISTRY. 3 Hours.
Principles governing the fractionation and distribution of stable isotopes (C, H, N, O, S) in nature, and application of stable isotope geochemistry to environmental problems and global climate change. Prerequisite: GEOL 2445 and CHEM 1442, or permission from instructor.

GEOL 4351. ENERGY RESOURCES FOR GEOSCIENTISTS. 3 Hours.
The course will review critical knowledges of minerals, rocks, stratigraphy, surface processes, geophysics, geochemistry, structures and tectonics, and connect these aspects of Earth system with Earth's six energy components: hydrocarbon, critical minerals, geothermal energy, CO2 sequestration, waste management, and green energies. Prerequisite: GEOL 1301, or GEOL 3340, or cons. inst.

GEOL 4352. ANALYTICAL METHODS IN GEOCHEMISTRY. 3 Hours.
Principles of geochemical analysis of waters, rocks and soils, and gases. Methods to be covered include x-ray fluorescence and diffraction, mass spectrometry, coulometry, inductively-coupled plasma, and gas/ion chromatography with various detection methods. Prerequisite: CHEM 1442.

GEOL 4356. ENVIRONMENTAL RISK ASSESSMENT. 3 Hours.
This course introduces the basic scientific components of environmental and occupational health risk assessment and describes the policy context in which decisions to manage environmental health risks are made. The course presents the quantitative methods used to assess the human health risks associated with exposure to toxic chemicals, focusing on the four major components of risk assessment-hazard identification, dose-response assessment, exposure assessment, and risk characterization.

GEOL 4357. MEDICAL GEOLOGY. 3 Hours.
Introduction to geoscience and health. Students will learn how the geologic and geochemical environment can impact health. The historic background to geoscience and health will be presented followed by discussions on the natural abundance of elements in the earth, and the nature of essential and toxic elements (dose-response). Students will then learn about health responses following exposures in specific geologic/geochemical situations. Prerequisite: GEOL 1301 or ENVR 1301, or equivalent.

GEOL 4360. GEOLOGICAL PROCESSES OF OCEANS. 3 Hours.
Sedimentation in the oceans, chemistry of seawater, geochemical cycles in the oceans, and physical and biological processes that relate to sediment production, origin of seafloor topography, and seafloor spreading. Prerequisite: GEOL 3442.

GEOL 4367. PALEO EARTH SYSTEMS. 3 Hours.
This course discusses the evolution of Earth's complex dynamic system that is controlled by feedback processes that are both non-linear and stochastic in nature. Prerequisite: GEOL 1301.

GEOL 4368. GEOLOGY OF THE PERMIAN BASIN. 3 Hours.
Overview of the geologic evolution of the Permian Basin of W Texas and SE New Mexico and its petroleum resources. Emphasis on student presentations and term paper. Prerequisite: GEOL 1301 or equivalent.

GEOL 4389. RESEARCH IN GEOLOGY. 3 Hours.
Supervised undergraduate research in any one of the various fields of geology. May be repeated but will not meet Geology degree requirements. Prerequisite: permission from instructor.

GEOL 4393. HONORS THESIS/SENIOR PROJECT. 3 Hours.
Required of all students in the University Honors College. During the senior year, the student must complete a thesis or project under the direction of a faculty member in the Earth and Environmental Sciences Department.

GEOL 4402. COMPUTER MODELING IN EARTH SCIENCE. 4 Hours.
An introduction to basic programming and computation in the earth sciences using Matlab®, with emphasis on development of univariate and bivariate statistical models, spatial and image analysis, time series analysis, and the development of basic deterministic physics-based models of geological processes. Prerequisite: MATH 2425.

GEOL 4405. METEOROLOGY AND CLIMATOLOGY. 4 Hours.
A quantitative approach to the study of the structure, energy, and motions of the atmosphere. Prerequisite: MATH 1426 and PHYS 1441, or permission of instructor.

GEOL 4420. HYDROGEOLOGY. 4 Hours.
Hydrologic cycle, Darcy's law, hydraulic properties, aquifer types and materials, groundwater flow to wells, fracture flow, vadose zone flow, groundwater chemistry, and groundwater modeling. Prerequisite: PHYS 1441 or PHYS 1443.

GEOL 4421. GEOCHRONOLOGY. 4 Hours.
Introduction to dating techniques, applied to understand past climate and tectonics. Prerequisite: GEOL 1301 or equivalent.

GEOL 4422. CONTAMINANT HYDROGEOLOGY. 4 Hours.
Sources and types of organic and inorganic contaminants; the physical, chemical, and biological factors and processes that affect the transport and fate of contaminants in the subsurface; non-aqueous phase liquids and multiphase flow; and various remedial techniques of contaminated sites. Prerequisite: GEOL 1301, ENVR 1301, or equivalent.

GEOL 4425. PALEOCLIMATE & CLIMATE CHANGE. 4 Hours.
Climate change throughout geologic time, especially the last 100 million years: models of the climate system, reconstruction and modeling of past climates, abrupt climate change, warm climates, paleoclimatology, climate change and mass extinctions. Prerequisite: GEOL 1301 or ENVR 1330 or GEOL 1330, or permission from instructor.

GEOL 4443. SEDIMENTARY SYSTEMS. 4 Hours.
Focuses on the processes transporting and archiving siliciclastic sediment, and the approaches using siliciclastic sedimentary rocks to reconstruct earth surface processes. This course includes a heavy component of student-led presentation and discussion. Prerequisite: GEOL 3442.

GEOL 4455. MATHEMATICAL MODELING OF ENVIRONMENTAL QUALITY SYSTEMS. 4 Hours.
This course is designed to introduce the process principles that govern contaminant transport and transformations in multimedia environments. This course will cover application of fate and transport models to evaluate pollutant interactions with the biosphere, particularly in the context of human exposure modeling and health risk assessment. Offered as ENVR 4455 and GEOL 4455. Credit will not be given for both.

GEOL 4456. ENVIRONMENTAL RISK ASSESSMENT. 4 Hours.
This course introduces the basic scientific components of environmental and occupational health risk assessment and describes the policy context in which decisions to manage environmental health risks are made. The course presents the quantitative methods used to assess the human health risks associated with exposure to toxic chemicals, focusing on the four major components of risk assessment-hazard identification, dose-response assessment, exposure assessment, and risk characterization. Offered as ENVR 4456 and GEOL 4456. Credit will not be given for both.

GEOL 4458. MACHINE LEARNING FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of machine learning and helps students apply machine learning to analyze data, predict outcomes and interpret results from the perspective of earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in earth and environmental sciences. Offered as GEOL 4458 and ENVR 4458. Credit will be not given for both. Prerequisite: GEOL 3454 or ENVR 3454 or equivalent.

GEOL 4465. PHYSICAL OCEANOGRAPHY AND LIMNOLOGY. 4 Hours.
An introduction to physical processes in lakes and oceans. Changes in lakes and oceans influence heat, and momentum fluxes at the aquatic/oceanic and atmospheric interface. Topics include ocean/lake structure and circulation, and the impact of global climate change on lakes and oceans. Field excursions to nearby lakes combine theoretical knowledge and field measurements. Prerequisite: MATH 1426 and PHYS 1441 or PHYS 1443.

GEOL 5151. TOPICS IN ENERGY AND EARTH RESOURCES. 1 Hour.
This course will discuss the historical evolution and current status of major research thrusts in the environment, energy, and resources studies, including Superfund and groundwater remediation, carbon sequestration, tight sands and coalbed methane, petroleum production in shale gas and oil reservoirs, geological repository of high-level nuclear waste, geothermal energy exploitation, mining of critical minerals, and gas (methane) hydrate. Prerequisite: GEOL 1301 or GEOL 3340 or EVSE 5311 or equivalent.

GEOL 5180. PROFESSIONAL ORIENTATION AND BUSINESS ETHICS. 1 Hour.
A mentoring program using working professionals selected by the Earth and Environmental Sciences Department. Each participant meets at least once a month with a mentor who provides information on practices and skills necessary to succeed in the workplace. Course participants review business ethics statements provided by the mentor's company or other companies and write a critique based on materials from professional business ethics organizations such as the International Business Ethics Institute. Prerequisite: Prerequisite or concurrent enrollment GEOL 5345.

GEOL 5181. RESEARCH IN GEOLOGY. 1 Hour.
Independent study in various areas of research including paleontology, stratigraphy, tectonics, structural geology, sedimentology, geochemistry, petrology, geophysics, and volcanology. May be repeated for credit. Graded P/F/R/W.

GEOL 5190. GEOSCIENCE INTERNSHIP. 1 Hour.
Work in geoscience for a commercial concern at least 20 hrs/wk for 3 months. Requirements include writing a resume, learning how to interview and function on the job, and a report describing the work. Prerequisite: Cons. inst.

GEOL 5199. TECHNICAL SESSIONS. 1 Hour.
Forum for presentation of results of graduate students and faculty research. Required each semester of all graduate students.

GEOL 5265. TOPICS IN GEOL. 2 Hours.

GEOL 5281. RESEARCH IN GEOLOGY. 2 Hours.
Independent study in various areas of research including paleontology, stratigraphy, tectonics, structural geology, sedimentology, geochemistry, petrology, geophysics, and volcanology. May be repeated for credit. Graded P/F/R/W.

GEOL 5301. ENVIRONMENTAL GEOCHEMISTRY. 3 Hours.
Fundamentals of low-temperature aqueous geochemistry, and anthropogenic impacts on natural water systems. Topics include equilibrium thermodynamics, kinetics, aqueous complexation, and oxidation/reduction processes that affect metals and organic matter in natural waters.

GEOL 5302. GEODYNAMICS. 3 Hours.
A comprehensive and quantitative study of fundamental aspects of plate tectonics. Introduction to heat flow, elasticity and flexure, fluid mechanics, faulting, gravity, and flow in porous media, with a wide range of geological applications. Includes collaborative problem solving. Prerequisite: GEOL 3443 and MATH 2425.

GEOL 5303. ROCK FRACTURE MECHANICS. 3 Hours.
Principles and tools of fracture mechanics are applied to the origins and physical behaviors of faults, dikes, joints, veins, and other natural structures in rock. Special emphasis will be given to combining field observations of fractures in rock with the elastic theory of cracks in order to explore the role of natural fractures in brittle rock deformation in the earth's crust with applications to crustal deformation, structural geology, engineering geology, and induced hydraulic fracture, i.e. Fracking. Prerequisite: GEOL 3443 and MATH 2425; or GEOL 3340 and CE 2313.

GEOL 5304. SOLID EARTH GEOMECHANICS. 3 Hours.
Application of continuum mechanics to understanding deformation in the earth, including mechanical analysis of natural geologic structures such as faults, folds, lava flows, and dikes, as well as practical problems related to reservoir geomechanics and mining applications. Prerequisite: GEOL 3443, MATH 2325, PHYS 1441 or PHYS 1443.

GEOL 5309. GEOMORPHOLOGY & QUATERNARY STRATIGRAPHY OF SEDIMENTARY SYSTEMS. 3 Hours.
This course examines those physical processes that sculpt the surface of the Earth and result in deposition of sediments. Surface systems covered include weathering, mass wasting, rivers, shorelines, eolian processes, and glaciers. The course also examines the stratigraphic techniques used to decode the recent (2 million to present) stratigraphic record of these systems. Course is designed for geologists, biologists, and other fields concerned with interpreting and/or managing modern environments.

GEOL 5320. UNDERSTANDING GEOGRAPHIC INFORMATION SYSTEMS. 3 Hours.
A practical introduction to GIS and methods of creating, maintaining and displaying spatial data using the ArcGIS software.

GEOL 5321. ANALYSIS OF SPATIAL DATA. 3 Hours.
Analyzing spatial data using ArcGIS, Spatial Analyst, and 3D Analyst, topological surface analysis and modeling; 3D visualization and viewscapes; spatial statistics and data quality management. Prerequisite: GEOL 4330 or GEOL 5320.

GEOL 5322. GLOBAL POSITIONING SYSTEM. 3 Hours.
Review of the NAVSTAR Global Positioning System and its segments: space, operational control, and GPS receivers. Mechanics of the satellite constellation; GPS signal structure; data and coordinate systems; precision and accuracy; error factors; absolute (point) versus relative (differential) positioning. Various positioning techniques using several types of GPS receivers; field data collection and input into GIS programs for data analysis and presentation. Prerequisite: GEOL 4330 or GEOL 5320.

GEOL 5323. REMOTE SENSING FUNDAMENTALS. 3 Hours.
The electromagnetic spectrum and the interaction of EM waves with matter; various types of sensing devices; spectral and spatial resolution parameters; airborne and satellite sensor platforms; aerial photographs and false-color images. The sequence of data acquisition, computer processing and interpretation; sources of data; the integration of remote sensing data with other data types in GIS. Prerequisite: GEOL 4330 or GEOL 5320.

GEOL 5324. GEOGRAPHIC DATA ANALYSIS PROJECT. 3 Hours.
Acquisition, processing and analysis of a set of spatial data selected by the student with the approval of the instructor. A written report of the results is required. Offered as GEOL 5324 and GEOG 5334. Credit will not be given for both. Prerequisite: GEOL 5320, and GEOL 5321 or GEOL 5323, or cons. inst.

GEOL 5332. STABLE ISOTOPE GEOCHEMISTRY. 3 Hours.
Principals governing the fractionation and distribution of stable isotopes (C, H, N, O, S) in nature, and application of stable isotope geochemistry to environmental problems and global climate change.

GEOL 5333. FIELD METHODS. 3 Hours.

GEOL 5334. ANALYTICAL METHODS IN ENVIRONMENTAL SCIENCE. 3 Hours.
Principals of geochemical analysis of waters, rocks and soils, and gases. Methods to be covered include x-ray fluorescence and diffraction, mass spectrometry, coulometry, inductively-coupled plasma, and gas/ion chromatography with various detection methods.

GEOL 5335. ISOTOPES AND TECTONICS. 3 Hours.
An Introduction to the fundamentals of clumped isotopes, and major radiogenic and cosmogenic isotope systems and their applications to the study of earth system processes and Earth history; emphasis will be placed on applications to tectonics, geochronology, and thermochronology. Prerequisite: CHEM 1442 or GEOL 4302.

GEOL 5342. MICROFOSSILS AND CARBONATE ROCKS. 3 Hours.
Half of this course consists of an introduction to microfossil groups occurring in sedimentary rocks: foraminifers, conodonts, coccolithophorids and others, and their usefulness in regional and global correlation of Phanerozoic strata. The biostratigraphy of these groups will be discussed along with the principles used in the correlation of sedimentary rocks. The other half of the course consists of the analysis of the lithofacies and biofacies of carbonate rocks, their genesis, depositional environments, and diagenesis. Prerequisite: GEOL 1302 or permission of the instructor.

GEOL 5345. PETROLEUM GEOLOGY. 3 Hours.
Origin, generation and migration of petroleum; reservoirs, seals and traps; the subsurface environment; properties of petroleum; exploration and production methods; use of seismic lines and well logs; types of petroleum basins; reserves and resources. Prerequisite: GEOL 3442 and GEOL 3443.

GEOL 5351. ENERGY RESOURCES FOR GEOSCIENTISTS. 3 Hours.
The course will review critical knowledges of minerals, rocks, stratigraphy, surface processes, geophysics, geochemistry, structures and tectonics, and connect these aspects of Earth system with Earth's six energy components: hydrocarbon, critical minerals, geothermal energy, CO2 sequestration, waste management, and green energies. Prerequisite: GEOL 1301, or GEOL 3340, or cons. inst.

GEOL 5365. TOPICS IN GEOLOGY. 3 Hours.
Topics offered depend on student and faculty interest. Such topics might include identification of fossil fragments in thin section; magmatic processes; plate tectonics and sedimentary basin evolution; stratigraphic paleontology; sedimentary or volcanogenic ore deposition; geostatistics; geophysical archeology; and various advanced subjects in sedimentology, stratigraphy, paleontology, geophysics, geochemistry, volcanology and petrology. May be repeated for credit when topic changes.

GEOL 5367. PALEO EARTH SYSTEMS. 3 Hours.
This course discusses the evolution of Earth's complex dynamic system that is controlled by feedback processes that are both non-linear and stochastic in nature. Prerequisite: GEOL 1301.

GEOL 5368. GEOLOGY OF THE PERMIAN BASIN. 3 Hours.
Overview of the geologic evolution of the Permian Basin of W Texas and SE New Mexico and its petroleum resources. Emphasis on student presentations and term paper.

GEOL 5369. SEQUENCE STRATIGRAPHY. 3 Hours.
This course introduces sequence stratigraphy within context of all stratigraphy and history of sequence stratigraphy. Includes overview of sequence stratigraphy principles. Review of basic fundamental concepts of surface- and facies-based physical stratigraphy. Review of architectural element analysis, sequence stratigraphic in seismic, borehole expression of sequences and overview of subsurface stratigraphic techniques. Prerequisite: GEOL 3442.

GEOL 5370. SEDIMENTARY SYSTEMS. 3 Hours.
Carbonate and clastic depositional systems, recognition of facies, systems tracts, diagenetic overprint, shelf to basin profiling, and sequence stratigraphic analysis.

GEOL 5371. BASIN ANALYSIS. 3 Hours.
Topics include: the classification and characteristics of of sedimentary basins and the mechanisms forming them; and the tectonic, climatic, and eustatic controls on basin subsidence and the basin fill. Applications include the influence of basin evolution on petroleum generation, migration, and accumulation. Prerequisite: GEOL 3442 (Sedimentology and Stratigraphy).

GEOL 5372. STRUCTURAL GEOMETRY AND TECTONICS OF PETROLEUM FIELDS. 3 Hours.
Structural styles of thin-skinned, basement involved and reactivated systems in shortening, extensional and strike-slip deformation. Use of structural modeling and restoration methods to test the reliability of structural interpretations. Prerequisite: GEOL 3443.

GEOL 5373. RESERVOIR CHARACTERIZATION. 3 Hours.
Principles, protocols, analysis and measurement of petrophysical properties (e.g., fluid content, porosity, permeability, pore size distribution, water retention curve, imbibition) of petroleum reservoir rocks.

GEOL 5374. SEISMIC INTERPRETATION. 3 Hours.
Introduction to the methods of acquisition and processing as they relate to the interpretation of seismic records. Structural and stratigraphic interpretation methods and pitfalls using two and three dimensional seismic data. Introduction to Seismic Interpretation Software such as the Kingdom Suite from Seismic Micro Technology, Inc. Prerequisite: GEOL 3442 and GEOL 3443.

GEOL 5375. INTRODUCTION TO WELL LOG INTERPRETATION AND MAPPING. 3 Hours.
Introduction to the various types of well logs used in the petroleum industry and their petrophysical interpretations, including evaluations of porosity, water saturation, shale volume, permeability, and lithology. Introduction to techniques of contouring data and use of mapping software such as PETRA. Prerequisite: GEOL 3442.

GEOL 5381. RESEARCH IN GEOLOGY. 3 Hours.
Independent study in various areas of research including paleontology, stratigraphy, tectonics, structural geology, sedimentology, geochemistry, petrology, geophysics, and volcanology. May be repeated for credit. Graded R.

GEOL 5395. MASTER'S PROJECT. 3 Hours.
May be used as elective for students in non-thesis program. Graded F,P,R,W. Prerequisite: GEOL 1301 or equivalent course.

GEOL 5398. THESIS. 3 Hours.
Graded F, R.

GEOL 5405. METEOROLOGY AND CLIMATOLOGY. 4 Hours.
A quantitative approach to the study of the structure, energy, and motions of the atmosphere. Prerequisite: MATH 1426 and PHYS 1441, or cons. inst.

GEOL 5421. GEOCHRONOLOGY. 4 Hours.
Introduction to dating techniques, applied to understand past climate and tectonics. Prerequisite: GEOL 1301 or equivalent.

GEOL 5425. PALEOCLIMATE AND CLIMATE CHANGE. 4 Hours.
Climate change throughout geologic time, especially the last 100 million years: models of the climate system, reconstruction and modeling of past climates, abrupt climate change, warm climates, paleoclimatology, climate change and mass extinctions. Prerequisite: GEOL 1301 or ENVR 1330 or GEOL 1330, or cons. inst.

GEOL 5428. HYDROGEOLOGY. 4 Hours.
Hydrologic cycle, Darcy's law, hydraulic properties, aquifer types and materials, groundwater flow to wells, fracture flow, vadose zone flow, groundwater chemistry, and groundwater modeling; a term paper about the relevant topics covered in the class is required. Prerequisite: GEOL 2446, MATH 2425.

GEOL 5450. CONTAMINANT HYDROGEOLOGY. 4 Hours.
Sources and types of organic and inorganic contaminants; the physical, chemical, and biological factors and processes that affect the transport and fate of contaminants in the subsurface; non-aqueous phase liquids and multiphase flow; and various remedial techniques of contaminated sites.

GEOL 5454. STATISTICS FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of statistics and helps students apply statistics to analyze data and interpret results from the perspective of Earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in Earth and environmental sciences. Offered as EVSE 5454 and GEOL 5454. Credit will not be given for both.

GEOL 5455. MATHEMATICAL MODELING OF ENVIRONMENTAL QUALITY SYSTEMS. 4 Hours.
This course is designed to introduce the process principles that govern contaminant transport and transformations in multimedia environments. This course will cover application of fate and transport models to evaluate pollutant interactions with the biosphere, particularly in the context of human exposure modeling and health risk assessment. Offered as EVSE 5455 and GEOL 5455. Credit will not be given for both.

GEOL 5456. ENVIRONMENTAL RISK ASSESSMENT. 4 Hours.
This course introduces the basic scientific components of environmental and occupational health risk assessment and describes the policy context in which decisions to manage environmental health risks are made. The course presents the quantitative methods used to assess the human health risks associated with exposure to toxic chemicals, focusing on the four major components of risk assessment-hazard identification, dose-response assessment, exposure assessment, and risk characterization. Offered as EVSE 5456 and GEOL 5456, credit will not be given for both.

GEOL 5458. MACHINE LEARNING FOR EARTH AND ENVIRONMENTAL SCIENTISTS. 4 Hours.
This course provides students with basic principles of machine learning and helps students apply machine learning to analyze data, predict outcomes and interpret results from the perspective of earth and environmental scientists. The course will first introduce basic concepts and then focus on applications to various examples in earth and environmental sciences. Offered as GEOL 5458 and EVSE 5458. Credit will not be given for both. Prerequisite: ENVR 3454 or GEOL 3454 or EVSE 5454 or GEOL 5454 or equivalent.

GEOL 5465. PHYSICAL OCEANOGRAPHY AND LIMNOLOGY. 4 Hours.
An introduction to physical processes in lakes and oceans. Changes in lakes and oceans influence heat, and momentum fluxes at the aquatic/oceanic and atmospheric interface. Topics include ocean/lake structure and circulation, and the impact of global climate change on lakes and oceans. Field excursions to nearby lakes combine theoretical knowledge and field measurements. Prerequisite: PHYS 1441 or PHYS 1443; and MATH 1426.

GEOL 5698. THESIS. 6 Hours.
Graded F, P, R.