Courses

**GEOL 101. Introduction to Geology. 3 Credits.**
Introduction to the dynamics of the Earth -- volcanoes, earthquakes, plate tectonics, streams, groundwater, glaciers, waves, wind, and landslides, with emphasis on the environmental applications of these processes. Introduction to the tools of the geologist -- minerals, rocks, maps, and aerial photographs. GEOL 101L may be taken concurrently. F,S,SS.

**GEOL 101L. Introduction to Geology Laboratory. 1 Credit.**
An introductory laboratory to complement GEOL 101. Field trip(s) included. Prerequisite or Corequisite: GEOL 101. F,S,SS.

**GEOL 102. The Earth Through Time. 3 Credits.**
The tracing of changes in the Earth and life through time, with emphasis on the record from North America. GEOL 102L may be taken concurrently. F, S.

**GEOL 102L. The Earth Through Time Laboratory. 1 Credit.**
An introductory laboratory to complement GEOL 102. Field trip included. Prerequisite or Corequisite: GEOL 102. F,S.

**GEOL 103. Introduction to Environmental Issues. 3 Credits.**
Introduction to Environmental Issues. A survey of environmental issues concerning society's interaction with Earth's natural systems and exploitation of Earth's resources. F,S.

**GEOL 104. Geology of National Parks. 3 Credits.**
An overview of the geology of U.S. National Parks. Unifying geological principles are emphasized. Major topics: sandstone parks, volcanic parks, hot springs and geothermal areas, caves and limestone parks, reefs and fossilized reefs, rivers and erosion, ice and glaciers, mountain building and mountain ranges. S.

**GEOL 105. Selected Topics. 1-4 Credits.**
A special topic course intended for non-geology majors. Subjects will include many issues of interest to non-geologists and non-scientists, such as earthquakes, evolutions, gems, and the geology of National Parks. Repeatable when topics vary. Repeatable. On demand.

**GEOL 106. Global Warming: The Facts and Myths. 3 Credits.**
Global warming is the most debated current challenge to humans. A large, multifaceted and technically challenging topic, it has been diluted to popular slogans that at best capture some aspects of the issue and at the worst are over-simplified. Most of us who are directly affected by global warming do not understand the background, do not know what the assertions are based on, and can not evaluate the correctness of the arguments propagated in mass media such as newspapers and talk-radio. This class will provide students with a clear grasp of the science behind global warming discussion, the typical strategies (pros/cons) that are used in the popular media, and a good understanding of the science-based predictions of upcoming changes in the climate and environment. In addition to providing general scientific background to understand global warming and the science behind it, the class will visit the arguments that are used both for and against global warming. The graded written tests require students to address typical misinformation about global warming, show general knowledge of the scientific background, and recognize typical means to distort science in the mass media.

**GEOL 111. Views of Earth and Planets. 3 Credits.**
An introduction to Earth and the Solar System. Coverage includes: the planets and their moons, comets, asteroids, impact craters, meteorites, the sun, the solar system's origin, planetary atmospheres, the living Earth, the question of life elsewhere. F,S.

**GEOL 111R. Views of the Earth and Planets Recitation. 1 Credit.**
A recitation-discussion to complement GEOL 111. Corequisite: GEOL 111. S.

**GEOL 205. Surviving on Planet Earth. 3 Credits.**
This Essential Studies course stresses critical thinking in covering the basic strategies about humans succeeding on our planet including Earth's hazards (our restless Earth); the balance of life on Earth (evolution and extinction); water in our lives (too much and too little); energy (use and population demands); and global change (Earth as a unique, ongoing experiment). S.

**GEOL 220. Computer Applications in Geology and Environmental Science. 2 Credits.**
Introduction to the application of computers, software, and digital processing in the geological and environmental sciences. F.

**GEOL 256. Critical Thinking in the Geosciences. 2 Credits.**
An introduction to the study of geoscience and skills needed to successfully complete a geoscience degree. F.

**GEOL 303. Selected Topics in Geology. 1-4 Credits.**
Each topic is concerned with a special aspect of geology. May be repeated up to a maximum of 8 hours. Prerequisite: Consent of the instructor. Repeatable to 8 credits. On demand.

**GEOL 311. Geomorphology. 4 Credits.**
Dynamics of weathering, mass movement, running water, groundwater, waves, wind and ice in the production of landforms. Includes field trips and laboratory. Prerequisites: GEOL 101 or GEOE 203; MATH 165, PHYS 211, CHEM 121 or consent of instructor. F.

**GEOL 316. Earth Materials. 4 Credits.**
We will organize the course into three parts: Part I will provide the context in which Earth materials are studied, fundamental concepts that will be used subsequently including: how we study Earth materials, how Earth materials interact with other components of the Earth system, and a rationale for why Earth materials are important for the study of Earth (including processes and history) and the importance of Earth materials in our personal and societal lives. Part II will undertake a systematic look at Earth materials as they occur in different settings. We will identify and describe the key Earth materials, their properties, their distribution and occurrences, the processes that form them, and how scientists use these materials to interpret Earth. Part III will be an investigation of the practical applications of Earth materials to issues of societal importance (e.g., resources, hazards, engineering) and special applications that affect contemporary issues related to living on Earth. This course has both a lecture and a laboratory component. Prerequisites: GEOL 101, GEOL 101L, and CHEM 121 or equivalent. S.

**GEOL 318. Mineralogy. 3 Credits.**
Survey of the origin, distribution and uses of rock-forming minerals. Introduction to mineral structures, crystal chemistry, and crystallography. Laboratory identification of common minerals in hand sample and petrographic thin section. Introduction to the use of the polarizing microscope. Includes field trip. Prerequisites: GEOL 101 or GEOE 203, and CHEM 121 or consent of instructor. S.

**GEOL 320. Petrology. 3 Credits.**
Description, classification and origin of igneous, metamorphic, and sedimentary rocks. Field and laboratory study of rocks. Engineering properties of earth materials. Advanced aspects of optical mineralogy. Includes laboratory. Prerequisite: GEOL 318. F.

**GEOL 321. Geochemistry. 3 Credits.**
Application of the principles of chemistry to geologic and hydrogeologic problems. Origin and distribution of the chemical elements. Introduction to radiochemistry, isotopic geochronology, and stable-isotope geochemistry. Prerequisites: GEOL 318, CHEM 122, and MATH 165 or consent of instructor. S.

**GEOL 322. Geology, Society, and the Environment. 3 Credits.**
Relationship of geology to society; natural hazards; protection, reclamation, and restoration of our natural environment; application of geology to engineering, land planning, and resource management. Prerequisite: One introductory geology course or upper division standing; MATH 103 is recommended. S, even years.

**GEOL 330. Structural Geology. 3 Credits.**
Mechanics of rock deformation, analysis of rock structures, preparation and interpretation of geologic maps and cross sections showing structural and tectonic features. Includes laboratory. Prerequisites: GEOL 318, GEOL 320 and MATH 105. S.

**GEOL 340. Digital Mapping Methods. 3 Credits.**
This course integrates "hands-on" data acquisitions and map generation with an overview of the technology (GPS, lasers, and data management). Field projects focus on mapping methodology and laboratory projects focus on analysis and presentation. It is assumed that students have an undergraduate geology background and a basic knowledge of computer applications. Prerequisite: Junior Standing in geology.

**GEOL 342. Conservation and Environmental Hydrology. 3 Credits.**
Topics relating hydrology to the environment and water conservation, including the global and local hydrological cycle, flood occurrence and prediction, water pollution, erosion and sedimentation, wetlands, and water management. Prerequisites: Introductory geology course or upper division standing; MATH 103. S, odd years.
GEOL 356. Geoscience Lectures. 1 Credit.
Students attend and evaluate departmental lectures given by visiting scientists and engineers, faculty, and students. May be repeated once. May not be ten
concurrently with GEOL 422. S/U grading. F.S.

GEOL 407. Petroleum Geology. 3 Credits.
Origin, accumulation and geologic occurrence of petroleum and gas. Prerequisites: GEOL 101 or GEOL 203, and GEOL 102. F, odd years.

GEOL 410. Site Characterization. 3 Credits.
Biochemical, and taxonomic criteria. Hands-on application of principles, tools and techniques at real sites. Prerequisites: GEOL 220, GEOL 311, GEOL 414;
Biol 332, BIOL 332L. F.

GEOL 411. Sedimentary and Stratigraphy. 5 Credits.
Origin, transportation, deposition, and diagenesis of sediments; principles and applications of stratigraphy. Includes field trip and laboratory. Prerequisite: GEOL 320. S.

GEOL 414. Applied Geophysics. 3 Credits.
Principles of various geophysical methods and their application to geologic problems. Prerequisites: GEOL 101 or GEOL 203; MATH 165; and PHYS 211 or 251. F.

GEOL 415. Introduction to Paleontology. 4 Credits.
The principles of paleontology/paleobiology are presented using fossils to document the evolutionary, stratigraphic, and paleoecologic history of animal and plant life on Earth. Includes field trip and laboratory. Prerequisites: GEOL 102; BIOL 150 and BIOL 151 are recommended prerequisites. F, even years.

GEOL 420. Geology Capstone. 3 Credits.
Geologic capstone entailing information literacy and communication about Earth materials, processes and history. The course checks retention of earlier learning and insures review and significant addition to that learning. Prerequisite: GEOL 487. Corequisite: GEOL 494. F.S.

GEOL 421. Seminar I. 1 Credit.
Instruction and practice of oral and visual presentation in science and engineering. Includes preparation and delivery of artifact talks, chalk talks, and slide talks. Includes critical review of student presentations and departmental guest lectures. Prerequisite: GEOL 356. F.S.

GEOL 422. Seminar II. 1 Credit.
Continuation of GEOL 421 experience. Preparation and delivery of oral presentations in science and engineering, culminating in oral presentation of senior thesis (Geo 490) or Engineering Design (485). Includes critical review of student presentations and departmental guest lectures. Prerequisites: GEOL 421, senior or graduate status in departmental major. F.S.

GEOL 487. Research I. 1 Credit.
Identification and proposal of research project. Includes literature review, feasibility review, and formal project identification and written proposal. Selection of faculty research adviser within first month of semester. Prerequisite: Senior standing in departmental major. F.S.

GEOL 488. Research II. 2 Credits.
Execution of research plan developed in GEOL 487. Prerequisite: GEOL 487.

GEOL 491. Geologic Problems. 1-4 Credits.
Individual or group study on selected geoscience topics. May be taken more than one semester to maximum of 8 hours. Prerequisite: Consent of instructor. Repeatable to 8 credits. F.S,SS.

GEOL 494. Senior Thesis. 1 Credit.
Written results of research conducted in GEOL 489. The thesis document should conform to the format guidelines of a major English-language journal in which the thesis could be published. A copy is to be provided to the F.D. Holland, Jr. Geology Library. Prerequisite or Corequisite: GEOL 488. F.S.

GEOL 500. Sedimentary Geology. 1-4 Credits.
Selected topics in sedimentary geology, such as sedimentary processes, carbonate petrology, clastic petrology, and basin analysis. May be repeated up to 12 credits. Prerequisite: Consent of instructor. Repeatable to 12 credits. F.

GEOL 505. Isotope Geochemistry. 3 Credits.
Geochemistry and cosmochemistry of radioactive and stable isotopes; isotope equilibria; applications in paleoclimatology, environmental isotope geochemistry, igneous, metamorphic, and sedimentary petrology. Prerequisite: GEOL 321 or permission of instructor.

GEOL 506. Glacial Geology. 4 Credits.
Origin, growth, and movement of glaciers; landforms and deposits incident to glaciation. 3 hours lecture, 2 hours laboratory time per week. Prerequisite: GEOL 311.

GEOL 509. Advanced Mineralogy. 1-4 Credits.
Advanced study of specific mineral groups or selected topics in mineralogy. Prerequisite: GEOL 320; recommended prerequisite GEOL 321.

GEOL 511. Advanced Structural Geology. 4 Credits.
Reading and research in special topics in structural geology and geotectonics.

GEOL 512. Advanced Petrology. 1-4 Credits.
Selected topics in petrology taught using conventional lecture and laboratory/field approach. Prerequisite: GEOL 320.

GEOL 515. Advanced Paleontology. 3 Credits.
Selected topics include (but not limited to): Invertebrate paleontology; vertebrate paleontology; paleoecology; taxonomy; museum studies; western continental stratigraphy; critical boundaries. May be repeated. Prerequisites: GEOL 415, BIOL 150, or consent of instructor. Repeatable to 40 credits. On demand.

GEOL 518. Topics in Advanced Stratigraphy. 2-4 Credits.
Selected topics in lithostratigraphy and biostratigraphy. Prerequisites: GEOL 411, GEOL 415. Repeatable to 4 credits.

GEOL 520. Statistical Applications in Geology. 3 Credits.
The application of statistical techniques to geologic data and problems, with emphasis on analysis of geologic sequences, map analysis, and multivariate analysis of geologic data. Prerequisites: An introductory statistics course, such as CTL 515 or PSYC 241, and consent of instructor.

GEOL 522. History and Philosophy of Geology. 3 Credits.
Historical and philosophical development of the science of geology. Prerequisite: Permission of instructor.

GEOL 523. Topics in Advanced Geomorphology. 1-4 Credits.
Selected topics in geomorphic processes and landforms. Prerequisite: GEOL 311. Repeatable to 4 credits.

GEOL 525. Weathering and Soils. 3 Credits.
Properties and classification of soils; the factors and processes of weathering and soil formation. Prerequisite: GEOL 311 and GEOL 411, or consent of instructor.

GEOL 530. Topics in Physical Hydrogeology. 2 Credits.
Selected topics in groundwater, vadose zone hydrology, fracture flow, analytical/numerical modeling, GIS and hydrology, and wetland soils/hydrology. Repeatable when topics vary. Prerequisite: Consent of instructor. Repeatable to 8 credits. F.S.

GEOL 531. Hydrogeochemistry. 3 Credits.
The origin, characteristics and modeling of surface and ground water geochemistry. Prerequisites: GEOL 321 and, MATH 166, or permission of instructor.

GEOL 532. Contaminant Hydrogeology. 3 Credits.
Chemical and physical processes affecting contaminant behavior in groundwater with analytical/numerical modeling and case studies. Prerequisites: GEOE 417 and GEOE 427 and MATH 265, or consent of instructor.

GEOL 540. Water Sampling and Analysis. 3 Credits.
Techniques of water and sediment sampling and analysis using equipment in the UND Water Quality Laboratory. Results are interpreted in the context of the natural systems from which the samples are taken. Enrollment is limited to eight students per section. A laboratory fee is required. Prerequisite: CHEM 121.

GEOL 551. Heat Flow. 3 Credits.
An exploration of Earth's thermal structure, thermal history and heat sources. The course begins with the theory of heat transfer within and through the surface of terrestrial planets. Methods of observation and modeling provide hands-on experience in field and laboratory activities. Applications of heat flow in tectonics, petrology, thermal maturity of kerogen, hydrogeology, geothermics and climate change are presented with current examples. Prerequisite: Graduate standing. Corequisite: Permission of instructor. On demand.
GEOL 560. Geothermics I. 3 Credits.
A survey of the methods of geothermal exploration, assessment and production. The course covers the various methods for discovery and characterization of geothermal resources. Methods for assessment of energy in place and determination of recoverable energy are covered in depth. Current technologies for energy extraction and power production are presented with current examples. Prerequisite: Graduate standing. Corequisite: Permission of instructor. On demand.

GEOL 561. Geothermics II. 3 Credits.
The course covers the historical development of geothermal policies, regulations and practices globally and in different states within the US. Matters of water usage, contamination and disposal are covered extensively. Current issues such as induced seismicity, hydrofracture, power plant size and location, electrical grid access and land use are critically examined. Prerequisite: Senior or Graduate Standing. Corequisite: Permission of Instructor. On demand.

GEOL 590. Research. 1-4 Credits.
Laboratory, field, or library research on problems of interest (may be repeated). Repeatable.

GEOL 591. Directed Studies. 1-4 Credits.
Directed advanced research in a specialized field of geologic study (may be repeated). Repeatable.

GEOL 996. Continuing Enrollment. 1-12 Credits.
Repeatable. S/U grading.

GEOL 997. Independent Study. 2 Credits.

GEOL 998. Thesis. 1-9 Credits.
Repeatable to 9 credits.

GEOL 999. Dissertation. 2-12 Credits.
May be repeated up to 24 credits. Repeatable to 24 credits.