

Harold Hamm School of Geology and Geological Engineering (GEOL, GEOE)

B.S. in Earth Science (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/geologyandgeologicalengineering/geol-bs-es/>)

B.S. in Environmental Geoscience (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/geologyandgeologicalengineering/geol-bs-eg/>)

B.S. in Geological Engineering (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/geologyandgeologicalengineering/geol-bs-ge/>)

B.S. Geology (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/geologyandgeologicalengineering/geol-bs/>)

Minor in Geology (<https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/geologyandgeologicalengineering/geol-minor/>)

Four Year Plan - B.S. in Geology (p. 1)

Four Year Plan - B.S. in Geology

Freshman Year

Fall		Credits
GEOL 101	Introduction to Geology	3
GEOL 101L	Introduction to Geology Laboratory	1
CHEM 121	General Chemistry I	3
CHEM 121L	General Chemistry I Laboratory	1
MATH 165	Calculus I	4
ENGL 110	College Composition I	3
Credits		15

Spring

GEOL 102	The Earth Through Time	3
GEOL 102L	The Earth Through Time Laboratory	1
GEOL 318		2
GEOL 318L		1
CHEM 122	General Chemistry II	3
CHEM 122L	General Chemistry II Laboratory	1
ENGL 130	Composition II: Writing for Public Audiences	3
Credits		14

Sophomore Year

Fall		Credits
GEOL 415		3
GEOL 415L		1
GEOL 320		2
GEOL 320L		1
PHYS 211	College Physics I	4
PHYS 211CL	College Physics I Laboratory	1
Humanities Essential Studies Elective		3
Credits		15

Spring

GEOL 411		3
GEOL 411L		1
MATH 321	Applied Statistical Methods	3
PHYS 212	College Physics II	4

PHYS 212CL	College Physics II Laboratory	1
Social Sciences Essential Studies Elective		3
Credits		15

Junior Year

Fall

GEOL 220	Computer Applications in Geology and Environmental Science	2
GEOL 421	Seminar	1
GEOE 417	Hydrogeology	3
Geology Concentration Elective	Concentrations offered at present: General Geology, Paleontology, Petroleum Geology, Water Resources	4
Oral Communication Essential Studies Elective		3
Free Elective		3
Credits		16

Spring

GEOL 330	Structural Geology	3
GEOL 330L	Structural Geology Laboratory (Structural Geology Laboratory)	1
Geology Concentration Elective	Concentrations offered at present: General Geology, Paleontology, Petroleum Geology, Water Resources	4
Fine Arts Essential Studies Elective		3
Free Elective		3
Credits		14

Senior Year

Summer

Geology Field Experience	Geology Field Experience credits must be pre-approved by the School and may be satisfied by successfully completing a total of 3 credits including, but not limited to: approved professional field camps, GEOL 491, GEOE 397, and internships.	3
Credits		3

Fall		Credits
GEOL 414	Applied Geophysics	3
GEOL 487	Undergraduate Research	1
Geology Concentration Elective	Concentrations offered at present: General Geology, Paleontology, Petroleum Geology, Water Resources	4
Social Sciences Essential Studies Elective		3
Free Elective		3
Credits		14

Spring

GEOL 420	Geology Capstone	3
GEOL 494	Senior Thesis	1
Geology Concentration Elective	Concentrations offered at present: General Geology, Paleontology, Petroleum Geology, Water Resources	4
Fine Arts Essential Studies Elective		3
Humanities Essential Studies Elective		3
Credits		14
Total Credits		120

The B.S. in Geology program includes the choice of a Concentration, in which students can choose one of four geoscience topics for further exploration and emphasis in their coursework. Each student should meet with their Academic Advisor early in their time at UND to map out their interests in their degree program. Students must complete enough electives to bring total credit hours up to the 120. Special Emphasis courses can fulfill an essential studies requirement (For example, HIST 104 United States Since 1877 would count toward the Diversity of Human Experience Special Emphasis as well as the Humanities Breadth of Knowledge area). Please note: Every student must fulfill all University, Departmental, and Essential Studies requirements. (<https://und.edu/academics/essential-studies/>)

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. Prerequisite or Corequisite: GEOL 101. F,S,SS.

GEOL 102. The Earth Through Time. 3 Credits.

In this course we examine the history of Earth, from its formation to today, as it is recorded in the geological record. With an emphasis on geologic time, this course follows the evolution of Earth and the fascinating organisms that have inhabited our planet, from the origin of life to the animals and plants we see today. We explore connections between the fundamental processes that have shaped the Earth and its lifeforms which created our world today. It is recommended to take GEOL 102L concurrently. F,S.

GEOL 102L. The Earth Through Time Laboratory. 1 Credit.

An introductory laboratory to complement GEOL 102 designed to provide additional hands-on and applied learning opportunities. This includes exploring fundamental geological concepts with mineral, rock, and fossil specimens. 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, evolution, 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 simplifications. 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. Introduction to Planetary Geology. 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, and the question of life elsewhere. F,S.

GEOL 111L. Introduction to Planetary Geology Laboratory. 1 Credit.

Laboratory to complement GEOL 111 Introduction to Planetary Geology. Corequisite: GEOL 111. S.

GEOL 112. Discovering Dinosaurs!. 3 Credits.

This course provides an introduction to the "terrible lizards" that ruled our planet for over 150 million years. Dinosaurs capture human imagination, and their existence and demise allows us to explore evolution and extinction on geologic timescales. Emphasis will be placed on the scientific method and its applications to the study of dinosaurs. Topics will include dinosaur evolution, interrelationships, extinction, and the evolution of those dinosaurs still among us (birds). We will also explore current debates within the field of dinosaur paleontology and the evidence supporting the hypothesis that their extinction was due to a meteorite impact. Suitable for all majors. F,S.

GEOL 115. Motion of Life. 3 Credits.

Explore introductory concepts and principles of evolution through the study of motion, including major evolutionary transitions such as the development of limbs, wings, and the upright posture of humans. This course connects the evolutionary history of organisms with their unique biomechanical traits, locomotor capabilities, and influences on human engineering and design. Topics covered will include the relationship of form and function in extinct and modern organisms, how their evolutionary history influences this relationship, and its connection to human designs. Suitable for all majors. 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 215. Introduction to Paleontology. 3 Credits.

This course provides an overview of the foundational principles of paleontology. Topics covered include the fundamentals of evolution, phylogenetics, fossilization, paleoecology, and fossil identification. Students also explore the critical importance of fossils to geology, industry, and other related geoscience careers. The separate laboratory portion of the course emphasizes practical application via identification and interpretation of fossils, especially invertebrates as they are common in the fossil record. Prerequisite: GEOL 102 and GEOL 102L. Corequisite: GEOL 215L. F.

GEOL 215L. Introduction to Paleontology Lab. 1 Credit.

This course provides an overview of the foundational principles of paleontology. Topics covered include the fundamentals of evolution, phylogenetics, fossilization, paleoecology, and fossil identification. Students also explore the critical importance of fossils to geology, industry, and other related geoscience careers. The laboratory emphasizes practical application via identification and interpretation of fossils, especially invertebrates as they are common in the fossil record. Prerequisite: GEOL 102 and GEOL 102L. Prerequisite or Corequisite: GEOL 215. F.

GEOL 218. Mineralogy. 2 Credits.

Survey of the origin, distribution and uses of rock-forming minerals. Introduction to mineral structures, crystal chemistry, and crystallography. Prerequisite: GEOL 101 or GEOE 203, and CHEM 121 or consent of instructor. Corequisite: GEOL 218L. S.

GEOL 218L. Mineralogy Lab. 1 Credit.

Hands-on laboratory activities relating to GEOL 218. Prerequisite: GEOL 101 or GEOE 203, and CHEM 121 or consent of instructor. Corequisite: GEOL 218. S.

GEOL 219. Petrology. 2 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. Prerequisite: GEOL 218. Corequisite: GEOL 219L. F.

GEOL 219L. Petrology Lab. 1 Credit.

Hands-on laboratory activities relating to GEOL 219. Prerequisite: GEOL 218. Corequisite: GEOL 219. F.

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 8.00 credits. On demand.

GEOL 311. Geomorphology. 4 Credits.

In this course you will learn about the Earth's surface: what processes created the landforms we see today and how those landforms are evolving through time. The topics include: rivers, glaciers, wind, weathering, soils, groundwater, slope processes, dating of the surface deposits, and current and past climate change. The course objective is to provide students with a good understanding of the processes and materials that shape the Earth's surface. Includes field trip and hands on laboratory. Prerequisite: GEOL 101 or GEOE 203 or consent of instructor. F.

GEOL 312. Sedimentology and Stratigraphy. 3 Credits.

Describe and classify siliciclastic and carbonate sedimentary rocks; interpret sedimentary structures in ancient sedimentary rocks in terms of depositional, erosional or deformational processes, interpret ancient depositional environments of siliciclastic and carbonate sedimentary rocks; understand and appreciate the difference between rock and time units in sedimentary successions; recognize and appreciate the importance of unconformities in sedimentary successions and for the formation of hydrocarbons; discuss mechanisms responsible for sedimentary basin formation, and describe and classify sedimentary basins. This course is also designed to teach you how to reference adequately in the text and how to make a reference list (plus what should be in there). Prerequisite: GEOL 219. Corequisite: GEOL 312L. S.

GEOL 312L. Sedimentology and Stratigraphy Lab. 1 Credit.

Describe and classify siliciclastic and carbonate sedimentary rocks and know how to put a name to a sedimentary rock sample. You will learn to interpret sedimentary structures based on hand samples in ancient sedimentary rocks in terms of depositional, erosional or deformational processes, and interpret ancient depositional environments of siliciclastic and carbonate sedimentary rocks based on core description; you will learn to recognize the importance of surfaces in sedimentary successions; this course will also briefly discuss mechanisms responsible for sedimentary basin formation, and describe and classify sedimentary basins. Prerequisite: GEOL 219. Prerequisite or Corequisite: GEOL 312. S.

GEOL 316. Earth Materials. 3 Credits.

This course has three components. We start by considering the context in which Earth materials are studied and some fundamental concepts about the Earth system. Then we undertake a systematic look at the most important materials that make up our planet and how they occur in different settings. Included are elements, minerals, rocks of all sorts, soils, and water. We will examine their properties, their distribution and occurrences, the processes that form them, and how scientists use these materials to interpret Earth. The third, and perhaps most important focus of the class is on the importance of Earth materials in our society and lives. This includes consideration of mineral and energy resources, hazards, and engineering. Class time has both a lecture and a laboratory component. Prerequisite: CHEM 121 or equivalent knowledge of chemistry. S.

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. Prerequisite: GEOL 218 or GEOE 301; CHEM 122; 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. Prerequisite: GEOL 219 or GEOE 301 and PHYS 211 or PHYS 251. Corequisite: GEOL 330L. S.

GEOL 330L. Structural Geology Laboratory. 1 Credit.

Hands-on laboratory activities relating to GEOL 330. Corequisite: GEOL 330. 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. Prerequisite: Introductory geology course or upper division standing; MATH 103. S, odd years.

GEOL 355. Economic Geology and Ore Deposits. 3 Credits.

Our world requires mineral resources to support our lifestyles. And when we confront resource supply and development issues, people are often faced with uncomfortable choices. For example, where do we want our resources to come from? And how much environmental degradation is acceptable? These and related questions are not only fascinating but critically important to maintaining modern society. This course explores the origins, types, extraction procedures, and legal and political aspects behind the collection of geologic resources. The class has a seminar format, focusing on student presentations and discussion of topics vital to your (and everyone's) future. Prerequisite: GEOL 218, or permission of the instructor. F.

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 taken concurrently with GEOL 422. S/U grading. F,S.

GEOL 407. Petroleum Geology. 3 Credits.

This course is designed to provide students with an introduction to the application of geological principles in the exploration and production of oil and gas. Prerequisite: GEOL 101 or GEOE 203 or GEOE 210. S.

GEOL 410. Site Characterization. 3 Credits.

Purposes, techniques, and tools of site investigation. Covers geologic, hydrologic, and ecologic concerns. Hands-on application of principles, tools and techniques at real sites. Prerequisite: GEOL 220, GEOL 311, GEOL 414; BIOL 332, BIOL 332L. F.

GEOL 414. Applied Geophysics. 3 Credits.

Principles of various geophysical methods and their application to geologic problems. Prerequisite: GEOL 101 or GEOE 203; MATH 165; and PHYS 211 or 251. F.

GEOL 416. Vertebrate Paleontology. 4 Credits.

This course examines the evolutionary history of vertebrates, ranging from the origin of chordates in the Cambrian to the rise of dinosaurs, mammals, and hominids. Emphases are placed on the anatomical diagnoses of vertebrate clades and their phylogenetic relationships, as well as major milestones in vertebrate evolution, such as the origins of terrestrial locomotion and flight. Lab exercises examine skeletal anatomy of vertebrates, functional adaptations, and the role of skeletons in discerning phylogenetic interrelationships of vertebrates. Prerequisite: GEOL 102 and GEOL 102L. F, odd years.

GEOL 417. Dinosaur Paleontology. 4 Credits.

This course examines the origin and evolutionary history of non-avian dinosaurs, including their extinction. Emphases are placed on the anatomical diagnoses of dinosaur clades and their phylogenetic relationships, the origin of birds, and functional adaptations exhibited by dinosaurs. Lab exercises will examine the anatomy of dinosaur bones, adaptations exhibited by dinosaurs, and the role of their skeletons in discerning their phylogenetic interrelationships. Prerequisite: GEOL 102 and GEOL 102L. S, odd years.

GEOL 418. Taphonomy and Fossilization Processes. 4 Credits.

All living organisms eventually succumb to the same end: death. Taphonomy is the study of everything that happens to an organism from the time of its death until its discovery as a fossil. This course explores the varied environmental, geologic, and biologic processes that act on organic remains after death, including how these processes can bias the fossil record or yield information about past ecosystems. The laboratory involves experiments and activities which provide opportunities to explore the lecture topics in further detail. Prerequisite: GEOL 102 and GEOL 102L. S, even years.

GEOL 420. Geology Capstone. 3 Credits.

Geology 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 312 or consent of advisor. F,S.

GEOL 421. Seminar. 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. Involves critical review of student presentations and departmental guest lectures. Prerequisite: GEOL 312. 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 (Geol 490) or Engineering Design (485). Includes critical review of student presentations and departmental guest lectures. Prerequisite: GEOL 421, senior or graduate status in departmental major. F,S.

GEOL 450. Advanced Planetary Geology. 3 Credits.

This course leads students deeper into Solar System processes. The topics covered include planetary properties, system dynamics, energy transport, planetary atmospheres and interiors, laws of physics that govern planetary bodies, exoplanets and other star systems, and the possibility of life elsewhere in the universe. Prerequisite: GEOL 111. S.

GEOL 487. Undergraduate Research. 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 or Corequisite: GEOL 421. 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.

Individualized 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 8.00 credits. F,S,SS.

GEOL 494. Senior Thesis. 1 Credit.

Written results of research conducted in GEOL 487 or GEOL 488. 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 487. F,S.

GEOE 203. Earth Dynamics. 3 Credits.

Introductory physical geology course that also includes elements of historical geology, geomorphology, geohazards, and ethics. Intended for engineering and geosciences majors. F.

GEOE 203L. Earth Dynamics Laboratory. 1 Credit.

Laboratory course to accompany Earth Dynamics lecture. The laboratory is delivered as on-campus and virtually using specific required products and digital material. F.

GEOE 210. Earth Dynamics & Geophysics. 4 Credits.

Introduction to geology with an emphasis on those aspects of the science that are essential for petroleum engineers. Topics covered include an introduction to geologic features and processes that are responsible for accumulations of petroleum products in the subsurface. F.

GEOE 301. Petrophysics. 3 Credits.

Mineral and rock formation, identification and petrophysical properties, particularly with respect to porous rocks and their interactions with fluids. Prerequisite: GEOE 203. Corequisite: GEOE 301L. S.

GEOE 301L. Petrophysics Laboratory. 1 Credit.

Laboratory to accompany GEOE 301, or PTRE 301. Prerequisite or Corequisite: GEOE 301 or PTRE 301. S, odd years.

GEOE 302. Reclamation Engineering. 3 Credits.

Principles of reclamation emphasizing: the need for reclamation; geology and hydrogeology of disturbed landscapes, geological, hydrological, and ecological reclamation objectives; current reclamation practices; reclamation of abandoned mine lands; reclamation design; laws, regulations, permits, bonds, and public perception. Includes laboratory and field trip. Prerequisite: GEOL 101 or GEOE 203 or consent of instructor. S.

GEOE 323. Engineering Geology. 2 Credits.

This course is to introduce the application of geological, hydrological and environmental principles to geotechnical/geological engineering design, construction and operation as well as various geohazards. Prerequisite: One introductory geology course and MATH 165. S.

GEOE 397. Cooperative Education. 1-2 Credits.

For qualified students majoring in geological engineering or environmental geoscience. A practical work experience with an employer closely associated with the student's academic area. Positions may require student relocation for one or more semesters. Arranged by mutual agreement among student, department, and employer. Repeatable to 6 credits. Prerequisite: Consent of advisor required. Repeatable to 24.00 credits. S/U grading. F,S,SS.

GEOE 412. Soil Mechanics. 3 Credits.

To introduce the student to the fundamental knowledge of geomaterials and mechanical behavior of Soils; to familiarize the student with the use of soil mechanics; to provide the student with a firm foundation for the continuation to more theoretical and applied aspects in pavement engineering, foundation engineering, dam engineering, geological engineering, Slope stability and earthquake engineering. Prerequisite: GEOE 323. Prerequisite or Corequisite: ENGR 203. F.

GEOE 417. Hydrogeology. 3 Credits.

Physical and chemical aspects of groundwater movement, supply, and contamination. Prerequisite: MATH 165. F.

GEOE 418. Hydrogeological Methods. 2 Credits.

Field and laboratory methods used in hydrogeology; techniques of drilling, well and piezometer installation, determination of aquifer parameters, geophysical exploration, soil classification and analysis, ground water sampling and analysis. Includes field trip. Prerequisite: GEOE 417. F.

GEOE 419. Groundwater Monitoring and Remediation. 3 Credits.

Statistical methods for groundwater sampling and monitoring network design. Groundwater remediation and design; including strategies that remove contaminants for external treatment and strategies for in-situ contaminant treatment. Prerequisite: MATH 165. S.

GEOE 420. Geological Modeling and Numerical Simulation of Reservoirs. 3 Credits.

This technical elective course targets senior or graduate student who has desire to pursue fossil energy industry or a transition from fossil energy to renewable energy as a future career or related. The course introduces workflow designs and software application from geological modeling to numerical simulation for hydrocarbon or geothermal energy, so that engineering student can communicate knowledgeably about geologic processes to reservoir fluid flow process that formed and continued to shape the rock formation and reservoir. Prerequisite: GEOE 301 and GEOL 407. F.

GEOE 421. Cold Region Hydrologic Modeling. 3 Credits.

This course aims to describe and explain the governing physical principles, processes and recent advances in cold region hydrology and physically based numerical simulation with special reference to northern prairie region. In addition, the students will learn the incorporation of physically based process into a numerical model using the cold region hydrologic model platform (CRHM). The CRHM allows the compilation of various modules (each module represent a process) to build a model to simulate watershed processes in a specific basin. Prerequisite: GEOL 101, GEOE 203, or MATH 165. F.

GEOE 425. Design Hydrology for Wetlands. 3 Credits.

Principles of chemistry, geology, hydraulics, and hydrology applied to natural and constructed wetlands and other small catchments. Prerequisite: CHEM 121 and either CE 306/ME 306 or GEOE 417. S.

GEOE 427. Groundwater Modeling. 3 Credits.

Fundamentals of numerical modeling applied to groundwater flow. Spreadsheet calculations will be used to demonstrate the finite difference method applied to groundwater movement and storage. Simulation of practical groundwater problems will be performed with the U.S. Geological Survey's MODFLOW code. Prerequisite: GEOE 417 and MATH 265; some programming experience is recommended. On demand.

GEOE 454. Unsaturated Soil Mechanics. 3 Credits.

This course is designed to introduce the students the unsaturated soil mechanics based on three fundamental perspectives: mechanics, hydrology and thermodynamics. This course is designed for undergraduate seniors and graduate students with general background in geological engineering, geotechnical engineering, civil engineering, and environmental engineering. Prerequisite: CE 412, GEOE 412, or GEOE 323. S.

GEOE 455. Geomechanics. 3 Credits.

The objective of this course is to train the students to use fundamental principles and field and lab techniques of Rock Mechanics to analyze real-world problems, identify the optimal methods, and solve the practical geological engineering problems with the combination of field and laboratory, analytical and experimental means. Emphases will be on the fundamental principles and their application to practical engineering problems, both surface and underground. Prerequisite: GEOE 323 and GEOE 412/CE 412 or consent of instructor. F.

GEOE 455L. Geomechanics Laboratory. 1 Credit.

Laboratory to accompany GEOE 455. Prerequisite: GEOE 323 or consent of instructor. Prerequisite or Corequisite: GEOE 455 or consent of instructor. F.

GEOE 456. Geomaterials Stabilization. 3 Credits.

The course is to highlight the need for geomaterial improvement and stabilization in engineering. To provide an understanding for the different principles, analysis, design procedures and applications for geomaterial stabilization and ground improvement. Prerequisite: GEOE 412 or CE 412. F.

GEOE 484. Geological Engineering Design. 3 Credits.

The first of a two-course sequence in geological engineering design. Define the design problem, establish design objectives, evaluate alternatives, specify constraints, determine a methodology, complete a formal design problem statement. Prerequisite: Advanced level standing in Geological Engineering and consent of advisor. F.

GEOE 485. Geological Engineering Design. 3 Credits.

Continuation of GEOE 484 taken the preceding semester. Systematic study and design, with determination of feasibility, careful assessment of economic factors, safety, reliability, aesthetics, ethics, and social and environmental impact. Results presented in GEOL 422 Seminar. Prerequisite: GEOE 484. Corequisite: GEOL 422. S.

GEOE 493. Selected Topics in Geological Engineering. 1-3 Credits.

Detailed study of selected topics in Geological Engineering. Includes laboratory if applicable. Repeatable. Repeatable. On demand.