

GEOLOGY (GEOL)

Courses primarily for undergraduates:

GEOL 1000: How the Earth Works

Credits: 3. Contact Hours: Lecture 3.

How does the earth work, what is it made of, and how does it change through time? Plate tectonics, Earth materials, landforms, structures, climate, and natural resources. Emphasis on the observations and hypotheses used to interpret earth system processes. Students may also enroll in GEOL 1000L. (Typically Offered: Fall, Spring, Summer)

GEOL 1000L: How the Earth Works: Laboratory

Credits: 1. Contact Hours: Laboratory 2.

Students will gain understanding of how Earth processes affect their lives and how they affect the Earth, and of the complex nature of the Earth and its processes. They will gain a deep knowledge of the methods used to understand the time scales and rates of Earth processes also through an applied research experience on groundwater and surface water. (Typically Offered: Fall, Spring)

GEOL 1010: Environmental Geology: Earth in Crisis

(Cross-listed with ENVS 1010).

Credits: 3. Contact Hours: Lecture 3.

Exploration of the interactions between humans and the geologic environment, and the consequences of those interactions, on local to global scales. Discussion of water, soil, mineral, and energy resources, pollution, climate change, and natural hazards such as earthquakes, volcanism, mass wasting, and flooding. (Typically Offered: Fall, Spring, Summer)

GEOL 1020: History of the Earth

Credits: 3. Contact Hours: Lecture 3.

Prereq: GEOL 1000 or GEOL 2010

Tectonic, climate, and biological evolution of the Earth. Interactions between the three are emphasized. Students will learn methods used to decipher earth history, including reading papers and maps, introductory computer coding, and using rocks and fossils. Students majoring in geology must also enroll in GEOL 1020L. (Typically Offered: Spring)

GEOL 1020L: History of the Earth: Laboratory

Credits: 1. Contact Hours: Laboratory 2.

Prereq: Credit or concurrent enrollment in GEOL 1020

Introduction to the tools used to study Earth history. Students will gain familiarity with sketching/drawing, rock/mineral/fossil identification, reading maps, learning about geologic history, and how we use these tools to reconstruct the Earth's history. (Typically Offered: Spring)

GEOL 1030: Age of Dinosaurs

Credits: 1. Contact Hours: Lecture 1.

Introduction to the diversity of dinosaur species. Discussion of basic evolutionary theory and interpretation of fossil evidence. Overview of Mesozoic Earth history including paleogeographic and paleoclimate reconstructions. Course available via the World Wide Web. (Typically Offered: Fall)

GEOL 1050: Gems and Gemstones

Credits: 1. Contact Hours: Lecture 1.

Offered in second half of the semester. Introduction to gems and gemstones, physical and optical properties of gems and gemstones, explanation of where gems come from and how they are found, how to distinguish between synthetic and naturally occurring gems, how the value of gems are determined, and the history of famous gems. (Typically Offered: Fall)

GEOL 1080: Introduction to Oceanography

(Cross-listed with ENVS 1080).

Credits: 3. Contact Hours: Lecture 3.

Introduction to the study of oceans and the processes that helped shape them. A major focus is on how the oceans work, with special attention on geological, chemical, and biological processes. Ocean circulation and its influence on climate. Life of the oceans. Use and misuse of ocean resources. Anthropogenic impacts on the oceanic environment. (Typically Offered: Fall)

GEOL 1110: Geological Disasters

(Cross-listed with ENVS 1110).

Credits: 1. Contact Hours: Lecture 1.

Introduction to the catastrophic geologic processes with the potential to devastate human populations that continue to expand into regions at greatest risk from geologic hazards. Selected case studies and discussion of plate tectonics, climate, and earth processes explain the driving forces behind natural hazards such as earthquakes, tsunamis, volcanic eruptions, landslides, and floods. (Typically Offered: Fall, Spring, Summer)

GEOL 1120: Geoscience Orientation

(Cross-listed with MTEOR 1120).

Credits: 1. Contact Hours: Lecture 1.

Orientation course for students enrolled in the Earth, Wind and Fire Learning Community. Provides an introduction to Iowa State University and meteorology, geology, and Earth science programs for students enrolled in the department's learning community. Activities include academic and social activities, talks and presentations on academic success, resume writing, and study abroad, as well as research talks by faculty members. (Typically Offered: Fall)

GEOL 1130: Spring Geoscience Orientation for Earth, Wind and Fire Learning Community

(Cross-listed with MTEOR 1130).

Credits: 1. Contact Hours: Lecture 1.

Spring orientation course for students enrolled in the 'Earth, Wind and Fire' Learning Community. Develop and apply quantitative, data-analysis, management, and communication skills on an authentic research project in a team to focus on professionalism and resilience. Introduction to interview strategies and the importance of creating a professional image on social media. Academic and social events, plus two field trips. (Typically Offered: Spring)

GEOL 1400: Climate and Society

(Cross-listed with AGRON 1400/ ENVS 1400/ MTEOR 1400).

Credits: 3. Contact Hours: Lecture 3.

The climate system of our planet. How nature and our actions alter the existing energy balance leading to climate change. Past climates on our planet. The influence of climate on society and resource availability during the Holocene (~ 11,000 years ago to present) with focus on changes post industrial revolution. Significant climate events that have altered our way of life in the past. Projected changes in future climate and potential impacts on society, environment and resources. Adaption to and mitigation of climate change. Meets International Perspectives Requirement. (Typically Offered: Fall, Spring)

GEOL 1600: Water Resources of the World

(Cross-listed with AGRON 1600/ ENVS 1600/ MTEOR 1600).

Credits: 3. Contact Hours: Lecture 3.

Study of the occurrence, history, development, and management of world water resources. Basic hydrologic principles including climate, surface water, groundwater, and water quality. Historical and current perspectives on water policy, use, and the role of water in society and the environment. Meets International Perspectives Requirement. (Typically Offered: Spring)

GEOL 2010: Geology for Engineers and Environmental Scientists

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Introduction to Earth materials and processes with emphasis on engineering and environmental applications. (Typically Offered: Fall)

GEOL 2900: Independent Study

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

Independent study for freshman and sophomore students.

GEOL 2980: Cooperative Education

Credits: Required.

Prereq: GEOL 1000 or GEOL 2010, GEOL 1000L, GEOL 1020, GEOL 1020L; sophomore classification

Required of all cooperative education students. Students must register for this course prior to commencing the work period. (Typically Offered: Fall, Spring, Summer)

GEOL 3020: Summer Field Studies

Credits: 6.

Prereq: GEOL 1020, GEOL 3560, and GEOL 3680

Geologic mapping; structural, stratigraphic, sedimentologic, metamorphic, geomorphic, and environmental analyses. Study areas in the Bighorn Basin and Wind River Range and excursions to Yellowstone and Grand Teton National Parks. A 6-week summer field course required of all geology majors. (Typically Offered: Summer)

GEOL 3150: Mineralogy and Earth Materials

Credits: 3. Contact Hours: Lecture 3.

Prereq: Credit or concurrent enrollment in CHEM 1630 or CHEM 1670 or CHEM 1770

Introduction to mineral classification, elementary crystal chemistry, crystal growth and morphology, mineral stability, and mineral associations. GEOL 1000 or GEOL 1010 or GEOL 2010 or equivalent recommended. (Typically Offered: Fall)

GEOL 3150L: Laboratory in Mineralogy and Earth Materials

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Credit or concurrent enrollment in CHEM 1630 or CHEM 1670 or CHEM 1770

Elements of mineral symmetry and hand-specimen mineral identification using physical properties. (Typically Offered: Fall)

GEOL 3160: Optical Mineralogy

Credits: 1. Contact Hours: Lecture 1, Laboratory 2.

Prereq: Credit or concurrent enrollment in CHEM 1630 or CHEM 1670 or CHEM 1770

Laboratory problems in mineral-identification methods utilizing optical microscopic techniques. GEOL 1000 or GEOL 1010 or GEOL 2010 or equivalent recommended. (Typically Offered: Fall)

GEOL 3240: Energy and the Environment

(Cross-listed with ENSCI 3240/ ENVS 3240/ MTEOR 3240).

Credits: 3. Contact Hours: Lecture 3.

Prereq: CHEM 1630, CHEM 1670, or CHEM 1770

Exploration of the origin of Earth's energy resources and the environmental and climatic impacts of energy acquisition and consumption. Renewable and non-renewable energy resources within an Earth-system context. Various environmentally-relevant topics such as water quality and availability, habitat destruction, greenhouse-gas emissions, and health and safety hazards to wildlife and human communities. (Typically Offered: Spring)

GEOL 3560: Structural Geology and Tectonics

Credits: 4. Contact Hours: Lecture 3, Laboratory 3.

Prereq: (GEOL 1000 or GEOL 2010); PHYS 1310; PHYS 1310L

Principles of stress, strain, and rheology. Brittle and ductile behavior of rocks. Mechanics of formation, description, and classification of fractures, faults, folds, foliation, and lineation. From micro-structures to tectonic processes. Laboratory includes application of learned concepts to real-world scenarios, geometrical techniques to solve structural problems. (Typically Offered: Spring)

GEOL 3570: Geological Mapping and Field Methods

Credits: 1. Contact Hours: Laboratory 3.

Prereq: (GEOL 1000 or GEOL 2010); PHYS 1310; PHYS 1310L

Generation and interpretation of geological maps via a combination of laboratory and field exercises. Developing skills in 3D thinking, cross-section construction, stereonet analysis, field data collection, and communicating scientific results. (Typically Offered: Fall)

GEOL 3650: Igneous and Metamorphic Petrology

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Prereq: GEOL 3150, GEOL 3150L, and GEOL 3160

Nature and origin of igneous and metamorphic rocks. Emphasis on important rock-forming environments and processes and their influence on rock characteristics. Laboratory includes thin section study of rock textures and mineralogy and the interpretation of these features. (Typically Offered: Spring)

GEOL 3680: Sedimentary Geology

Credits: 4. Contact Hours: Lecture 3, Laboratory 3.

Prereq: GEOL 1020

Exploration of the interplay between weathering, sedimentation, sea-level change, tectonics, and life through time that creates sedimentary rocks and stratigraphic packages. Understanding of the historical development of sedimentary geology through the development of petrography, paleontology, deep earth sampling, geophysical technologies, and geochemistry. Field and laboratory problem sets illuminate lecture material. (Typically Offered: Fall)

GEOL 3980: Cooperative Education

Credits: Required.

Prereq: GEOL 1000 or GEOL 2010, GEOL 1000L, GEOL 1020, GEOL 1020L and Junior classification

Required of all cooperative education students. Students must register for this course prior to commencing each work period. (Typically Offered: Fall, Spring, Summer)

GEOL 4020: Watershed Hydrology

(Dual-listed with GEOL 5020/ ENSCI 5020/ MTEOR 5020/ NREM 5020).

(Cross-listed with ENSCI 4020/ MTEOR 4020/ NREM 4020).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Examination of watersheds as systems, emphasizing the surface components of the hydrologic cycle. Combines qualitative understanding of hydrological processes and uncertainty with quantitative representation. Laboratory emphasizes field investigation and measurement of watershed processes. (Typically Offered: Fall)

GEOL 4060: Geology Field Course

Credits: 1-2. Repeatable, maximum of 2 credits.

Prereq: GEOL 1000 or GEOL 2010

Weekly seminar introduces students to a selected geological region or theme that is visited on a required ten-day field excursion. Introduction to field-safety leadership. (Typically Offered: Fall, Spring)

GEOL 4090: Field Methods in Hydrogeology

(Dual-listed with GEOL 5090/ ENSCI 5090). (Cross-listed with ENSCI 4090).

Credits: 3. Contact Hours: Laboratory 4.

Prereq: GEOL 4020/ENSCI 4020, GEOL 4110/ENSCI 4110 or CE 4730

Introduction to field methods used in groundwater investigations. In-field implementation of pumping tests, slug tests, monitoring well installation and drilling techniques, geochemical and water quality sampling, seepage meters, minipiezometers, stream gaging, and electronic instrumentation for data collection. Field trips to investigate water resource, water quality, and remediation projects. Offered even-numbered years. (Typically Offered: Summer)

GEOL 4110: Hydrogeology

(Dual-listed with GEOL 5110/ ENSCI 5110). (Cross-listed with ENSCI 4110).

Credits: 4. Contact Hours: Lecture 3, Laboratory 2.

Physical principles of groundwater flow, nature and origin of aquifers and confining units, well hydraulics, groundwater modeling, and contaminant transport. Lab emphasizes applied field and laboratory methods for hydrogeological investigations. (Typically Offered: Spring)

GEOL 4120: Micropaleontology

(Dual-listed with GEOL 5120). (Cross-listed with ENSCI 4120).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Prereq: GEOL 1020 and GEOL 1020L

Evolution, identification and utility of major microfossil groups from the Mesozoic to present. Focus on Cenozoic applications including biostratigraphy, paleoclimate, and paleothermometry using assemblages, stable isotopes, Mg/Ca, and molecular fossils. Laboratory includes processing and analysis of specific microfossils. Major groups covered include foraminifera, calcareous nanofossils, sponge spicules, diatoms, radiolarians, and silicoflagellates. Offered even-numbered years.

(Typically Offered: Fall)

GEOL 4130: Applied and Environmental Geophysics

(Cross-listed with CE 4130/ ENSCI 4130).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Seismic, gravity, magnetic, resistivity, electromagnetic, and ground-penetrating radar techniques for shallow subsurface investigations and imaging. Data interpretation methods. Lab emphasizes computer interpretation packages. Field work with seismic - and resistivity-imaging systems and radar. Introductory geology, algebra, and trigonometry recommended. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 4140: Applied Groundwater Flow Modeling

(Dual-listed with GEOL 5140/ ENSCI 5140). (Cross-listed with ENSCI 4140).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Prereq: (GEOL 4110 or CE 4730); MATH 1650

Introduction to the principles of modeling groundwater flow systems. Finite-difference and analytic-element methods, spreadsheet models, boundary conditions, calibration, sensitivity analysis, parameter estimation, particle tracking, and post-audit analysis. Application of MODFLOW to regional flow-system analysis. Computer laboratory emphasizes assigned problems that illustrate topics discussed in the course. Offered even-numbered years. (Typically Offered: Spring)

GEOL 4150: Paleoclimatology

(Dual-listed with GEOL 5150/ ENSCI 5150). (Cross-listed with ENSCI 4150).

Credits: 3. Contact Hours: Lecture 3.

Introduction to mechanisms that drive climate, including the interplay between oceanic and atmospheric circulation and fluctuation in Earth's orbital parameters. Examination and analysis of past climate records ranging from historical documentation to ecological and geochemical proxies (e.g. tree ring analysis; O and C isotopes of skeletal carbonates and soils). Dating methods used to constrain and correlate climatic periods; utility of computer models to reconstruct past climates and predict future climate change. Emphasis placed on paleoclimatology and paleoecology of the late Quaternary (last ~1 million years). Offered even-numbered years. (Typically Offered: Fall)

GEOL 4160: Hydrologic Modeling and Analysis

(Dual-listed with GEOL 5160/ ENSCI 5160/ MTEOR 5160). (Cross-listed with ENSCI 4160/ MTEOR 4160).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Study of the basic principles of hydrologic modeling, including rainfall-runoff analysis, lumped and distributed modeling, conceptual and physical models, parameter estimation and sensitivity analysis, input and validation data, uncertainty analysis, and the use of models in surface water hydrology. A range of common models are applied to study hydrologic topics such as flood forecasting and land use change impacts. Previous experience with Matlab or other programming language is needed. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 4190: Aqueous and Environmental Geochemistry

(Dual-listed with GEOL 5190/ ENSCI 5190). (Cross-listed with ENSCI 4190).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Prereq: CHEM 1780, CHEM 1780L and *Junior classification*

Geochemistry of natural waters and water-rock interactions. Acid-base equilibria, carbonate chemistry and buffer systems, mineral dissolution and precipitation, sorption, ion exchange, and redox reactions. Introduction to thermodynamics and kinetics. Laboratory emphasizes chemical analysis of waters and computer modeling. Offered even-numbered years. (Typically Offered: Spring)

GEOL 4200: Mineral Resources

(Dual-listed with GEOL 5200).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Prereq: GEOL 3650

Geology and geochemistry of non-metallic and metallic ore deposits. Major processes that concentrate metals in the Earth. Geochemical conditions of ore formation using stable-isotope and fluid-inclusion studies. Laboratory emphasizes the study of metallic ores. Offered even-numbered years. (Typically Offered: Fall)

GEOL 4260: Stable Isotopes in the Environment

(Dual-listed with GEOL 5260/ ENSCI 5260). (Cross-listed with ENSCI 4260).

Credits: 3. Contact Hours: Lecture 3.

Introduction to the theory, methods and applications of stable isotopes. Primary focus on the origin, natural abundance, and fractionation of carbon, hydrogen, oxygen, nitrogen isotopes. Applications of isotopic occurrence for elucidation of physical, chemical, biological, and environmental processes. Effects of plant physiology, photosynthesis, trophic structure, diffusion, evaporation, chemical precipitation, soil and atmospheric processes, and environmental factors on isotope abundance. Offered odd-numbered years. (Typically Offered: Fall)

GEOL 4390: Seismic Methods in Geology, Engineering, and Petroleum Exploration

(Cross-listed with CE 4390).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Physics of elastic-wave propagation. Seismic surveys in environmental imaging, engineering, and petroleum exploration. Reflection and refraction techniques. Data collection, processing, and geological interpretation. Field work with state-of-the-art equipment. Introductory geology, algebra, and trigonometry recommended. Offered even-numbered years. (Typically Offered: Spring)

GEOL 4440: Petroleum Geoscience and Engineering

(Dual-listed with GEOL 5440).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

The geoscience and engineering aspects of exploration, development, and production of hydrocarbon resources around the world, as well as the historical and legal frameworks through which the industry has developed. Broader discussions of safety, risk, uncertainty, cost, and integrity as relevant to the petroleum industry. Offered even-numbered years. (Typically Offered: Spring)

GEOL 4520: Intro GIS for Geoscientists

(Dual-listed with GEOL 5520/ AGRON 5520/ ENSCI 5520). (Cross-listed with AGRON 4520/ ENSCI 4520).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Introduction to geographic information systems (GIS) using ArcGIS Pro with particular emphasis on geoscientific data. Teaches typical GIS operations and analyses in the geosciences to prepare students for practical use of GIS in industry and academia. Includes a class project for GEOL 5520. Sophomore classification or above recommended. (Typically Offered: Fall, Spring)

GEOL 4680: Applied Geostatistics for Geoscientists

(Dual-listed with GEOL 5680/ ENSCI 5680/ MTEOR 5680). (Cross-listed with ENSCI 4680/ MTEOR 4680).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Prereq: GEOL 4520; CRP 3510; CRP 4520; (NREM 3450 or NREM 4470)

Introduction to geospatial data collection, analysis, interpretation, and presentation. Geospatial techniques including geographic information systems (GIS), remote sensing (RS), and global positioning systems (GPS). Study of applied geostatistical analysis (e.g., interpolation and spatial regression). Offered even-numbered years. (Typically Offered: Fall)

GEOL 4740: Glacial and Quaternary Geology

(Dual-listed with GEOL 5740).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Prereq: GEOL 1000 or GEOL 2010

The study of glaciers, the landscapes and sediments they create, and their behavior during the Quaternary Period. Discussion of the flow of glaciers, glacial erosion and sediment transport, glacial landforms, Quaternary glacier/climate interactions, and the landscapes of Iowa. Laboratory emphasizes topographic map interpretation and local field trips. An introductory course in geology is recommended as background. Offered even-numbered years. (Typically Offered: Spring)

GEOL 4790: Surficial Processes

(Dual-listed with GEOL 5790/ ENSCI 5790). (Cross-listed with ENSCI 4790).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

The study of physical processes that shape Earth's surface. Topics include weathering, sediment transport, and landform genesis with emphasis on fluvial, glacial, hillslope, eolian, and coastal processes. Applications to engineering and environmental problems. Laboratory includes topographic map interpretation and local field trips. An introductory course in geology is recommended as background. (Typically Offered: Fall)

GEOL 4830: Environmental Biogeochemistry

(Dual-listed with ENSCI 5830). (Cross-listed with BIOL 4830/ ENSCI 4830).

Credits: 3. Contact Hours: Lecture 3.

Prereq: Combined 12 credits in biology, chemistry, and physics

An exploration of biological, physical and geochemical impacts on the structure and function of ecosystems from local to global scales. Emphasis on the cycles of carbon, nitrogen, phosphorus, sulfur, and metals, and how these have been impacted by human activity. Topics may include biological feedbacks to climate change, microbial physiology and redox reactions, plant/soil feedbacks, terrestrial/aquatic linkages, early Earth processes and the origins of life. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 4870: Microbial Ecology

(Cross-listed with ENSCI 4870/ BIOL 4870/ MICRO 4870).

Credits: 3. Contact Hours: Lecture 3.

Prereq: 6 credits in Biology and 6 credits in Chemistry

Introduction to major functional groups of autotrophic and heterotrophic microorganisms and their roles in natural and environmental systems. Consequences of microbial activity on water chemistry, weathering, and precipitation/dissolution reactions will be emphasized. (Typically Offered: Fall)

GEOL 4880: Raster GIS for Geoscientists

(Dual-listed with GEOL 5880/ AGRON 5880/ ENSCI 5880). (Cross-listed with AGRON 4880/ ENSCI 4880).

Credits: 3.

GIS course with focus on the spatial analysis and modeling of raster and triangulated irregular network (TIN) data using ArcGIS Pro. Includes practical exercises during lectures, lab exercises, homework assignments, and (for GEOL 5880) a class project. Basic knowledge of ArcGIS Pro is a plus but not required. Course can be taken concurrently to any other Intro GIS course. Sophomore classification or above recommended. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 4890: Survey of Remote Sensing Technologies

(Cross-listed with EE 4890/ ENSCI 4890/ MTEOR 4890/ NREM 4890).

Credits: 3. Contact Hours: Lecture 3.

Electromagnetic-radiation principles, active and passive sensors, multispectral and hyperspectral sensors, imaging radar, SAR, thermal imaging, lidar. Examples of applications. Also offered online S. (Typically Offered: Fall)

GEOL 4890L: Satellite Remote Sensing Laboratory

(Cross-listed with EE 4890L/ MTEOR 4890L/ NREM 4890L).

Credits: 1. Contact Hours: Laboratory 3.

Prereq: Completion or concurrent enrollment in MTEOR/GEOL/ NREM/EE 4890/5890

Processing and analysis of satellite sensor data (optical and radar). Provides practical applications in an environmental context. (Typically Offered: Fall)

GEOL 4900: Independent Study

Credits: 1-3. Repeatable, maximum of 9 credits.

Prereq: 6 credits in geology; Permission of Instructor

Independent study for senior students. Graduation Restriction: No more than 9 credits of GEOL 4900 may be counted toward graduation.

GEOL 4950: Undergraduate Seminar

Credits: 1. Contact Hours: Lecture 1.

Prereq: Junior or Senior Classification

Weekly seminar on topics of current research interest. Requires written summaries of three presentations of choice. (Typically Offered: Fall, Spring)

GEOL 4980: Cooperative Education

Credits: Required.

Prereq: (GEOL 1000 or GEOL 2010); GEOL 1000L; GEOL 1020; GEOL 1020L; Permission of Department Cooperative Education Coordinator; Senior classification

Required of all cooperative education students. Students must register for this course prior to commencing each work period. (Typically Offered: Fall, Spring, Summer)

Courses primarily for graduate students, open to qualified undergraduates:

GEOL 5020: Watershed Hydrology

(Dual-listed with GEOL 4020/ ENSCI 4020/ MTEOR 4020/ NREM 4020).

(Cross-listed with ENSCI 5020/ MTEOR 5020/ NREM 5020).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Examination of watersheds as systems, emphasizing the surface components of the hydrologic cycle. Combines qualitative understanding of hydrological processes and uncertainty with quantitative representation. Laboratory emphasizes field investigation and measurement of watershed processes. (Typically Offered: Fall)

GEOL 5060: Geology Field Course

Credits: 1-2. Repeatable, maximum of 2 credits.

Weekly seminar introduces students to a selected geological region or theme that is visited on a required ten-day field excursion. Graduate students are expected to assist in field teaching and safety leadership. (Typically Offered: Fall, Spring)

GEOL 5070: Midwestern Geology Field Trip

Credits: 1. Contact Hours: Laboratory 1.

Repeatable, maximum of 1 credits.

On-site inspection of various ore deposits, mining operations, and terrains dominated by igneous or metamorphic rocks. Offered on a satisfactory-fail basis only. (Typically Offered: Fall)

GEOL 5090: Field Methods in Hydrogeology

(Dual-listed with GEOL 4090/ ENSCI 4090). (Cross-listed with ENSCI 5090).

Credits: 3. Contact Hours: Laboratory 4.

Introduction to field methods used in groundwater investigations. In-field implementation of pumping tests, slug tests, monitoring well installation and drilling techniques, geochemical and water quality sampling, seepage meters, minipiezometers, stream gaging, and electronic instrumentation for data collection. Field trips to investigate water resource, water quality, and remediation projects. Offered even-numbered years. (Typically Offered: Summer)

GEOL 5110: Hydrogeology

(Dual-listed with GEOL 4110/ ENSCI 4110). (Cross-listed with ENSCI 5110).

Credits: 4. Contact Hours: Lecture 3, Laboratory 2.

Physical principles of groundwater flow, nature and origin of aquifers and confining units, well hydraulics, groundwater modeling, and contaminant transport. Lab emphasizes applied field and laboratory methods for hydrogeological investigations. (Typically Offered: Fall)

GEOL 5120: Micropaleontology

(Dual-listed with GEOL 4120). (Cross-listed with ENSCI 5120).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Evolution, identification and utility of major microfossil groups from the Mesozoic to present. Focus on Cenozoic applications including biostratigraphy, paleoclimate, and paleothermometry using assemblages, stable isotopes, Mg/Ca, and molecular fossils. Laboratory includes processing and analysis of specific microfossils. Major groups covered include foraminifera, calcareous nannofossils, sponge spicules, diatoms, radiolarians, and silicoflagellates. Offered even-numbered years. (Typically Offered: Fall). (Typically Offered: Fall)

GEOL 5130: Applied and Environmental Geophysics

(Cross-listed with CE 5130/ ENSCI 5130).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Seismic, gravity, magnetic, resistivity, electromagnetic, and ground-penetrating radar techniques for shallow subsurface investigations and imaging. Data interpretation methods. Lab emphasizes computer interpretation packages. Field work with seismic - and resistivity-imaging systems and radar. Introductory geology, algebra, and trigonometry recommended. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 5140: Applied Groundwater Flow Modeling

(Dual-listed with GEOL 4140/ ENSCI 4140). (Cross-listed with ENSCI 5140).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Introduction to the principles of modeling groundwater flow systems. Finite-difference and analytic-element methods, spreadsheet models, boundary conditions, calibration, sensitivity analysis, parameter estimation, particle tracking, and post-audit analysis. Application of MODFLOW to regional flow-system analysis. Computer laboratory emphasizes assigned problems that illustrate topics discussed in the course. Offered even-numbered years. (Typically Offered: Spring)

GEOL 5150: Paleoclimatology

(Dual-listed with GEOL 4150/ ENSCI 4150). (Cross-listed with ENSCI 5150).

Credits: 3. Contact Hours: Lecture 3.

Introduction to mechanisms that drive climate, including the interplay between oceanic and atmospheric circulation and fluctuation in Earth's orbital parameters. Examination and analysis of past climate records ranging from historical documentation to ecological and geochemical proxies (e.g. tree ring analysis; O and C isotopes of skeletal carbonates and soils). Dating methods used to constrain and correlate climatic periods; utility of computer models to reconstruct past climates and predict future climate change. Emphasis placed on paleoclimatology and paleoecology of the late Quaternary (last ~1 million years). Offered even-numbered years. (Typically Offered: Fall)

GEOL 5160: Hydrologic Modeling and Analysis

(Dual-listed with GEOL 4160/ ENSCI 4160/ MTEOR 4160). (Cross-listed with ENSCI 5160/ MTEOR 5160).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Study of the basic principles of hydrologic modeling, including rainfall-runoff analysis, lumped and distributed modeling, conceptual and physical models, parameter estimation and sensitivity analysis, input and validation data, uncertainty analysis, and the use of models in surface water hydrology. A range of common models are applied to study hydrologic topics such as flood forecasting and land use change impacts. Previous experience with Matlab or other programming language is needed. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 5190: Aqueous and Environmental Geochemistry

(Dual-listed with GEOL 4190/ ENSCI 4190). (Cross-listed with ENSCI 5190).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Geochemistry of natural waters and water-rock interactions. Acid-base equilibria, carbonate chemistry and buffer systems, mineral dissolution and precipitation, sorption, ion exchange, and redox reactions. Introduction to thermodynamics and kinetics. Laboratory emphasizes chemical analysis of waters and computer modeling. Offered even-numbered years. (Typically Offered: Spring)

GEOL 5200: Mineral Resources

(Dual-listed with GEOL 4200).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

Geology and geochemistry of non-metallic and metallic ore deposits. Major processes that concentrate metals in the Earth. Geochemical conditions of ore formation using stable-isotope and fluid-inclusion studies. Laboratory emphasizes the study of metallic ores. Offered even-numbered years. (Typically Offered: Fall)

GEOL 5260: Stable Isotopes in the Environment

(Dual-listed with GEOL 4260/ ENSCI 4260). (Cross-listed with ENSCI 5260).

Credits: 3. Contact Hours: Lecture 3.

Introduction to the theory, methods and applications of stable isotopes. Primary focus on the origin, natural abundance, and fractionation of carbon, hydrogen, oxygen, nitrogen isotopes. Applications of isotopic occurrence for elucidation of physical, chemical, biological, and environmental processes. Effects of plant physiology, photosynthesis, trophic structure, diffusion, evaporation, chemical precipitation, soil and atmospheric processes, and environmental factors on isotope abundance. Offered odd-numbered years. (Typically Offered: Fall)

GEOL 5390: Seismic Methods in Geology, Engineering, and Petroleum Exploration

(Cross-listed with CE 5390).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Physics of elastic-wave propagation. Seismic surveys in environmental imaging, engineering, and petroleum exploration. Reflection and refraction techniques. Data collection, processing, and geological interpretation. Field work with state-of-the-art equipment. Introductory geology, algebra, and trigonometry recommended. Offered even-numbered years. (Typically Offered: Spring)

GEOL 5440: Petroleum Geoscience and Engineering

(Dual-listed with GEOL 4440).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

The geoscience and engineering aspects of exploration, development, and production of hydrocarbon resources around the world, as well as the historical and legal frameworks through which the industry has developed. Broader discussions of safety, risk, uncertainty, cost, and integrity as relevant to the petroleum industry. Offered even-numbered years. (Typically Offered: Spring)

GEOL 5520: Intro GIS for Geoscientists

(Dual-listed with GEOL 4520/ AGRON 4520/ ENSCI 4520). (Cross-listed with AGRON 5520/ ENSCI 5520).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Introduction to geographic information systems (GIS) using ArcGIS Pro with particular emphasis on geoscientific data. Teaches typical GIS operations and analyses in the geosciences to prepare students for practical use of GIS in industry and academia. Includes a class project for GEOL 5520. Sophomore classification or above recommended. (Typically Offered: Fall, Spring)

GEOL 5590: Quantitative Methods in Geology

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Analysis of geologic data on applied and quantitative basis using MATLAB. Introduction to basic programming with special focus to applied geoscience problems such as stress and strain analysis, particle tracking for fracture propagation and strain field visualization, basic tectonic modeling, red noise filtering. Toolkit development for effective handling of large data sets and picture analysis. Offered even-numbered years. (Typically Offered: Fall)

GEOL 5680: Applied Geostatistics for Geoscientists

(Dual-listed with GEOL 4680/ ENSCI 4680/ MTEOR 4680). (Cross-listed with ENSCI 5680/ MTEOR 5680).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

Introduction to geospatial data collection, analysis, interpretation, and presentation. Geospatial techniques including geographic information systems (GIS), remote sensing (RS), and global positioning systems (GPS). Study of applied geostatistical analysis (e.g., interpolation and spatial regression). Offered even-numbered years. (Typically Offered: Fall)

GEOL 5740: Glacial and Quaternary Geology

(Dual-listed with GEOL 4740).

Credits: 3. Contact Hours: Lecture 2, Laboratory 2.

The study of glaciers, the landscapes and sediments they create, and their behavior during the Quaternary Period. Discussion of the flow of glaciers, glacial erosion and sediment transport, glacial landforms, Quaternary glacier/climate interactions, and the landscapes of Iowa. Laboratory emphasizes topographic map interpretation and local field trips. An introductory course in geology and is recommended as background. Offered even-numbered years. (Typically Offered: Spring)

GEOL 5790: Surficial Processes

(Dual-listed with GEOL 4790/ ENSCI 4790). (Cross-listed with ENSCI 5790).

Credits: 3. Contact Hours: Lecture 2, Laboratory 3.

The study of physical processes that shape Earth's surface. Topics include weathering, sediment transport, and landform genesis with emphasis on fluvial, glacial, hillslope, eolian, and coastal processes. Applications to engineering and environmental problems. Laboratory includes topographic map interpretation and local field trips. An introductory course in geology is recommended as background. (Typically Offered: Fall)

GEOL 5870: Microbial Ecology

(Cross-listed with ENSCI 5870/ EEOB 5870/ MICRO 5870).

Credits: 3. Contact Hours: Lecture 3.

Introduction to major functional groups of autotrophic and heterotrophic microorganisms and their roles in natural and environmental systems. Consequences of microbial activity on water chemistry, weathering, and precipitation/dissolution reactions will be emphasized. (Typically Offered: Fall)

GEOL 5880: Raster GIS for Geoscientists

(Dual-listed with GEOL 4880/ AGRON 4880/ ENSCI 4880). (Cross-listed with AGRON 5880/ ENSCI 5880).

Credits: 3.

Qualified Undergrad Prereq: GEOL 4520; CRP 4510; CRP 4520; NREM 3450; NREM 4460; *AE 4080 or graduate standing*

GIS course with focus on the spatial analysis and modeling of raster and triangulated irregular network (TIN) data using ArcGIS Pro. Includes practical exercises during lectures, lab exercises, homework assignments, and (for GEOL 5880) a class project. Basic knowledge of ArcGIS Pro is a plus but not required. Course can be taken concurrently to any other Intro GIS course. Sophomore classification or above recommended. Offered odd-numbered years. (Typically Offered: Spring)

GEOL 5890: Survey of Remote Sensing Technologies

(Cross-listed with EE 5890/ ENSCI 5890/ MTEOR 5890/ NREM 5890).

Credits: 3. Contact Hours: Lecture 3.

Electromagnetic-radiation principles, active and passive sensors, multispectral and hyperspectral sensors, imaging radar, SAR, thermal imaging, lidar. Examples of applications. Also offered online S. (Typically Offered: Fall)

GEOL 5890L: Satellite Remote Sensing Laboratory

(Cross-listed with EE 5890L/ MTEOR 5890L/ NREM 5890L).

Credits: Required. Contact Hours: Laboratory 3.

Processing and analysis of satellite sensor data (optical and radar). Provides practical applications in an environmental context. (Typically Offered: Fall)

GEOL 5900A: Special Topics: Surficial Processes

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900B: Special Topics: Stratigraphy

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900C: Special Topics: Sedimentation

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900D: Special Topics: Paleontology

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900E: Special Topics: Petrology

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900F: Special Topics: Structural Geology

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900G: Special Topics: Geochemistry

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900H: Special Topics: Hydrogeology

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900I: Special Topics: Earth Science

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900J: Special Topics: Mineral Resources

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900K: Special Topics: Geophysics

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900L: Special Topics: Mineralogy

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900M: Special Topics: Tectonics

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900N: Special Topics: Paleocology and Paleoclimatology

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900O: Special Topics: Isotope Geochemistry

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900P: Special Topics: Computational Methods and GIS

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900R: Special Topics: Surface Hydrology

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5900S: Special Topics: Oceanography

Credits: 1-3. Repeatable.

Prereq: Instructor Permission for Course

GEOL 5950A: Graduate Seminar: Presentation Required

(Cross-listed with MTEOR 5950A).

Credits: 1. Contact Hours: Lecture 1.

Repeatable.

Weekly seminar on topics of current research interest. All students seeking a graduate degree must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only. (Typically Offered: Fall, Spring)

GEOL 5950B: Graduate Seminar: Attendance Only

(Cross-listed with MTEOR 5950B).

Credits: Required. Contact Hours: Lecture 1.

Repeatable.

Attendance only. Weekly seminar on topics of current research interest. All students seeking a graduate degree must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only. (Typically Offered: Fall, Spring)

GEOL 5990: Creative Component

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

Courses for graduate students:

GEOL 6100A: Advanced Seminar: Earth Materials

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100B: Advanced Seminar: Economic Geology

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100C: Advanced Seminar: Environmental Geochemistry

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100D: Advanced Seminar: Geophysics

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100E: Advanced Seminar: Geotectonics

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100F: Advanced Seminar: Hydrogeology

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100G: Advanced Seminar: Surficial Processes

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100H: Advanced Seminar: Sedimentation and Stratigraphy

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100I: Advanced Seminar: Paleocology and Paleoclimatology

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100J: Advanced Seminar: Isotope Geochemistry

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6100K: Advanced Seminar: Computational Methods and GIS

Credits: 1-3. Contact Hours: Lecture 3.

Repeatable.

(Typically Offered: Fall, Spring)

GEOL 6990A: Research: Surficial Processes

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990B: Research: Stratigraphy

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990C: Research: Sedimentation

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990D: Research: Paleontology

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990E: Research: Petrology

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990F: Research: Structural Geology

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990G: Research: Geochemistry

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990H: Research: Hydrogeology

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990I: Research: Earth Science

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990J: Research: Mineral Resources

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990K: Research: Geophysics

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990L: Research: Mineralogy

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990M: Research: Tectonics

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990N: Research: Paleocology and Paleoclimatology

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990O: Research: Isotope Geochemistry

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990P: Research: Computational Methods and GIS

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990R: Research: Surface Hydrology

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course

GEOL 6990S: Research: Geoscience Education

Credits: 1-30. Repeatable.

Prereq: Instructor Permission for Course