## GEOLOGY (GEOL)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 11040</td>
<td>HOW THE EARTH WORKS (KBS)</td>
<td>3</td>
<td>Explores processes that shape Earth's landscapes (e.g., volcanism, flooding, landslides, sea-level rise, mountain building) and that are of vital interest to humans (e.g., earthquakes, groundwater, energy and mineral resources, climate change).</td>
</tr>
<tr>
<td>GEOL 11041</td>
<td>HOW THE EARTH WORKS LABORATORY (KBS) (KLAB)</td>
<td>1</td>
<td>Students study earth materials (e.g., mineral crystals, common and unusual rock specimens) and Google Earth images. Students conduct experiments demonstrating processes at earth's surface such as groundwater pollution, flooding and earthquakes.</td>
</tr>
<tr>
<td>GEOL 11042</td>
<td>EARTH AND LIFE THROUGH TIME (KBS)</td>
<td>3</td>
<td>Explores major events in the history of Earth, including mass extinctions, Snowball Earth hypothesis, birth and death of oceans, growth of continents, explosion of life, dinosaurs and the inter-relatedness of earth and life processes.</td>
</tr>
<tr>
<td>GEOL 11043</td>
<td>EARTH AND LIFE THROUGH TIME LABORATORY (KBS) (KLAB)</td>
<td>1</td>
<td>Student conduct lab experiments with fossils, rocks and sedimentary features, a river process simulator and the concept of deep time.</td>
</tr>
<tr>
<td>GEOL 21062</td>
<td>ENVIRONMENTAL EARTH SCIENCE (KBS)</td>
<td>3</td>
<td>Application of Earth science to environmental problems, including natural resource extraction, water supply, pollution, waste disposal, landslides, floods and land use planning. Students take local field trips.</td>
</tr>
<tr>
<td>GEOL 21080</td>
<td>ALL ABOUT THE OCEANS (KBS)</td>
<td>3</td>
<td>Explores the many fascinating (and some still little known) features and processes of the Earth's oceans, including mid-ocean ridges, hydrothermal vents, tsunamis, tides, rogue waves, marine life and the role of the ocean in climate change.</td>
</tr>
<tr>
<td>GEOL 22000</td>
<td>DEGREE AND CAREER PATHS IN GEOLOGY (ELR)</td>
<td>1</td>
<td>Provides students with an overview of career paths and opportunities in the Geology and Earth Science majors. Components of the course include a journal club, informational presentations by geoscientists in industry, government and academia; and skills training needed for the majors. Required overnight field trip.</td>
</tr>
<tr>
<td>GEOL 23063</td>
<td>EARTH MATERIALS I</td>
<td>4</td>
<td>Occurrence, associations, characteristics, crystallography and crystal chemistry of common minerals. Laboratory identification emphasizing physical properties. Required field trip.</td>
</tr>
<tr>
<td>GEOL 31070</td>
<td>EARTH MATERIALS II (WIC)</td>
<td>4</td>
<td>Occurrence, associations, characteristics, crystallography and crystal chemistry of common minerals. Laboratory identification emphasizing physical properties. Required field trip.</td>
</tr>
<tr>
<td>GEOL 31080</td>
<td>STRUCTURAL GEOLOGY</td>
<td>4</td>
<td>Mechanical principles of rock deformation. Structures in sedimentary igneous and metamorphic rocks. Lecture three hours lab two hours weekly. Required field trip.</td>
</tr>
<tr>
<td>GEOL 32066</td>
<td>GEOMORPHOLOGY</td>
<td>4</td>
<td>Earth's surface features as functions of geological structures, processes and time. Landform analysis using topographic maps and some stereographic aerial photos. Trigonometry recommended.</td>
</tr>
</tbody>
</table>
GEOL 33025  WATER AND THE ENVIRONMENT  3 Credit Hours
How water moves on the surface and in the subsurface, with an emphasis on societal issues such as pollution, the conservation and management of water resources, and the impacts of environmental change.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 34061  INVERTEBRATE PALEONTOLOGY  4 Credit Hours
Prerequisite: GEOL 11042 and GEOL 11043.
Corequisite: BSCI 10002 or BSCI 10110.
Schedule Type: Combined Lecture and Lab
Contact Hours: 5 other
Grade Mode: Standard Letter

GEOL 40093  VARIABLE TITLE WORKSHOP IN GEOLOGY  1-8 Credit Hours
(Repeatable for credit)(Slashed with GEOL 50093 and GEOL 70093) Workshop and/or training program focused on a specific professional or disciplinary topic.
Prerequisite: Special approval.
Schedule Type: Workshop
Contact Hours: 1-8 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 40095  SELECTED TOPICS IN GEOLOGY  1-3 Credit Hours
(Repeatable for credit)(Slashed with GEOL 50095)(Slashed with GEOL 50097) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: 20 credit hours of GEOL courses.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

GEOL 40096  INDIVIDUAL INVESTIGATION IN GEOLOGY  1-3 Credit Hours
(Repeatable for credit) Directed field, laboratory and/or library research. Written report required. Maximum 3 credit hours applied toward bachelor’s degree.
Prerequisite: Special approval.
Schedule Type: Individual Investigation
Contact Hours: 1-3 other
Grade Mode: Standard Letter-IP

GEOL 41025  GENERAL GEOPHYSICS  3 Credit Hours
(Slashed with GEOL 51025) Physics of Earth, seismology, geomagnetism, heat flow, radioactivity, geochronology, geotectonic models. Required field trip.
Prerequisite: GEOL 31070 and GEOL 31080 and MATH 12002; and PHY 13001 or PHY 23101.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41073  GEOLOGY OF OHIO  3 Credit Hours
(Slashed with GEOL 51073) Minerals, rocks, fossils, structural geology, physiography, environmental geology and geologic resources. Required field trips. Does not count toward the Geology major.
Prerequisite: Junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41077  GEOLOGY OF THE NATIONAL PARKS  3 Credit Hours
(Slashed with GEOL 51077) Introduction to the geology of selected major national parks, emphasizing basic geological principles and the processes that have produced the spectacular scenery, rocks and fossils in each park. Does not count toward the Geology major.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41079  ALL ABOUT DINOSAURS  3 Credit Hours
(Slashed with GEOL 51079) Dinosaurs (and some relatives) and their world, emphasizing how to interpret evidence concerning their history, biology and evolutionary relationships. Does not count toward the Geology major.
Prerequisite: None.

GEOL 41080  TECTONICS AND OROGENY  3 Credit Hours
(Slashed with GEOL 51080) Introduces advanced concepts of plate tectonics and mountain building, with emphasis on Western United States and the Appalachians. Required field trip to New England.
Prerequisite: GEOL 31080.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41082  ADVANCED STRUCTURAL GEOLOGY  3 Credit Hours
(Slashed with GEOL 51082) Theoretical and applied studies in structural geology, including mechanical, mathematical, model and field investigations. Required field trip.
Prerequisite: GEOL 31080.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 41084  SPECIAL TOPICS IN MINERALOGY  1-2 Credit Hours
(Slashed with GEOL 51084 and GEOL 71084) Advanced topics in mineralogy, as determined by the faculty. Required field trip.
Prerequisite: GEOL 31070.
Schedule Type: Lecture
Contact Hours: 1-2 other
Grade Mode: Standard Letter

GEOL 41092  SUMMER FIELD CAMP (ELR)  6 Credit Hours
(Repeatable for credit)(Slashed with GEOL 51092) Five weeks devoted to geologic mapping and solving structural and stratigraphic problems in the Black Hills of South Dakota.
Prerequisite: GEOL 31070 and GEOL 31080.
Schedule Type: Practicum or Internship
Contact Hours: 42 other
Grade Mode: Standard Letter
Attributes: Experiential Learning Requirement

GEOL 42030  REMOTE SENSING  3 Credit Hours
(Cross-listed with GEOG 49230)(Slashed with GEOL 52030, GEOL 72030, GEOG 59230, GEOG 79230) Computer analysis of multispectral satellite datasets. Applications in terrestrial Earth science are emphasized.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
GEOL 42035  SCIENTIFIC METHODS IN GEOLOGY  
3 Credit Hours  
(Slashed with GEOL 52035) Applying scientific methods to geologic data in the field and laboratory; models and sampling procedures. Collecting and analyzing data. Formulating and testing hypotheses. Provides background necessary for upper-division geology courses.  
Prerequisite: None.  
Schedule Type: Combined Lecture and Lab  
Contact Hours: 2 lecture, 2 lab  
Grade Mode: Standard Letter  

GEOL 42036  PHYSICAL HYDROGEOLOGY LABORATORY  
1 Credit Hour  
(Slashed with GEOL 52036) Laboratory course offering fundamental training for professional hydrogeologists. Required weekend field trip.  
Prerequisite: Junior standing.  
Corequisite: GEOL 42066.  
Schedule Type: Laboratory  
Contact Hours: 2 lab  
Grade Mode: Standard Letter  

GEOL 42065  WATERSHED HYDROLOGY  
3 Credit Hours  
(Slashed with GEOL 52065) Study of water movement, storage and transformation across landscapes.  
Prerequisite: Junior standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 42066  PHYSICAL HYDROGEOLOGY  
3 Credit Hours  
(Slashed with GEOL 52066) Principles of water flow in hydrologic cycle, soil and aquifer hydraulic properties, groundwater flow, surface water–groundwater interactions and geochemical evolution of groundwater. Application of principles for evaluation of water resources; emphasizing utilization, conservation and management of groundwater resources in a changing environment.  
Prerequisite: MATH 12002 or higher MATH course; and junior standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 42074  ENVIRONMENTAL CORE AND WELL LOGGING  
3 Credit Hours  
(Slashed with GEOL 52074) Examination of subsurface processes and the distribution of stratigraphic layers using core and well-logging techniques and based on analysis of physical properties of sediments, rocks and pore fluids. Applications to paleoclimate, hydrogeology, engineering geology, oil and gas exploration and environmental remediation.  
Prerequisite: GEOL 31070.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 42069  HYDROGEOCHEMISTRY  
3 Credit Hours  
(Slashed with GEOL 52069 and GEOL 72069) Processes and evolution of the chemical composition of water in the natural hydrologic cycle. Methods of hydrochemical interpretation applied to ground water and pollution problems.  
Prerequisite: 10 credit hours of CHEM courses.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 42078  ENGINEERING GEOLOGY  
4 Credit Hours  
(Slashed with GEOL 52078) Engineering properties of soils and rocks. Site evaluation for building foundations, dams, tunnels and highways. Slope stability.  
Prerequisite: Geology or Earth Science major; and junior standing.  
Schedule Type: Combined Lecture and Lab  
Contact Hours: 4 other  
Grade Mode: Standard Letter  

GEOL 43040  PRINCIPLES OF GEOCHEMISTRY  
3 Credit Hours  
(Slashed with GEOL 53040) Introduction to chemical thermodynamics and its applications in solving geochemical problems. Distributions of elements and isotopes in the Earth and laws governing these distributions.  
Prerequisite: CHEM 10060 and CHEM 10061 and GEOL 31070 and MATH 12002.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 43042  ENVIRONMENTAL GOCHEMISTRY  
3 Credit Hours  
(Slashed with GEOL 53042 and GEOL 73042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem-solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.  
Prerequisite: CHEM 10060 and CHEM 10061.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

CHEM 10060 and CHEM 10061 and CHEM 10062 and GEOL 42067.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

CHEM 10060 and CHEM 10061 and GEOL 31070.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

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Grade Mode: Standard Letter  

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Grade Mode: Standard Letter  

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Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

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Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter
GEOL 43043 ENVIRONMENTAL MINERALOGY  3 Credit Hours
(Slashed with GEOL 53043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and the potential role of remediation.
Prerequisite: GEOL 23063; and junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 43044 ENVIRONMENTAL ISOTOPES  3 Credit Hours
(Slashed with GEOL 53044 and GEOL 73044) Deals with the fundamentals of isotope geochemistry and the application of primarily light stable isotopes (H, O, C, N) to Earth system processes (involving the hydrosphere, biosphere and upper geosphere).
Prerequisite: CHEM 10060 and CHEM 10061.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 44025 GEOLOGIC HAZARDS AND DISASTERS  3 Credit Hours
(Slashed with GEOL 44025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geological risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks; and the communication of accurate, relevant, actionable information about these risks to the public and authorities.
Prerequisite: Junior standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 44052 GLACIERS AND GLACIATION  3 Credit Hours
(Cross-listed with GEOG 41052) (Slashed with GEOL 54052, GEOL 74052, GEOG 51052, GEOG 71052) Examination of how glacial ice masses change the shape of the earth’s surface, how they are integral to climate and sea level change, and how they pose high risk hazards.
Prerequisite: GEOG 21062 or GEOL 11040.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 44070 SEDIMENTOLOGY AND STRATIGRAPHY  4 Credit Hours
(Slashed with GEOL 54070) Students are introduced to the principles regarding the systematics of sedimentary rocks and the relationships between geologic formations at various spatial and temporal scales. Lectures are integrated with readings from the open literature and required labs and field trips.
Prerequisite: GEOL 31070.
Schedule Type: Combined Lecture and Lab
Contact Hours: 3 lecture, 2 lab
Grade Mode: Standard Letter

GEOL 44074 PALEOCEANOGRAPHY  3 Credit Hours
(Slashed with GEOL 54074) A broad spectrum of geological approaches. Paleontology, geochemistry and stratigraphy are employed to interpret the history of earth’s oceans.
Prerequisite: None.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 50093 VARIABLE TITLE WORKSHOP IN GEOLOGY  1-8 Credit Hours
(Repeatable for credit) (Slashed with GEOL 40093 and GEOL 70093) Workshop or training program focused on a specific professional or disciplinary topic within geology.
Prerequisite: Graduate standing; and special approval.
Schedule Type: Workshop
Contact Hours: 1-8 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 50095 SELECTED TOPICS IN GEOLOGY  1-3 Credit Hours
(Slashed with GEOL 50095) (Repeatable for credit) Selected topics presented by visiting professors or one-time offerings presented by regular faculty.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

GEOL 51025 GENERAL GEOPHYSICS  3 Credit Hours
(Slashed with GEOL 51025) Physics of Earth, seismology, geomagnetism, heat flow, radioactivity, geochronology, geotectonic models. Required field trip.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 51073 GEOLOGY OF OHIO  3 Credit Hours
(Slashed with GEOL 41073) Minerals, rocks, fossils, structural geology, physiography, environmental geology and geologic resources. Required field trips. Does not count toward the Geology major.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 51077 GEOLOGY OF THE NATIONAL PARKS  3 Credit Hours
(Slashed with GEOL 41077) Introduction to the geology of selected major national parks, emphasizing basic geological principles and the processes that have produced the spectacular scenery, rocks and fossils in each park. Does not count toward the Geology major.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 51079 ALL ABOUT DINOSAURS  3 Credit Hours
(Slashed with GEOL 41079) Dinosaurs (and some relatives) and their world, emphasizing how to interpret evidence concerning their history, biology and evolutionary relationships. Does not count toward the Geology major.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
GEOL 51080  TECTONICS AND OROGENY  3 Credit Hours
(Slashed with GEOL 41080) Introduces advanced concepts of plate tectonics and mountain building, with emphasis on Western United States and the Appalachians. Required field trip to New England.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 51082  ADVANCED STRUCTURAL GEOLOGY  3 Credit Hours
(Slashed with GEOL 41082) Theoretical and applied studies in structural geology, including mechanical, mathematical, model and field investigations. Required field trip.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 51092  SUMMER FIELD CAMP  6 Credit Hours
(Repeatable for credit)(Slashed with GEOL 41092) Five weeks devoted to geologic mapping and solving structural and stratigraphic problems in the Black Hills of South Dakota.
Prerequisite: Graduate standing.
Schedule Type: Practicum or Internship
Contact Hours: 42 other
Grade Mode: Standard Letter-IP

GEOL 52030  REMOTE SENSING  3 Credit Hours
(Cross-listed with GEOG 51052)(Slashed with GEOL 42030, GEOL 72030, GEOG 41052, GEOG 71052) Computer analysis of multispectral satellite datasets. Applications in terrestrial Earth science are emphasized.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52035  SCIENTIFIC METHODS IN GEOLOGY  3 Credit Hours
(Slashed with GEOL 42035) Applying scientific methods to geologic data in the field and laboratory; models and sampling procedures. Collecting and analyzing data. Formulating and testing hypotheses.
Prerequisite: Graduate standing.
Schedule Type: Combined Lecture and Lab
Contact Hours: 2 lecture, 2 lab
Grade Mode: Standard Letter

GEOL 52036  PHYSICAL HYDROGEOLOGY LAB  1 Credit Hour
(Slashed with GEOL 52036) Laboratory course offering fundamental training for professional hydrogeologists. Required weekend field trip.
Prerequisite: Graduate standing.
Corequisite: GEOL 52066.
Schedule Type: Laboratory
Contact Hours: 2 lab
Grade Mode: Standard Letter

GEOL 52065  WATERSHED HYDROLOGY  3 Credit Hours
(Slashed with GEOL 42065) Study of water movement, storage and transformation across landscapes.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52066  PHYSICAL HYDROGEOLOGY  3 Credit Hours
(Slashed with GEOL 42066) Principles of water flow in hydrologic cycle, soil and aquifer hydraulic properties, groundwater flow, surface water–groundwater interactions and geochemical evolution of groundwater. Application of principles for evaluation of water resources; emphasizing utilization, conservation and management of groundwater resources in a changing environment.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52067  INTRODUCTORY HYDROGEOLOGY  3 Credit Hours
(Slashed with GEOL 42067) Occurrence of ground water in geologic materials; emphasizing utilization, conservation and management of ground water resources.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52068  CONTAMINANT HYDROLOGY AND HYDROGEOLOGY  3 Credit Hours
(Cross-listed with GEOL 42068) An introduction to the basic principles of chemical and physical behavior of contaminants introduced by humans into the environment. Students are expected to understand concepts and work practical quantitative problems.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52069  HYDROGEOCHEMISTRY  3 Credit Hours
(Slashed with GEOL 42069 and GEOL 72069) Processes and evolution of the chemical composition of water in the natural hydrologic cycle. Methods of hydrochemical interpretation applied to ground water and pollution problems.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52074  ENVIRONMENTAL CORE AND WELL LOGGING  3 Credit Hours
(Slashed with GEOL 42074) Examination of subsurface processes and the distribution of stratigraphic layers using core and well-logging techniques and based on analysis of physical properties of sediment, rock and pore fluids. Applications to paleoclimate, hydrogeology, engineering geology, oil and gas exploration and environmental remediation.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 52078  ENGINEERING GEOLOGY  4 Credit Hours
(Slashed with GEOL 42078) Engineering properties of soils and rocks. Site evaluation for building foundations, dams, tunnels and highways. Slope stability.
Prerequisite: Graduate standing.
Schedule Type: Combined Lecture and Lab
Contact Hours: 4 other
Grade Mode: Standard Letter
GEOL 53040 PRINCIPLES OF GEOCHEMISTRY 3 Credit Hours  
(Slashed with GEOL 43040) Introduction to chemical thermodynamics and its applications in solving geochemical problems. Distributions of elements and isotopes in the Earth and laws governing these distributions.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 53042 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours  
(Slashed with GEOL 43042 and GEOL 73042) Explores chemical processes that influence the natural environment, including anthropogenic impacts. Topics include atmospheric chemistry and air pollution, energy and climate change, toxic organic compounds, water chemistry and water pollution, metals, soils, sediments and waste disposal. Environmental problem-solving using steady state and non-steady state box models, thermodynamics and energy transfer and chemical reactions and equilibria. Required half-day field trip.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 53043 ENVIRONMENTAL MINERALOGY 3 Credit Hours  
(Slashed with GEOL 43043) Explores reactions between minerals and aqueous solutions, focusing on their role in chemical weathering, contaminant mobility, microbe-mineral interactions and an understanding of mineral-water interface processes and mechanisms at the molecular level. Through a series of case studies, the course explores the societal impacts of environmental contaminants and the potential role of remediation.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 53044 ENVIRONMENTAL ISOTOPES 3 Credit Hours  
(Slashed with GEOL 43044 and GEOL 73044) Deals with the fundamentals of isotope geochemistry and the application of primarily light stable isotopes (H, O, C, N) to Earth system processes (involving the hydrosphere, biosphere and upper geosphere).  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 54025 GEOLOGIC HAZARDS AND DISASTERS 3 Credit Hours  
(Slashed with GEOL 44025) Explores the geological processes that drive a broad range of different natural hazards (including earthquakes, volcanoes, landslides and floods), and how they interact with human behavior to produce geological risks and disasters. Through discussion of historical and topical events, students focus on the dual challenges of combining uncertain and incomplete information from various geological and historical sources into realistic assessments of future risks; and the communication of accurate, relevant, actionable information about these risks to the public and authorities.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 54052 GLACIERS AND GLACIATION 3 Credit Hours  
(Cross-listed with GEOG 51052)(Slashed with GEOL 44052, GEOL 74052, GEOG 41052, GEOG 71052) Examination of how glacial ice masses change the shape of the earth’s surface, how they are integral to climate and sea level change and how they pose high risk hazards.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 54070 SEDIMENTOLOGY AND STRATIGRAPHY 4 Credit Hours  
(Cross-listed with GEOL 44070) Students are introduced to the principles regarding the systematics of sedimentary rocks and the relationships between geologic formations at various spatial and temporal scales. Lectures are integrated with readings from the open literature and required labs and field trips.  
Prerequisite: Graduate standing.  
Schedule Type: Combined Lecture and Lab  
Contact Hours: 3 lecture, 2 lab, 1 other  
Grade Mode: Standard Letter  

GEOL 54074 PALEOCEANOGRAPHY 3 Credit Hours  
(Cross-listed with GEOL 44074) A broad spectrum of geological approaches. Paleontology, geochemistry and stratigraphy are employed to interpret the history of earth’s oceans.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 60080 RESEARCH ORIENTATION 1 Credit Hour  
(Slashed with GEOL 70080) Faculty research presentations; thesis/dissertation proposal preparation; discussion of professional organizations, preparation of manuscripts and oral presentation of papers.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 1 lecture  
Grade Mode: Satisfactory/Unsatisfactory  

GEOL 60084 GEOLOGY GRADUATE STUDENT ORIENTATION 1 Credit Hour  
(Slashed with GEOL 70084) Introduction to departmental resources, procedures and expectations, as well as approaches to successfully conduct research at a graduate level. Training and experience in presentation of data and college teaching of applied geology, as well as a discussion forum on professional ethics and responsibilities.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 1 lecture  
Grade Mode: Satisfactory/Unsatisfactory  

GEOL 60091 SEMINAR 1-2 Credit Hours  
(Repeatable for credit)(Slashed with GEOL 70091) Topics in geology varies per course offering.  
Prerequisite: Graduate standing.  
Schedule Type: Seminar  
Contact Hours: 1-2 other  
Grade Mode: Standard Letter
GEOL 60095  SELECTED TOPICS IN GEOLOGY  1-3 Credit Hours  
(Repeatable for credit)Selected topics presented by visiting professors or one-time offerings presented by regular faculty.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 1-3 lecture  
Grade Mode: Standard Letter  

GEOL 60098  RESEARCH  1-15 Credit Hours  
(Repeatable for credit)Research for master's level students. Credits earned may be applied toward degree if department approves.  
Prerequisite: Graduate standing.  
Schedule Type: Research  
Contact Hours: 1-15 other  
Grade Mode: Satisfactory/Unsatisfactory-IP  

GEOL 60199  THESIS I  2-6 Credit Hours  
Thesis students must register for a total of 6 hours, 2 to 6 hours in a single semester distributed over several semesters if desired.  
Prerequisite: Graduate standing.  
Schedule Type: Masters Thesis  
Contact Hours: 2-6 other  
Grade Mode: Satisfactory/Unsatisfactory-IP  

GEOL 60299  THESIS II  2 Credit Hours  
Thesis students must continue registration each semester until all degree requirements are met.  
Prerequisite: GEOL 60199; and graduate standing.  
Schedule Type: Masters Thesis  
Contact Hours: 2 other  
Grade Mode: Satisfactory/Unsatisfactory-IP  

GEOL 62011  HYDROLOGY  3 Credit Hours  
(Slashed with GEOL 72011) Introduction to hydrologic measurements, properties of water precipitation, evapotranspiration runoff computations, streamflow and flood routing.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 62068  ADVANCED HYDROGEOLOGY  3 Credit Hours  
(Slashed with GEOL 72068) Quantitative approach to occurrence of ground water; methods of investigation, evaluation and development of ground water resources emphasizing optimization and maximal exploitation without environmental changes.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 62079  ADVANCED ENGINEERING GEOLOGY  3 Credit Hours  
(Slashed with GEOL 72079) Role of geology in site selection, design and construction relative to dams, tunnels, highways, slope stability and nuclear power plants. Selected case histories. Field trip and term paper required.  
Prerequisite: GEOL 52078; and graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 62082  INTRODUCTION TO SOIL MECHANICS  4 Credit Hours  
(Slashed with GEOL 72082) Engineering properties and engineering behavior of soils, including classification properties, compaction permeability strength and compressibility.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 5 other  
Grade Mode: Standard Letter  

GEOL 62083  ROCK SLOPE STABILITY  3 Credit Hours  
(Slashed with GEOL 72083) Provide information used to recognize, avoid, design for, control and correct slope movements in rocks; determination of shear strength along rock discontinuities; stability analysis of rock slopes.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 62084  FOUNDATION ENGINEERING  3 Credit Hours  
Prerequisite: GEOL 52078 or GEOL 72082; and graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 63063  SEDIMENTARY PETROLOGY  3 Credit Hours  
(Slashed with GEOL 73063) Classification, texture, composition, provenance and diagenesis of sandstones and carbonates, following review of optical mineralogy. Petrographic microscopy and other laboratory techniques are emphasized.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 64028  PALEOECOLOGY  3 Credit Hours  
(Slashed with GEOL 74028) Relationships between ancient organisms and their environments, as interpreted from fossils, enclosing rock strata and recent analogs. Field and laboratory studies. Saturday field trips.  
Prerequisite: Graduate standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter
GEOL 64030  SYSTEMATIC INVERTEBRATE PALEONTOLOGY I  3 Credit Hours
(Slashed with GEOL 74030) Detailed investigation and examination of important literature concerning taxonomic characters of invertebrate phyla: Protista, Porifera, Cnidaria and Bryozoa. Numerous oral reports, specimen examination.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 64032  SYSTEMATIC INVERTEBRATE PALEONTOLOGY II  3 Credit Hours
(Slashed with GEOL 74032) Detailed investigation and examination of important literature concerning taxonomic characters of invertebrate phyla: Brachiopoda, Mollusca, Arthropoda and Echinodermata. Numerous oral reports, specimen examination.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 64036  CENOZOIC CLIMATE CHANGE  3 Credit Hours
(Slashed with GEOL 74036) An overview of the concepts and principles involved in interpreting global and hemispheric Cenozoic climate change (past 65 million years). Emphasis on particular temporal and spatial scales and cycles. Extensive reading in scientific journals.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 64038  PALEOCLIMATOLOGY  3 Credit Hours
(Slashed with GEOL 74038) An overview of significant topics and applications in paleoecology of Holocene (last 10,000 years) and Pleistocene (last two million years) records, including current issues in environmental and climatic reconstitution. Extensive reading expected.
Prerequisite: Graduate standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 70091  SEMINAR  1-2 Credit Hours
(Repeatable for credit)(Slashed with GEOL 60091) Topics in geology varies per course offering.
Prerequisite: Doctoral standing.
Schedule Type: Seminar
Contact Hours: 1-2 other
Grade Mode: Standard Letter

GEOL 70093  VARIABLE TITLE WORKSHOP IN GEOLOGY  1-8 Credit Hours
(Repeatable for credit)(Slashed with GEOL 40093 and GEOL 50093) Workshop and/or training program, of varying duration focused on a specific professional or disciplinary topic.
Prerequisite: Doctoral standing; and special approval.
Schedule Type: Workshop
Contact Hours: 1-8 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 71093  WORKSHOP IN COLLEGE TEACHING  1-2 Credit Hours
(Repeatable for credit)(Slashed with GEOL 61093) Workshop in college teaching.
Prerequisite: Doctoral standing.
Schedule Type: Workshop
Contact Hours: 1-2 other
Grade Mode: Satisfactory/Unsatisfactory

GEOL 72011  HYDROLOGY  3 Credit Hours
(Slashed with GEOL 62011) Introduction to hydrologic measurements, properties of water precipitation, evapotranspiration, runoff computations, streamflow and flood routing.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72030  REMOTE SENSING  3 Credit Hours
(Cross-listed with GEOG 71052)(Slashed with GEOL 42030, GEOL 52030, GEOG 41052, GEOG 51052) Computer analysis of multispectral satellite datasets. Applications in terrestrial Earth science are emphasized.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72068  ADVANCED HYDROGEOLOGY  3 Credit Hours
(Slashed with GEOL 62068) Quantitative approach to occurrence of ground water;methods of investigation evaluation and development of ground water resources emphasizing optimization and maximal exploitation without environmental changes.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 72069  HYDROGEOCHEMISTRY  3 Credit Hours
(Slashed with GEOL 42069 and GEOL 52069) Processes and evolution of the chemical composition of water in the natural hydrologic cycle. Methods of hydrochemical interpretation applied to ground water and pollution problems.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter
GEOL 72079 ADVANCED ENGINEERING GEOLOGY 3 Credit Hours  
(Slashed with GEOL 62079) Role of geology in site selection, design and 
construction relative to dams, tunnels, highways, slope stability and 
nuclear power plants. Selected case histories. Field trip and term paper 
required.  
Prerequisite: GEOL 52078; and doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 72082 INTRODUCTION TO SOIL MECHANICS 3 Credit Hours  
(Slashed with GEOL 62082) Engineering properties and engineering 
behavior of soils, including classification properties, compaction 
permeability strength and compressibility.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 72083 ROCK SLOPE STABILITY 3 Credit Hours  
(Slashed with GEOL 62083) Provide information used to recognize, avoid, 
design for control and correct slope movements in rocks; determination 
of shear strength along rock discontinuities; stability analysis of rock 
slopes.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 72084 FOUNDATION ENGINEERING 3 Credit Hours  
(Slashed with GEOL 62084) Seepage and drainage of foundation soils. 
Subsurface investigations. Principles, design and construction of shallow 
and deep foundations. Earth retaining structures.  
Prerequisite: GEOL 52078 or GEOL 72082; and doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 72085 ENVIRONMENTAL GEOCHEMISTRY 3 Credit Hours  
(Slashed with GEOL 43042 and GEOL 53042) Explores chemical 
processes that influence the natural environment, including 
anthropogenic impacts. Topics include atmospheric chemistry and 
air pollution, energy and climate change, toxic organic compounds, 
water chemistry and water pollution, metals, soils, sediments and waste 
disposal. Environmental problem-solving using steady state and non-
steady state box models, thermodynamics and energy transfer and 
chemical reactions and equilibria. Required half-day field trip.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 72088 PALEOECOLOGY 3 Credit Hours  
(Slashed with GEOL 64030) Detailed investigation and examination of 
ancient environments, as interpreted from fossils, enclosing rock strata 
and recent analogs. Field and laboratory studies. Saturday field trips.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 72096 INTRODUCTION TO GEOLOGY 3 Credit Hours  
(Slashed with GEOL 62096) Role of geology in site selection, design and 
construction. Overview of geologic processes and structure and 
behavior of rocks and soils.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 73063 SEDIMENTARY PETROLOGY 3 Credit Hours  
(Slashed with GEOL 63063) Classification, texture, composition, 
provenance and diagenesis of sandstones and carbonates, following 
review of optical mineralogy. Petrographic microscopy and other 
laboratory techniques are emphasized.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 74028 PALAEOECOLOGY 3 Credit Hours  
(Slashed with GEOL 64028) Relationships between ancient organisms 
and their environments, as interpreted from fossils, enclosing rock strata 
and recent analogs. Field and laboratory studies. Saturday field trips.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 74030 SYSTEMATIC INVERTEBRATE PALEONTOLOGY I 3 Credit Hours  
(Slashed with GEOL 64030) Detailed investigation and examination of 
important literature concerning taxonomic characters of invertebrate 
phylla: Protista, Porifera, Cnidaria and Bryozoa. Numerous oral reports, 
specimen examination.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 74032 SYSTEMATIC INVERTEBRATE PALEONTOLOGY II 3 Credit Hours  
(Slashed with GEOL 64032) Detailed investigation and examination of 
important literature concerning taxonomic characters of invertebrate 
phylla: Brachiopoda, Mollusca, Arthropoda and Echinodermata. Numerous 
oral reports, specimen examination.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 74036 CENOZOIC CLIMATE CHANGE 3 Credit Hours  
(Slashed with GEOL 64036) An overview of the concepts and principles 
involved in interpreting global and hemispheric Cenozoic climate change 
(past 65 million years). Emphasis on particular temporal and spatial 
scales and cycles. Extensive reading in scientific journals.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter  

GEOL 74038 PALEOLIMNOLOGY 3 Credit Hours  
(Slashed with GEOL 64038) An overview of significant topics and 
applications in paleolimnology of Holocene (last 10,000 years) and 
Pleistocene (last two million years) records, including current issues in 
environmental and climatic reconstruction. Extensive reading expected.  
Prerequisite: Doctoral standing.  
Schedule Type: Lecture  
Contact Hours: 3 lecture  
Grade Mode: Standard Letter
GEOL 74052  GLACIERS AND GLACIATION    3 Credit Hours
(Cross-listed with GEOG 71052)(Slashed with GEOG 41052, GEOG 51052,
GEOL 44052, GEOL 55052) Examination of how glacial ice masses
change the shape of the earth’s surface, how they are integral to climate
and sea level change and how they pose high risk hazards.
Prerequisite: Doctoral standing.
Schedule Type: Lecture
Contact Hours: 3 lecture
Grade Mode: Standard Letter

GEOL 80095 ADVANCED TOPICS IN GEOLOGY  1-3 Credit Hours
(Repeatable for credit) Advanced topics presented by visiting professors
or one-time offerings presented by regular faculty.
Prerequisite: Doctoral standing; and special approval.
Schedule Type: Lecture
Contact Hours: 1-3 lecture
Grade Mode: Standard Letter

GEOL 80098 RESEARCH  1-15 Credit Hours
(Repeatable for credit) Research for doctoral students. Credits earned
may be applied toward degree with departmental approval.
Prerequisite: Doctoral standing.
Schedule Type: Research
Contact Hours: 1-15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

GEOL 80199 DISSERTATION I  15 Credit Hours
(Repeatable for credit)Doctoral dissertation, for which registration in at
least two semesters is required first of which will be semester in which
dissertation work is begun and continuing until the completion of 30
hours. rerequisite: Admission to candidacy for doctoral degree; and
doctoral standing.
Schedule Type: Dissertation
Contact Hours: 15 other
Grade Mode: Satisfactory/Unsatisfactory-IP

GEOL 80299 DISSERTATION II  15 Credit Hours
(Repeatable for credit)Continuing registration required of doctoral
students who have completed the initial 30 hours of dissertation,
continuing until all degree requirements are met.
Prerequisite: GEOL 80199; and doctoral standing.
Schedule Type: Dissertation
Contact Hours: 15 other
Grade Mode: Satisfactory/Unsatisfactory-IP