GEOG 476. Sustainable Cities Seminar. 3 credits
This seminar explores ways to make cities more environmentally, socially and economically sustainable. Students will study key urban sustainability principles, examine global case studies, undertake local fieldwork and pursue projects developing interventions in real-world city settings. The course emphasizes a geographical approach in addressing urban human and environmental challenges. Prerequisite: GEOG 290.

GEOG 485. Processing Remotely Sensed Data. 3 credits.
This course focuses on computer-based techniques for processing remotely sensed data and applications of these techniques. Subjects covered will include geometric and radiometric correction, image enhancement, data transformations, change detection and quantification, and classification. Both traditional techniques and techniques designed for newly available data types will be examined. Prerequisite: GEOG 385 or permission of the instructor.

GEOG 486. High Spatial Resolution Remotely Sensed Data. 3 credits.
This course focuses on the acquisition and use of high spatial resolution remotely sensed data. Topics include aerial photograph acquisition, digital terrain model creation, orthorectification, object oriented image processing, image fusion, visual image interpretation, collecting and processing LiDAR data, and ethical and legal issues associated with high spatial resolution data. Prerequisite: GEOG 385 or permission of the instructor.

GEOG 490. Senior Research or Field Practicum. 3 credits.
Working with a research advisor, student completes an internship, a study abroad program, or project research. Student delivers interim progress reports and an annotated bibliography or other relevant research products. May be repeated once. Prerequisites: GEOG 380 and permission of their research advisor.

GEOG 491. International Studies. 1-3 credits.
Student will make arrangements for the international experience. A research project or work-study project will be designed by the student and faculty member prior to departure. The research of work will be carried out in the country of travel. May not be taken for capstone credit. Project must be approved by GS faculty. May be repeated for credit.

GEOG 495. Internship in Geography. 3-6 credits.
Practical experience within a public agency, non-profit or private business utilizing geographic methodology. Work experience will be supervised by an official of the business or agency and a faculty member. Periodic seminars and written reports are required. Prerequisites: Permission of the faculty sponsor and the GS Program Operations Manager. May not be taken for capstone credit.

GEOG 497. Independent Study. 3 credits.
Student performs an independent research project, either alone or within an investigative team, to identify and analyze a problem from a geographic perspective. Prerequisite: Permission of the instructor. May not be taken for capstone credit.

GEOG 499 A, B, C. Honors. 1-3 credits.
Year course.

Geology

GEOL 102. Environment: Earth. 3 credits.
A study of geological processes causing global change and their impact on human thought. The relationship between some geological processes and life on the Earth is also considered. Not available for major or minor credit in geology. Students may not receive credit for both GEOL 102 and ISCI 102. Prerequisite: ISCI 101.

GEOL 110. Physical Geology. 3 credits.
A systematic study of earth materials and the internal and external processes that affect earth structure and landforms. Topics include the genesis/properties of rocks and minerals, plate tectonics, and the agents of change that drive surface processes and landform development. The laboratory and lecture portions of GEOL 110 must be taken concurrently. Corequisite: GEOL 110L.

GEOL 110L. Physical Geology Laboratory. 1 credit.
This laboratory course is designed to complement and supplement the GEOL 110 course. The laboratory and lecture portions must be taken concurrently. Corequisite: GEOL 110.

GEOL 115. Earth Systems and Climate Change. 3 credits.
This course explores cycles, trends and abrupt events in the Earth system. Analyses of the geologic record and global climate models provide perspective for understanding paleoclimate and future climate changes, including global warming. Current hypotheses for causes of climate change are evaluated, including plate tectonics, orbital cyclicity, variations in the sun's strength and human activities. The two recurring questions of this class are: What are Earth's climate stories? How do we know?

GEOL 130. Quantitative Geology. 2 credits.
An introduction to quantitative techniques used in descriptive and predictive aspects of the earth and environmental sciences, with emphasis on algorithmic approaches. The focus is on pragmatic application of mathematical methods to geologic problems, considering requirements, uses and limitations. Automatic computation is stressed.

GEOL 167. History and Philosophy of the Geosciences. 3 credits.
As an introductory experience in the Bachelor of Arts in Earth Science, students will be inculcated in the philosophy of geosciences as an interdisciplinary medium for extending classical science viewpoints to complex earth systems. Students will study the geosciences as distinct among sciences, establishing relevance and value of earth science literacy in professional and personal settings.

An investment of a theoretical principle behind evolutionary systems of all types based on mathematical modeling in chaos, complexity theory and artificial life studies with extensive computer experimentation and examples drawn from physical, chemical, biological, economic and social systems. The purpose is to explore what is common and universal to all evolutionary processes. May be used for general education credit.

GEOL 210. Applied Physical Geology. 3 credits.
A problem-based study of Earth materials and the processes that affect Earth structure and landforms. Topics include plate tectonics, the genesis/properties of rocks and minerals, and agents of change that drive surface processes and landform development. Quantitative problem-solving skills will be applied to case studies that address 3D visualization and time-based processes, such as Earth materials, solid earth and surface processes, natural hazards and engineering applications. May be used for general education credit. Prerequisite: Either PHYS 140 or PHYS 240 or CHEM 131 or by permission of the instructor. Corequisite: MATH 205 or MATH 220 or MATH 235 or by permission of the instructor.

GEOL 211. Introduction to Oceanography. 3 credits.
An introduction to the oceanography of coastal environs including barrier islands, estuaries and tidal marshes. The physical, geological and biochemical characteristics of coastal waters will be discussed in the context of the economic and social pressures brought to bear on these areas by an increasing global population. Cannot receive credit for both GEOL 211 and GEOL 401. May be used for general education credit.

GEOL 230. Evolution of Earth (3, 2). 4 credits.
An introduction to the evidence, methods and assumptions used by scientists to unravel the Earth's origin and history. Emphasis on rock analysis/interpretation, modern and ancient processes of mountain building, origin and evolution of life and the history of the North American continent. Prerequisite: GEOL 110L or permission of the instructor.

GEOL 272. Planetary Geology (2, 2). 3 credits.
A survey of currently developing ideas in planetology including origin of the planets, meteorites and planetary interiors. Also included are geologic processes and land forms on the moon and terrestrial planets, their modification under various planetary environments, and analogies to familiar earth land forms. Includes laboratory. Prerequisite: GEOL 110L.

GEOL 280. Mineralogy (3, 2). 4 credits.
A comprehensive study of minerals, including: crystallography, mineral chemistry, x-ray diffraction, mineral optics with thin section recognition using petrographic microscope, and hand specimen identification of both silicate and non-silicate minerals. Prerequisite: GEOL 110L.

GEOL 290. Optical Mineralogy (3, 2). 3 credits.
A study of the optical properties of minerals and mineral identification with the petrographic microscope. Prerequisite: GEOL 280.

GEOL 291. Writing and Communicating in the Geosciences. 1 credit.
This course prepares students for independent research by providing them the fundamental skills in literature searches, writing, critical reading and communication in the geosciences. Prerequisites: GEOL 110 or GEOL 102 or GEOL 115; must take prior to senior year.

GEOL 300. Introduction to Petrology (3, 3). 4 credits.
Igneous and metamorphic processes explained using crystallization theory, phase diagrams, thermodynamics and geochemistry; laboratory study of rocks, their chemical and mineralogical signatures, and their geologic origins. Prerequisites: GEOL 280 and CHEM 131, or permission of the instructor.
GEOL 301. Earth Sciences for Teachers. 4 credits.
Earth science content is blended with a systems approach to provide pre-service teachers with an understanding of how the Earth works, as well as strategies for teaching it. Major content themes include reconstructing the geologic history of the mid-Atlantic, exploring the interaction of living things and the environment, and predicting how matter and energy circulate in the earth system.

GEOL 302. Sedimentary Petrology. 1 credit.
This is a course about sedimentary rocks in hand sample and thin section. Mineral associations and the processes of sedimentation will be studied in a laboratory context.

GEOL 310 A-D. Environmental Impact. 2-3 credits, repeatable to 6 credits.
Focuses on a selected environmental realm. The course will examine the interface between human activities and environmental systems. It will address the impacts of social, economic and political activities on the environment. A-Atmosphere (air pollution); B-Biosphere (vegetation/wildlife); C-Hydrosphere (water); D-Lithosphere (geologic hazards/land issues).

GEOL 320. Meteorology. 3 credits.
A survey of the science of weather including weather forecasting, weather maps and related atmospheric processes. Emphasis is placed on the dynamic aspects of meteorology and the interrelationships of atmospheric phenomena with land masses and the world ocean.

The origin, distribution, and chemical, biological, and physical properties of soil are introduced. Processes responsible for soil properties are emphasized. Field trip highlight the stabilay of soils, their distribution across the Shenandoah Valley and their role in biogeochemical cycles. Prerequisite: GEOL 110 or GEOL 210 or permission of the instructor may be granted for students with 4 hours of a lab course.

GEOL/BIO 350. Paleobiology (3, 2). 4 credits.
A study of the origin and evolution of the vertebrates. Emphasis will be on understanding how the processes of earth evolution and biological evolution are linked. Topics include the fossil record, biostratigraphy, paleoecology, evolution and extinction. Lectures discuss methods used to interpret the fossil record and cover topics such as phylogeny and systematics, functional morphology, biostatigraphy, paleoecology, evolution and extinction. Laboratories focus on the major groups of invertebrates that are common in the geologic record. Prerequisite: GEOL 230 or BIO 114 or permission of the instructor.

GEOL/CHEM 355. Geochemistry of Natural Waters. 3 credits.
Study of chemical theory and reactions important in natural water systems. The role of atmospheric, geologic and biological inputs in determining the geochemistry of streams, rivers and oceans. Prerequisites: CHEM 131 and CHEM 132 or equivalent.

This course addresses the natural relationship between minerals and the rocks they make up. Using the concept of mineralizing environments, illustrated by classic examples, students will investigate minerals through the processes of mineral genesis and associated rock types. This approach provides insight and predictive value for natural conditions in which specific minerals and rocks occur. Not acceptable for B.S. in geology. Prerequisite: GEOL 110L.

GEOL 377. Earth Surface Processes (2, 2). 3 credits.
The interrelationships among climate, landscapes, soils and bedrock geology are examined using the mid-Atlantic region as a conceptual laboratory. Course instruction includes lecture, laboratory and field trip meetings. The processes of rock weathering and erosion and soil formation are reinvestigated. Topographic maps and aerial photography are examined for landforms and landscape evolution. Prerequisite: GEOL 110L, GEOL 210 or GEOG 210, or permission of the instructor.

GEOL 380. Genetic Mineralogy (2, 2). 3 credits.
A study of mineral genesis. Emphasis is directed toward mineralogical environments, mineral associations and the geometry/mineralogy of classical localities. An appreciation of mineral value and aesthetics is incorporated throughout the course.

GEOL 387. Stratigraphy, Structure, and Tectonics (3, 2). 4 credits.
Examination of how stratigraphic, structural, and tectonic principles control the character and distribution of rocks. Study of principles, regional patterns in sedimentary rocks, and stresses that deform rocks are explored in laboratory and field exercises. Topics and techniques are discussed within the framework of the 1.2 billion year geologic history of the VA region and its connection with tectonic processes throughout the rest of the world. Prerequisites: GEOL 110L and GEOL 230.

GEOL 388. Advanced Stratigraphy, Structure, Tectonics (3, 2). 4 credits
Advanced concepts in structural geology (analyses of rheology, stress & strain, deformation fabrics, and chronologic constraints) applied to the tectonic evolution of orogens and basins. This will include exploration of the mechanisms controlling the stratigraphic record (auto- and allochthonous) and sequence theory of basins, as well as methods of dating the stratigraphic record (biostratigraphy and magnetostratigraphy, and magneto and chronostratigraphy). Prerequisite: GEOL 387.

GEOL 390. Laboratory Techniques in Geology (2, 2). 3 credits.
An elective course for science majors. A study of the basic theories and techniques of laboratory methods and instrumentation. Implementation and application of techniques to geological problems. Prerequisites: GEOL 280 and permission of the instructor.

GEOL/MATS 395. Geologic Perspectives in Materials Science and Engineering. 3 credits.
A one-semester course which emphasizes the commonalities between the geological sciences and materials science. Course includes topics from mineralogy, crystallography, petrology and structural geology which are also important in metallurgy and ceramics. Prerequisites: An introductory course in any physical science or integrated science and technology (GEOL 110, CHEM 131, PHYS 140 or ISAT 141) and at least one additional advanced course in the major.

GEOL/MATS 398. X-ray Characterization of Solid Materials. 3 credits.
Covers fundamental principles and theory behind two powerful, X-ray based, technologies: X-ray Diffraction and Energy Dispersive Analysis of X-rays (EDS). Students will collect and analyze data from a single crystal Gandolfi X-ray camera, automated powder diffraction system (focusing goniometer) and EDAX system (EDS). Prerequisites: GEOL 280, MATS/CHEM/PHYS 275 or ISAT 300.

GEOL 398. Topics in Geology. 1-4 credits.
Topics in geology at the advanced level. May be repeated for credit when course content changes. Topics selected may determine prerequisites. Students should consult the instructor prior to enrolling in the course. Prerequisite: Permission of the instructor.

GEOL 399. Field Geology. 6 credits.
Field methods include use of Brunton compass, telescopic alidade and plane table, and compass traversing. A synthesis of geologic concepts and principles leading to the construction and interpretation of geologic and topographic maps. Prerequisites: GEOL 387 and 398 or permission of the instructor.

GEOL/BIO 400. Geology and Ecology of the Bahamas. 3 credits.
This course explores the geology and ecology of the shallow-water marine environment by examining the premodern modern example, the Bahama platform. The Bahamas provide an excellent model for understanding modern and ancient carbonate and reef deposits and a variety of terrestrial/aquatic habitats. Biological processes are responsible for many of the geological features of the Bahamas, so the course considers the biology/ecology of marine organisms in addition to geological topics. Prerequisites: GEOL 110 or GEOL 211 or a 200-level GEOL or BIO course; at least four hours of additional lab science, at least sophomore status, and permission of the instructor.

GEOL 401. Oceanography for Teachers. 3 credits.
A comprehensive study of the world’s oceans and the interrelationships among physical, chemical, biological and geological oceanography for pre- and in-service teachers. Special emphases on Virginia coastal oceanography, the National Ocean Literacy Principles and the integration of pedagogy applicable to K-12 instruction. Includes a field trip to the Virginia coast. Credit may not be earned in both GEOL 211 and GEOL 401.

GEOL/BIO 405. Vertebrate Paleontology. 3 credits.
A study of the origin and evolution of the vertebrates. Emphasis will be on understanding how the processes of earth evolution and biological evolution have interacted through time to produce a coherent picture of vertebrate history. Prerequisite: GEOL 230 or BIO 124 or permission of the instructor.

GEOL 406. Paleoclimatology and Paleoceanography. 3 credits.
Investigate the methodologies and data used to reconstruct Earth’s climate history. Emphasis will be placed on the marine sediment and ice core records of the Cenozoic though detailed lecture and lab activities. Case studies include the Paleocene Eocene Thermal Maximum, the glaciation of Antarctica, Milankovitch cyclicity and Northern Hemisphere glaciation. Prerequisite: GEOL 230 or GEO/BIO 350 or permission of the instructor.
GEOL 410. Engineering Geology (2, 2). 3 credits.
Study of the applications of geology to engineering practice. Topics include soil mechanics, foundations, engineering classification of soils, slope stability and mineral aggregates. Prerequisites: GEOL 110, GEOL 210 or GEOL 210, and either MATH 231 or MATH 235 or equivalent.

GEOL 415. Geologic Evolution of North America. 3 credits.
A systematic survey of the tectonic evolution of the North American continent and the corresponding evolution of depositional basins and paleoenvironments. Prerequisites: GEOL 367 and GEOL 368 or permission of the instructor.

GEOL 440. Geophysics (3, 2). 4 credits.
A survey of geophysical methods, with joint attention on near-surface and solid earth applications. Topics include seismology, heat flow, gravity, magnetism, electrical methods, ground penetrating radar and geophysical aspects of plate tectonics. Labs focus on practical experience with data acquisition, reduction, and interpretation and are a combination of field, classroom and computational activities. Prerequisite: GEOL 110L or PHYS 140-150 or PHYS 240-250 or permission of the instructor.

GEOL 442. Field Geophysics. 3 credits.
This course focuses on collection of geophysical data in the field and interpretation, analysis and technical reporting afterwards. Case studies discussed include applications to geology, archaeology, and engineering. Students will get hands-on experience with geophysical equipment and an understanding of how and where these tools can be applied. Topics include Ground Penetrating Radar, Electrical Resistivity, Magnetism, Seismic Refraction and Total Station Data. Prerequisite: GEOL 110 or GEOL 210 or ANTH 197 or consent of instructor.

GEOL 444. Topics in Geophysics. 1-4 credits.
An in-depth investigation into selected aspects of geophysics. Topics will be chosen by the instructor and students and may vary from year to year. Some common candidate issues include earthquake seismology, field survey planning and execution, geophysical interpretation theory and the geophysical underpinnings of plate tectonic theory. Prerequisite: Permission of the instructor.

GEOL 450. Geology Seminar. 1 credit.
An in-depth study of a particular problem in geology (e.g., plate tectonics, astrogeology, low-temperature geochemistry, etc.) Scientific literature will be reviewed and discussed. Prerequisite: 20 credits in geology.

GEOL 460. Hydrogeology (2, 2). 3 credits.
Basic concepts of subsurface water as a part of the hydrologic cycle. Topics include storativity and permeability in porous media, principles of flow, computer applications, groundwater exploration, and mapping and environmental aspects of groundwater. Prerequisites: GEOL 110L and two semesters of calculus or permission of the instructor.

GEOL 477. Contemporary Issues in the Geosciences. 3 credits.
As a capstone experience, this course serves as an opportunity for students to view issues of the Earth system from an Earth-based perspective. Building on previous course work in the major, this course focuses on the economic, social and environmental aspects of groundwater. This course fulfills the College of Arts and Letters writing-intensive requirement. Prerequisites: GEOL 211, GEOL 320, GEOL 367 and GEOL 377.

GEOL 489. Quantitative Methods in Geology. 3 credits.
An introduction to the mathematical methods and statistical techniques that are employed by scientists in the disciplines of geochemistry, geophysics, hydrology and the petroleum/mineral industry. The course provides the quantitative skills necessary to manipulate geological data.

GEOL 491. Geological Literature and Research. 2 credits.
Provides advanced instruction in literature research to meet the B.A. Earth Science and B.S. Geology research requirements. Activities include the identification of a literature-based research problem, literature research techniques, critical reading and discussion, and the preparation of individual review papers on each student's research topic. Prerequisite: GEOL 291 or permission of the instructor.

GEOL 494. Internship in Geology. 1-3 credits.
Student conducts a research or applied project in geology outside of the university. Requires an approved proposal prior to registration and a final report at the culmination of the project. Prerequisites: Minimum of eight credit hours in geology, GEOL 367 and a geology GPA of 2.5 or higher.

GEOL 497. Problems in Geology. 1-3 credits.
An undergraduate research course in one of the fields of geology. Open to advanced students who have adequate preparation. Prerequisites: GEOL 291 and permission of the instructor.

GEOL 499. Honors in Geology. 3 credits.
Three semester sequence for a total of 6 hours. Prerequisites: GEOL 291 and 2.5 GPA or higher.

German

GER 101. Elementary German I. 3-4 credits.
The fundamentals of German through listening, speaking, reading and writing. Practice in pronunciation and development of comprehension. One hour’s work a week in the language laboratory. If student has had two or more years of the language in high school, he/she will not receive credit for the course.

GER 102. Elementary German II. 3-4 credits.
The fundamentals of German through listening, speaking, reading and writing. Practice in pronunciation and development of comprehension. One hour’s work a week in the language laboratory. If student has had two or more years of the language in high school, he/she will not receive credit for the course. Prerequisite: GER 101.

GER 109. Accelerated Review of Elementary German. 3 credits.
Reviews elementary German grammar, reading, writing, speaking and listening skills in German. One hour of work a week in the language laboratory. For students who have had no more than two or three years of German in high school or qualify through the placement exam. Prerequisite: Permission of the department head or placement exam score.

GER 111. Intensive German I. 6 credits.
The fundamentals of German through intensive listening, speaking, reading and writing. This four-week course is the equivalent of GER 101-102.

GER 212. Intensive German II. 6 credits.
The fundamentals of German through intensive listening, speaking, reading and writing at the intermediate level. This four-week course is the equivalent of GER 231-232. Prerequisite: GER 102 or 111 or sufficient score on the Foreign Language Placement Exam.

GER 231. Intermediate German I. 3 credits.
A thorough review of grammar and vocabulary building, conversation, composition and reading. Prerequisite: GER 102 or 111 or sufficient score on the foreign language placement test.

GER 232. Intermediate German II. 3 credits.
A thorough review of GER 231 grammar and vocabulary building. Conversation, composition and reading will be chosen to reach competency at the advanced intermediate level. Prerequisite: GER 231 or sufficient score on the foreign language placement test.

GER 266. Contemporary German Literature in Translation. 3 credits.
German literature from the 1920s to the present. All lectures and readings are in German.

GER 300. Grammar and Communication. 3 credits.
Intensive training in grammatical structures and their application to oral and written communication. Instruction is in German. Fulfills the College of Arts and Letters writing-intensive requirement for the major. Prerequisite: GER 232 or per placement exam score.

GER 307. A History of German Civilization. 3 credits.
A study of society, economics, politics and the arts in central Europe from Indo-European beginnings to the present. Emphasis is also placed on outstanding contributions of German-speaking people. Instruction is in German.

GER 308. Contemporary German Civilization. 3 credits.
A study of life, culture, politics and economics in modern Germany. May be repeated for credit. Prerequisite: GER 300 or equivalent.

GER 320. German Oral and Written Communication. 3 credits.
Intensive training in the use of modern, everyday German with emphasis on conversation and composition. Readings in German will provide a context for discussion and writing. Prerequisite: GER 300 or equivalent.

GER 330. Business German. 3 credits.
A study of commercial and trade vocabulary and customs in conjunction with practice in commercial communication, including letter writing, interviews and interpretation. Instruction is in German. Prerequisite: GER 300 or equivalent.

GER 335. Introduction to German Literature. 3 credits.
A survey of German literature from 750 to the present. Textual analysis of sample writings of the most important literary movements. Instruction is in German. Prerequisite: GER 300 or equivalent.