Division of Science

Chair
Dr. Robert Crackel

Division of Science Mission
The mission of the Division of Science is (1) to instill the knowledge and critical and creative thinking skills needed by students in today’s society, and (2) to serve the university, the academic community of scientists, and the general public. This is accomplished by offering distinctive programs in which students are mentored by faculty in a collaborative environment that integrates teaching and research through scientific inquiry.

Division of Science Objectives
The Division of Science is composed of the disciplines of Chemistry, Geosciences, Physics, Radiologic Technology, and Science Education. While much variation in degree requirements exists among the programs within the Division, all have the following common objectives: proficiency in a recognized field of science and broad liberal training for effective citizenship. Majors within the Division provide the student with a sound basic education within one of the sciences and the opportunity to elect courses in Mathematics, the Arts, and the Humanities. Pre-professional programs offer the option of preliminary coursework at Minot State before transferring to a professional school.

Chemistry
Chemistry is a rewarding subject of study in itself. Science may be the chief mode by which we perceive ourselves, and the world, in terms of what constitutes a “modern society.” Chemistry draws heavily on all of the sciences and it contributes in many ways to all the other sciences. Chemistry is the servant science because it supplies descriptions and understanding of many kinds of matter that are studied in other sciences. The objectives of the faculty in chemistry include:

1. the provision of high-quality undergraduate education to students seeking a career in the chemical industry, to those wishing to pursue a graduate degree in chemistry, and to those wishing to teach chemistry at the secondary level, and to those pursuing careers in areas requiring substantial background in chemistry such as medicine and forensic sciences;
2. the introduction of the philosophy and fundamentals of chemistry to students who are satisfying General Education requirements;
3. the broadening of scientific literacy;
4. provide opportunities for students to be involved in scientific research.

Students desiring the best preparation for graduate work and professional careers should pursue the BA degree. Those desiring to teach chemistry at the secondary level should earn the BSEd degree.

Geosciences
The Geosciences are among the most important fields of study in our highly technological world. It brings together a study of our energy resources, mineral deposits, land utilization, water resources, the atmosphere, planetary exploration, and the universe into one complex and interrelated discipline. Earth scientists are constantly examining each of these areas relative to mankind’s present and future needs in an attempt to maintain the quality of life on this planet earth.

The primary objectives of the geosciences curriculum are:

1. To prepare students as professional geologists for jobs with the petroleum industries, regulatory agencies, civil service positions, and for the continuation of studies in graduate school.
2. To prepare motivated, innovative, competent, and professional earth science teachers.
3. To give non-geoscience science majors a stimulating and comprehensive background in the earth sciences to prepare them to fulfill their role as knowledgeable and informed citizens who will direct the future growth of this country.

Physics
The BA major in physics prepares graduates for work in industrial and government research and development and for advanced study in graduate school. A physics major is good preparation for graduate study in astronomy, meteorology, engineering, environmental sciences, geophysics, oceanography, and many other fields in addition to physics.

The BSEd degree gives graduates a comprehensive background for high school physics teaching.

Radiologic Technology
The Radiologic Technology program is designed to prepare graduates with the knowledge, clinical experience, and critical thinking skills needed for a successful career in the healthcare system as radiologic technologists. Working with radiologists, radiologic technologists (radiographers) use their
knowledge of physics and human anatomy to create medical images to diagnose disease or injury. Various types of imaging instruments may be used by radiographers.

The Radiologic Technology program involves two to three years of course work at Minot State University. To work as radiologic technologists, students will have to pass the American Registry of Radiologic Technology (ARRT) national registry exam. The objectives of the BS major in Radiologic Technology are:

1. To prepare students with the background needed in the sciences and other disciplines for a career as radiologic technologists, and
2. To prepare students for admission to an accredited clinical education program, which will provide students with the necessary clinical experiences and prepare them for the ARRT exam.

**University Teacher Education Policies**

Refer to Teacher Education and Policies (http://catalog.minotstateu.edu/undergraduate/teachereducationpoliciesandprocedures) section of the catalog for details regarding Teacher Education at Minot State University. These pages will explain admission, retention, and exit requirements of the program for biology, chemistry, earth science, physical science, and physics majors in Teacher Education.

**Division Teacher Education Requirements**

In addition to University-wide teacher education retention policies listed above, science majors in the BSEd degree programs must:

1. Select an advisor in the Division of Science within the department of their major to coordinate course work within their major.
2. Select an advisor within the Division of Science’s Science Education faculty to coordinate course work within Science Education.
3. Apply to the Division of Science to be recommended for Admission to Teacher Education. Minimum requirements for recommendation are:
   a. Completed General Education communications requirement with a minimum GPA of 2.50 with no grade lower than a “C.”
   b. Basic Skills Test (PPST) with satisfactory scores.
   c. Minimum cumulative GPA of 2.50 for all course work taken.
   d. Evidence of having completed speech and hearing tests.
   e. Completed autobiography stating reasons teaching was chosen as a profession.
   f. Recommendations from two faculty within the Division of Science.
   g. Minimum GPA of 2.50 within the major (at least 8 credits completed).

Once admitted to Teacher Education students must:

1. Maintain a GPA of 2.50 for all course work taken.
2. Maintain a GPA of 2.50 within their major.
3. Apply to the Division of Science at least two semesters before student teaching.
4. Complete the required science teaching methods courses before student teaching.

All students majoring in another division or department and planning to teach with a minor in the sciences must submit their credentials to the Division of Science for review at least two semesters before student teaching.

The Division of Science will initially approve pre-service teachers. In addition, each candidate’s progress is reviewed each semester, in accordance with standards set by the University and the Division.

**CHEM Courses**

**CHEM 110. Survey of Chemistry. 4 Hours.**
An introductory course covering topics that concern students’ everyday lives. This course is designed for liberal arts and general education students. The course consists of an introduction to the science and includes historical perspectives. The course is intended to present chemistry in its broad culture, social, and economic context. Lecture, 3 hours; laboratory, 2 hours.

**CHEM 110H. Honors Survey of Chemistry. 4 Hours.**
An introductory course covering topics that concern students’ everyday lives. This course is designed for liberal arts and general education students. The course consists of an introduction to the science and includes historical perspectives. The course is designed to present chemistry in its broad cultural, social, and economic context. Assignments will include investigation of specific topics and written descriptions of the findings. Lecture, 3 hours; laboratory, 3 hours. Prerequisite: Honors program admission or 3.30 cumulative GPA and permission of the instructor.

**CHEM 115. Introductory Chemistry. 4 Hours.**
Presents knowledge of concepts of chemical principles in greater depth and with more mathematical applications than in CHEM 110. Includes studies of general inorganic principles. Lecture, 3 hours; laboratory, 2 hours.
CHEM 115H. Honors Introductory Chemistry. 4 Hours.
This course introduces concepts in general, organic, and biochemistry. Topics likely to be covered include: measurement, atoms, molecules, elements, the periodic table, nuclear chemistry, compounds, bonds, molecular geometry, classes of organic compounds, gases, liquids, solutions, chemical reactions, solutions, acids, bases, and biochemical compounds. Assignments will include investigation of specific topics and written descriptions of the findings. Lecture, 3 hours; laboratory, 3 hours. Corequisite: Math 102 or 103. Prerequisite: Honors program admission or 3.30 cumulative GPA and permission of the instructor.

CHEM 121. General Chemistry I. 5 Hours.
This course is the first of two-semester sequence primarily intended for students majoring in science and science-related fields. Topics likely to be covered in this semester include: matter, measurement, atoms, ions, molecules, reactions, physical chemistry, thermodynamics, periodicity, and gases. Lecture, 3 hours; recitation, 1 hour; laboratory, 3 hours. Corequisite: MATH 103.

CHEM 121H. Honors General Chemistry I. 5 Hours.
This course is the first of a two-semester sequence primarily intended for students majoring in science and science-related fields. Topics likely to be covered in this semester include: matter, measurement, atoms, ions, molecules, reactions, physical chemistry, thermodynamics, periodicity, and gases. Note: Chem 121 and 121L must be taken concurrently. Assignments will include investigations of specific topics and written descriptions of the findings. Lecture, 3 hours; recitation, 1 hour; laboratory, 3 hours. Corequisite: Math 103. Prerequisite: Honors program admission or 3.30 cumulative GPA and permission of the instructor.

CHEM 122. General Chemistry II. 5 Hours.
This course in the second of a two-semester sequence primarily intended for students majoring in science and science-related fields. Topics likely to be covered in this semester include: intermolecular forces, liquids, solids, kinetics, equilibria, acids, bases, solution chemistry, precipitation, thermodynamics, and electrochemistry. Lecture, 3 hours; recitation, 1 hour; laboratory, 3 hours. Prerequisite: CHEM 121.

CHEM 122H. Honors General Chemistry II. 5 Hours.
This course is the second of a two-semester sequence primarily intended for students majoring in science and science-related fields. Topics likely to be covered in this semester include: intermolecular forces, liquids, solids, kinetics, equilibria, acids, bases, solution chemistry, precipitation, thermodynamics, and electrochemistry. Assignments will include investigation of specific topics and written descriptions of the findings. Lecture, 3 hours; recitation, 1 hour; laboratory, 3 hours. Corequisite: Math 103. Prerequisites: CHEM 121H/121HL. Honors program admission or 3.30 cumulative GPA and permission of the instructor.

CHEM 127. Chemistry of the Environment. 4 Hours.
This course is unique in that it uses topics of concern/interest to facilitate the learning and understanding of the scientific concepts behind them. The course will use current environmental topics, such as our atmosphere, global warming, energy, the ozone layer and water quality, to bring forward important chemical concepts as naming, bonding, stoichiometry, energetics, pH and chemical reactions. The course will also bring an interdisciplinary flavor to the material, discussing such topics as the carbon cycle and biological contributions, how earth processes may affect the quality of our drinking water and the effect of acid rain on the earth (both in terms of the geology and the ecosystem).

CHEM 227. Principles of Environmental Chemistry. 4 Hours.
Designed to provide students with a basic introduction to Environmental Chemistry. The course will introduce students to the environmental pathways, toxicology, and organic and inorganic environmental contaminants. The students will also study various processes in the environment, including those in air, soil, and water. Depending on time, the students may also be introduced to the management of hazardous chemicals. Prerequisite: Student must complete CHEM 127 before enrolling in this course.

CHEM 230. Quantitative Analysis. 5 Hours.
A course in quantitative chemistry including gravimetric and volumetric analysis, statistical treatment of data, and an introduction to some instrumental analysis. Lecture, 3 hours; laboratory, 6 hours. Prerequisites: CHEM 122.

CHEM 240. Fundamentals of Organic Chemistry. 5 Hours.
Theory of bonding and structure in organic molecules and their reactions. An emphasis on functional groups related to biological molecules. This course presents the minimum preparation for CHEM 480. Offered in the spring. Lecture, 4 hours; laboratory, 2 hours. Prerequisite: CHEM 122.

CHEM 299. Special Topics. 1-8 Hour.

CHEM 341. Organic Chemistry I. 5 Hours.
A study of different classes of organic functional groups, their nomenclature, reactions, and properties. An introduction to Infrared and Nuclear Magnetic Resonance Spectroscopy is included. Offered in the fall. Lecture, 3 hours; laboratory, 3 hours; recitation, 1 hour. Prerequisite: CHEM 122.

CHEM 342. Organic Chemistry II. 5 Hours.
A continuation of CHEM 341. A study of the chemical and mechanistic properties of organic functional groups. Offered in the spring. Lecture, 3 hours; laboratory, 3 hours; recitation, 1 hour. Prerequisite: CHEM 341.

CHEM 360. Principles of Physical Chemistry. 4 Hours.
This course is designed for students interested in chemical education at the secondary level. Topics include gas laws, thermodynamics, equilibria, kinetics, quantum mechanism and spectroscopy. Offered alternate years. Lecture, 3 hours; laboratory, 3 hours. Prerequisites: CHEM 230 and MATH 107.

CHEM 380. Environmental Chemistry. 4 Hours.
The course examines the interaction of chemical substances with the environment. Emphasis is placed on water quality and air quality. Offered alternate years. Lecture, 3 hours; laboratory, 3 hours. Prerequisite: CHEM 230.
CHEM 420. Inorganic Chemistry. 3 Hours.
An advanced course in inorganic chemistry, including theories of covalent and ionic bonding, crystalline structure, coordinate covalent bonding, group theory, and coordination chemistry. Offered alternate years. Lecture, 3 hours. Prerequisites: CHEM 122, MATH 165.

CHEM 422. Inorganic Synthesis. 1 Hour.
Applied techniques in inorganic synthesis and compound characterization. Offered on demand. Laboratory, 3 hours. Prerequisite: Consent of instructor. Corequisite: CHEM 420.

CHEM 423. Instrumental Analysis. 5 Hours.
A survey of instrumental methods used for chemical analysis. These methods include molecular absorption, atomic absorption and emission, fluorescence and phosphorescence, infrared absorption, chromatography, nuclear magnetic resonance and mass spectrometry. Offered alternate years. Lecture, 3 hours; laboratory, 6 hours. Prerequisite: CHEM 230.

CHEM 440. Organic Spectroscopy. 3 Hours.
Identification of organic molecules via spectroscopic methods. Methods studied include infrared, UV-visible, proton and carbon-13 nuclear magnetic resonance, and mass spectrometry. Offered alternate years. Lecture, 2 hours; laboratory, 2 hours. Prerequisite: CHEM 342.

CHEM 442. Medicinal Chemistry. 3 Hours.
This course is designed for students interested in medicinal applications of organic chemistry and for students interested in continuing their education in medicine, pharmacy, and other health related fields. The course offers the study of major classes of medicinal compounds presented in a broad historic and cultural perspective of the development of medicinal chemistry from the first attempt to synthesize quinine in the early XIX century to modern days' antibiotics. Offered alternate years. Lecture, 3 hours. Prerequisite: CHEM 342 and junior or senior status.

CHEM 461. Physical Chemistry I. 4 Hours.
This course is the first of a two-semester sequence of calculus-based physical chemistry for chemistry majors. Topics covered include thermodynamics and equilibrium. Offered alternate years. Lecture, 3 hours; laboratory, 3 hours. Prerequisites: CHEM 122, MATH 166, and PHYS 222.

CHEM 462. Physical Chemistry II. 4 Hours.
A continuation of CHEM 461. Topics include: quantum mechanics, molecular orbital theory, group theory, and spectroscopy. Offered alternate spring terms. Lecture, 3 hours; laboratory, 3 hours. Prerequisite: CHEM 461.

CHEM 480L. Biochemistry Laboratory. 2 Hours.
A course covering theory and laboratory experience with a variety of techniques used in biochemistry. Laboratory, 6 hours. Prerequisite: CHEM 230. Corequisite: CHEM 481.

CHEM 481. Biochemistry I. 3 Hours.
Study of major classes of biological compounds, synthesis of macromolecules, enzyme kinetics, intermediary metabolism, and control mechanisms. Lecture, 3 hours. Prerequisite: BIOL 150 and CHEM 240 or 342.

CHEM 482. Biochemistry II. 3 Hours.
A continuation of Chem 481 with more in-depth studies of particular pathways; particular emphasis is placed on medicinal chemistry and on corresponding clinical applications associated with the various pathways. Lecture 3 hours; Pre-requisite Chem 481.

CHEM 494. Directed Research in Chemistry. 1-6 Hour.
Students conduct research under the direction of a faculty mentor. The general topic and specific goals and activities are agreed upon by the student the mentor. The number of credits is proportional to the time committed to the research.

CHEM 497. Internship in Chemistry. 1-4 Hour.
A cooperative occupational training program in the field of chemistry or a related area. The course may be repeated in the same or different position. Prerequisite(s): Departmental approval and student must be a Chemistry or Chemistry Education major. Student must be at Junior or Senior status.

CHEM 499. Special Topics. 1-8 Hour.

GEOL Courses

GEOL 101. Environmental Geology with Lab. 4 Hours.
Mankind's interaction with the earth. Major environmental problems facing citizens today including: water resources, energy and mineral resoures, and geologic hazards. Local field trips. Lecture, 3 hours; laboratory, 2 hours.

GEOL 101H. Honors Environment Geology W/Lab. 4 Hours.
Mankind's interaction with the earth. Major environmental problems facing citizens today including: water resources, energy and mineral resources, and geological hazards. Laboratory time will focus on small-scale research projects, in-depth discussions of particular topics including current events, and local field trips. Lecture, 3 hours; laboratory, 3 hours. Prerequisites: Honors Program admission of 3.30 cumulative GPA and permission of instructor.

GEOL 105. Physical Geology with lab. 4 Hours.
Earth as a physical body, its structure, composition, and the geologic processes acting on and within the earth. Designed especially for students with a specific interest in geology and for those students contemplating a major in sciences. Field trips. Lecture, 3 hours; laboratory, 2 hours.

GEOL 106. Historical Geology with lab. 4 Hours.
Earth through time, its origin, history, and the history and evolution of animal and plant life. Laboratory study of fossils, sedimentary rocks, and stratigraphic problems. Field trips. Lecture, 3 hours; laboratory, 2 hours. Prerequisite: GEOL 105.
GEOL 108. Earth and Planetary Science. 4 Hours.
An introduction to the physical geology of Earth and astronomy, focusing on our solar system. Earth's materials and structure; internal and surficial processes that work to shape Earth; the history of the Earth. Introduction to astronomy, including the earth's moon, the planets, and minor bodies of our solar system, the sun, and the universe beyond our solar system. Lecture, 3 hours; laboratory, 2 hours.

GEOL 110. Earth Science by Inquiry. 4 Hours.
This course uses inquiry-based methods to explore observational astronomy and some of the physical principles that shape the earth. Students will explore heat and temperature, magnetism, and optics, as well as the paths of the sun, earth, and moon through space.

GEOL 127. Environmental Earth Systems. 4 Hours.
This course is an introduction to Earth Science with an emphasis on people's connections to environmental issues. Earth science is covered within an Earth systems framework with an emphasis on interactions, now the various Earth systems interact with one another. It also deals with how Earth interacts with people, including how Earth affects people (resources, hazards), and how people affect Earth in both positive and negative ways. An underlying concept in this course is stewardship: how people can live with Earth responsibly, working toward a sustainable future.

GEOL 210. Minerals & Rocks. 3 Hours.
Physical, chemical, structural, and optical properties of minerals; description and identification of common rock-forming and ore minerals; mineral associations and introduction to classification of common rock types. Field trips. Offered each spring. Lecture, 1 hour; laboratory, 2 hours. Prerequisite: GEOL 105.

GEOL 220. Introduction to GIS. 3 Hours.
Introduces students to theory and techniques of geographic information systems (GIS), which includes the discovery, management, analysis, and display of spatial data. GIS is a valuable tool in disciplines that deal with spatial data, including geography, history, field or environmental sciences, epidemiology, economics, and business. This course is equivalent to GEOG 289. Lecture, 2 hours; laboratory, 2 hours.

GEOL 227. Earth Materials and Analysis. 4 Hours.
A study of earth materials, including minerals, rocks, soil, and water, and the basic processes that relate them. It can be considered essentially a course on the rock cycle (materials and processes), and to some extent the hydrologic cycle, with some emphasis on the methods used to characterize and identify earth materials. The laboratory portion of the course will focus on forensic geology, the use of a variety of laboratory/instrumental techniques to characterize and identify earth materials. Lecture, 3 hours; laboratory, 3 hours. Prerequisites: Students must complete GEOL 127 and CHEM 127 before enrolling in this course.

GEOL 240. Geology of North Dakota. 3 Hours.
Geology of North Dakota for including historical geology of North Dakota and surrounding areas; Precambrian basement rocks; Phanerozoic sedimentary rocks; glacial geology; relationships between geology and physical geography (landforms); and existing and potential economic resources of North Dakota. Weekend field trip(s) required. Lecture, 2 hours; laboratory, 2 hours. Prerequisite: GEOL 105.

GEOL 260. Energy Resources. 3 Hours.
A survey of energy resources including fossil fuels, renewable, nuclear and unconventional sources. Emphasis on origin, use and implications of development. 2 hours Lec, 3 hours Lab. Prerequisite: GEOL 105. Offered alternate falls.

GEOL 290. Regional Geology. 3 Hours.
A study of the geology of a particular region in the United States or abroad. Class time involves introduction to the geology and preparation for a field trip to the region. Field trip is typically 10-14 days long and may involve hiking and camping. Special fees required. May be repeated for credit. Lecture, 2 hours, field trip required. Prerequisite: GEOL 101 or GEOL 105 or consent of instructor.

GEOL 299. Special Topics. 1-8 Hour.

GEOL 300. Geologic Field Methods. 3 Hours.
Geologic mapping and sampling techniques. Students use basic mapping instruments, gather datum record it while in the field, and construct complete and accurate geologic maps. Offered alternate falls. Lecture, 1 hour; laboratory, 4 hours. Prerequisites: GEOL 106 and 210 or consent of instructor.

GEOL 305. Methods in Mineral and Petrology. 2 Hours.
Application of modern laboratory methods to the study of minerals and rocks. Methods include optical and scanning electron microscopy, analysis of bulk materials by ICP-ACES and XRD, and EDX macroanalysis of minerals. Offered alternate fall semesters. Laboratory: 6 hours. Prerequisite: Students must complete GEOL 210 before enrolling in this course.

GEOL 310. Igneous & Metamorphic Petrology. 3 Hours.
Description and classification of igneous and metamorphic rocks based on mineralogy, textures, and chemical compositions; study of the origins of rocks through laboratory investigation of suites of related rocks. Field trips. Offered alternate springs. Lecture, 2 hours; laboratory, 2 hours. Prerequisite: GEOL 305.

GEOL 311. Paleontology. 4 Hours.
Fossilization, classification, evolution, and paleoecology. Geologic history and identification of major invertebrates phyla. Laboratory emphasizes fossils identification. Offered alternate falls. Field trip. Lecture, 2 hours; laboratory, 4 hours. Prerequisites: GEOL 106 and BIOL 151.

GEOL 320. Oceanography. 3 Hours.
Nature, origin, and evolution of ocean basins and sea water. Sea water chemistry, movement, and ability to support life. Life forms. Lecture, 2 hours; laboratory, 2 hours. Prerequisite: GEOL 105.
GEOL 321. Hydrogeology. 3 Hours.
Surface water hydrology; runoff and stream flow; groundwater hydrogeology; distribution of groundwater, aquifer properties, local and regional groundwater flow, geology of groundwater occurrence; groundwater resource development and management; water law. Offered alternate springs. Lecture, 2 hours; laboratory, 3 hours. Prerequisite: GEOL 210.

GEOL 322. Geomorphology. 4 Hours.
Processes that shape the Earth's surface. Effects of rock type, geologic structure, and climate on the formation and evolution of land forms. Lecture, 3 hours; laboratory, 3 hours. Prerequisite: GEOL 210.

GEOL 323. Global Climate Change. 3 Hours.
Examination of physical, chemical and biological processes that cause environments to change naturally or under the influence of human activities. Consideration of small watersheds, large lake systems and global atmospheric-ocean systems including meteorological processes. Emphasis on positive and negative feedback in controlling environments and their susceptibility to change. Pre-Requisite: Geol 101 or Geol 105 or Geol 108.

GEOL 331. Soils. 4 Hours.
Principles of soils including formation, properties, and classification. This course includes the use of soils information in environmental applications. Lecture, 3 hours; laboratory, 3 hours. Prerequisite: GEOL 210.

GEOL 340. Chemistry of Natural Waters. 4 Hours.
Principles of aqueous chemistry, interactions between water and geologic materials, and the chmical nature of various natural waters; includes both fresh and saline waters found in both surface water environments (streams, lakes, oceans) and subsurface environments (vadose zone and saturated zones). Lecture, 3 hours; laboratory, 2 hours. Prerequisite: GEOL 210. Co-requisite: CHEM 121.

GEOL 361. Structural Geology. 4 Hours.
Stress, strain, mechanical behavior of rocks; description and interpretation of folds, faults, joints, and foliation; tectonic processes; interpretation of geologic maps and field data. Field trip. Offered alternate springs. Lecture, 2 hours; laboratory, 6 hours. Prerequisite: GEOL 210.

GEOL 394. Independent Study General Es. 1-4 Hour.

GEOL 410. Advance Earth Science by Inquiry. 4 Hours.
Course involving aiding instructors in Earth Science by Inquiry (GEOL 110). Students will conduct oral interviews with GEOL 110 students during GEOL 110 class to determine their progress. Students will be required to learn plate tectonics and observational astronomy in depth during class preparation periods. Course exposes future secondary science teachers to inquiry methods in earth science and teaches them alternate reasoning methods that can be used at a variety of instructional levels. Lecture, 3 hours; laboratory, 2 hours. Prerequisite: Consent of instructor.

GEOL 411. Field Geology. 6 Hours.
The methods of geology, including the preparation of stratigraphic columns, cross sections and geologic maps integrated with paleoenvironmental interpretation and structural history. Students must write professional level reports. Offered in summer. Prerequisites: GEOL 361, 471, and consent of instructor.

GEOL 421. Applied Hydrogeology. 3 Hours.
Mass transport in vadose and saturated zones; origin and behavior of inorganic and organic contaminants; investigative techniques; groundwater models; site remediation. Lecture, 2 hours; laboratory, 3 hours. Prerequisites: GEOL 321.

GEOL 471. Sedimentation and Stratigraphy. 4 Hours.
Origins, characteristics, and classification of sedimentary rocks. Techniques of study, interpretation of data, lithostratigraphy, biostratigraphy, chronostratigraphy, and correlation. Offered alternate falls. Lecture, 3 hours; laboratory, 2 hours. Prerequisite: Student must complete GEOL 106 and 210 before enrolling in this class.

GEOL 494. Directed Research in Geology. 1-2 Hour.
Students conduct research under direction of a faculty mentor. The topic and goals are agreed to by student and mentor in writing at the beginning of the research. A requirement for successful completion of a second credit of GEOL 494 on a project is that the student will submit an acceptable draft of a research paper that includes introduction/background, methods, and results. Repeatable for credit.

GEOL 497. Co-Op Practicum. 4-8 Hour.

GEOL 499. Special Topics. 1-8 Hour.

PHYS Courses

PHYS 110. Astronomy. 4 Hours.
A study of the universe that begins with the earth as a planet, the planets and the satellites of our solar system, and moves out through stellar astronomy to galaxies and into the very fabric of the universe. It includes an evaluation of the methods and techniques of astronomy. Offered fall semester. Both day and night laboratories. Lecture, 3 hours; laboratory, 2 hours.

PHYS 110H. Honors Astronomy. 4 Hours.
A study of the universe that begins with the earth as a planet, the planets and the satellites of our solar system, and moves out through stellar astronomy to galaxies and into the very fabric of the universe. Evaluation of the methods and techniques of astronomy. Explicit training in use of the full spectrum of the MSU observatory equipment. Offered fall semester. Both day and night laboratories. Lecture, 3 hours; laboratory, 3 hours. Prerequisite: Honors program admission or 3.30 cumulative GPA and permission of instructor.
PHYS 203. Introduction to Physics I. 4 Hours.
Elementary laws and principles of mechanics and fluids. Lecture, 2 hours; laboratory, 2 hours; recitation, 2 hours. Prerequisite: MATH 103.

PHYS 204. Introduction to Physics II. 4 Hours.
Elementary laws of electricity and magnetism, optics, and modern physics. Lecture, 2 hours; laboratory, 2 hours; recitation, 2 hours. Prerequisite: PHYS 203.

PHYS 221. General Physics I. 5 Hours.
Newton's laws; work and energy; impulse and momentum; angular momentum; oscillations; gravity; wave motion; thermodynamics. Lecture, 3 hours; laboratory, 2 hours; recitation, 2 hours. Corequisite: MATH 165.

PHYS 221H. Honors General Physics I. 5 Hours.
Newton's Laws; work and energy; impulse and momentum; angular momentum; oscillations; gravity; wave motion; thermodynamics. Emphasis on sophisticated quantitative reasoning, order of magnitude estimation, in-depth application of calculus, and physical underpinnings of other sciences and technology. Lecture, 3 hours; Laboratory, 2 hours; recitation, 2 hours. Prerequisite: Math 165 and admission to the honors program or 3.30 cumulative GPA and permission of instructor.

PHYS 222. General Physics II. 5 Hours.
Electricity; Gauss' laws and potential difference; magnetism; Maxwell's equations; optics; introduction to Modern Physics. Lecture, 3 hours; laboratory, 2 hours; recitation, 2 hours. Prerequisite: PHYS 221. Corequisite: MATH 166.

PHYS 222H. Honors General Physics II. 5 Hours.
Electricity; Gauss' laws and potential difference; magnetism; Maxwell's equations; optics; introduction to modern physics. Emphasis on sophisticated quantitative reasoning, order of magnitude estimation, in-depth application of calculus, and physical underpinnings of other sciences and technology. Lecture, 3 hours; laboratory, 2 hours; recitation, 2 hours. Corequisite: Math 166. Prequisite: Honors program admission.

PHYS 299. Special Topics. 1-8 Hour.

PHYS 394. Independent Study General Phys. 1-4 Hour.

PHYS 397. Spec Prob In Physics. 1-2 Hour.
3/94 Dropped Q For Pre Req Purposes.

PHYS 494. Independent Study Honors Phys. 1-8 Hour.

PHYS 499. Special Topics. 1-8 Hour.

SCI Courses

SCI 95. Interconnecting Perspectives in Science. 0 Hours.
Science 095 examines how to present important scientific concepts to students from a diversity of backgrounds including different cultures, different learning styles, different ages, different genders, different physical abilities and different intellectual abilities.

SCI 102. Introduction to Radiologic Technology. 1 Hour.
Designed to acquaint first year student (freshman) radiologic technology students with the depth and breadth of this field. Students visit the radiology department of a local hospital. The course is presented by the education coordinator of a local school of radiologic technology. Lecture, 1 hour.

SCI 240. Research Methods. 2 Hours.
This course will introduce students to library skills, computer skills and communication skills used to plan and carry out research projects. Student will search for, read, and discuss journal articles; write and edit project proposals; and learn basic data management and analysis skills. Prerequisite: sophomore, junior, or senior status.

SCI 299. Special Topics. 1-8 Hour.

SCI 301. Biogeochemical Cycles. 3 Hours.
A broad overview of global biogeochemical process, including the origin of elements. Earth evolution, evolution of biogeochemical cycles, biogeochemical cycles of major elements such as carbon, nitrogen, phosphorous, and sulfur, cycles of select trace elements, interactions of biogeochemical cycles, biogeochemistry of various ecosystems, and environmental biogeochemistry. Lecture, 3 hours. Prerequisite: Student must take BIOL 127, CHEM 127, or GEOL 127 before enrolling in this course.

SCI 391. Teaching Science in Secondary Schools. 3 Hours.
Study of science teaching in middle school and high school grades with emphasis on clinical experience. Basic techniques for all disciplines are individualized in practice. Emphasis on teaching an investigative approach to science. Prerequisite: Admission to Teacher Education.

SCI 394. Independent Study General Sci. 1-4 Hour.

SCI 405. Radiologic Technology Clinical. 6-15 Hour.
Students spend 24 months in a hospital environment. Education includes both didactic and clinical studies. Restricted to students who have been admitted to the Radiologic Technology degree program.
SCI 426. Elementary Science Methods. 4 Hours.
Study of basic concepts of science within a framework of elementary school teaching methodology. Interpretation of science content, learning theory, curriculum approaches, instructional strategies, and lesson planning are emphasized. Includes extensive clinical experience. Lecture, 4 hours. Prerequisite: Admission to Teacher Education and ED 320. Corequisites: ED 320, 421, 422, 423, 424.

SCI 480. Seminar. 3 Hours.
Students present and discuss original student research project in both written and oral forms. To enroll, students must have completed their research and must have written the Introduction, Methods, and Results components of the research paper. Time in this course is also dedicated to a review of fundamental aspects of the discipline of their major and successful completion of a comprehensive exam. Prerequisites: senior status; and 2 credits of CHEM 494 or GEOL 494, or permission of instructors.

SCI 494. Independent Study Honors Sci. 1-8 Hour.

SCI 499. Special Topics. 1-8 Hour.