Earth Science

The study of Earth Science draws primarily on geology and meteorology with additional attention to the fields of oceanography and life history. The traditional background for Earth Science focuses on mathematics and the quantitative aspects of science. The contemporary study and practice of Earth Science includes the qualitative evaluation and understanding of earth processes.

Both the quantitative and qualitative factors are applied in decision-making processes that range from plans for worldwide concerns, such as global warming, and for natural disasters, such as earthquakes and floods, to evaluation of a building site for a home. Earth Science is also a companion field of study for hydrologists and environmental scientists and for related careers in government, business, and industry.

Programs

- Science Education, B.S. (Earth and Space Science Specialty (Teacher Licensure)) *major*
- Earth Science *minor*

Career Directions

Federal/State Agent
Industry/Business Consultant
Park Naturalist
Science Curriculum Coordinator
Also: Graduate Study

Preparation

Recommended High School Courses
Algebra
Biology
Chemistry
Physics
Trigonometry

Science Education, B.S. *major*
Earth and Space Science Specialty (Teacher Licensure)

Required Credits: 86
Required GPA: 2.50

Core Courses for Science Teaching in Grades 5-8

COMPLETE THE FOLLOWING COURSES:

- BIOL 1211 Introductory Biology I (4 credits)
  or BIOL 1110 Human Biology (4 credits)
- BIOL 1212 Introductory Biology II (4 credits)
  or BIOL 1120 General Biology: Evolution And Ecology (3 credits)
- CHEM 2211 Principles of Chemistry I (4 credits)
  or CHEM 1111 General Chemistry I (4 credits)
- CHEM 2212 Principles of Chemistry II (4 credits)
  or CHEM 1112 General Chemistry II (4 credits)
- GEOL 1110 Physical Geology (4 credits)
- SCI 3100 Integrative Science for Teachers (4 credits)
- SCI 3450 Science Methods For Grades 5-8 (4 credits)
  or ED 3410 Middle School Science Methods (4 credits)

REQUIRED PROFESSIONAL EDUCATION COURSES

COMPLETE THE FOLLOWING COURSES:

- ED 3100 Introduction to the Foundations of Public School Education (3 credits)
- ED 3110 Educational Psychology (3 credits)
- ED 3140 Human Relations In Education (3 credits)
- ED 3350 Pedagogy: Planning for Instruction (3 credits)
- ED 3780 Adaptation and Management: Designing the Learning Environment (3 credits)
- ED 4737 Content Area Reading (3 credits)
- ED 4799 The Professional Teacher (1 credit)
- HLTH 3400 Health and Drugs in Society (2 credits)

Complete 12 credits of student teaching:

- ED 4830 Student Teaching - Secondary (1-12 credits)

EARTH AND SPACE SCIENCE SPECIALTY

COMPLETE THE FOLLOWING COURSES:

- ENVR 2000 Introduction to Environmental Science (3 credits)
- GEOL 1120 Historical Geology (4 credits)
- GEOL 2110 Mineralogy and Petrology (4 credits)
- GEOL 3500 Topics in Paleontology (3 credits)
- GEOL 3600 Stratigraphy and Sedimentation (3 credits)
- SCI 2100 Astronomy (3 credits)

SELECT 1 OF THE FOLLOWING COURSES:

- GEOL 3211 Environmental Hydrology (3 credits)
- ENVR 4050 Geochemistry (3 credits)

SELECT 1 OF THE FOLLOWING COURSES:

- GEOL 4970 Internship (3 credits)
- GEOL 4980 Research (3 credits)

Earth Science *minor*

The Earth Science minor is designed to support other fields such as geography, biology, and chemistry. The program will complement and enhance many majors, but does not in and by itself lead to a career choice.

Multiple Credentials
Any additional major, minor or certificate in a degree must have at least 6 credits of course work not used to meet the requirements of another major, minor or certificate in the degree.

Required Credits: 23
Required GPA: 2.00

I REQUIRED COURSES

COMPLETE THE FOLLOWING COURSES:

- BIOL 3630 Conservation Biology (3 credits)
- GEOL 1110 Physical Geology (4 credits)
- GEOL 1120 Historical Geology (4 credits)
- GEOL 3211 Environmental Hydrology (3 credits)
- SCI 2200 Meteorology (3 credits)

II REQUIRED ELECTIVES

SELECT 2 OF THE FOLLOWING COURSES:

- GEOL 2110 Mineralogy and Petrology (4 credits)
- GEOL 2730 Introduction to Planetary Science (4 credits)
- GEOL 3212 Hydrogeology (3 credits)
- GEOL 3400 Glacial and Pleistocene Geology (3 credits)
- GEOL 3500 Topics in Paleontology (3 credits)
- GEOL 3600 Stratigraphy and Sedimentation (3 credits)
- GEOL 3700 Environmental Geophysics (3 credits)
- GEOL 3120 Soils (4 credits)
  or BIOL 3120 Soils (4 credits)

Biology Courses

BIOL 1110 Human Biology (4 credits)
General introduction to biology, focusing on humans, including topics on cell biology, genetics, molecular biology, form and function of organ systems, and the interaction between humans and their environment. Intended for nonbiology majors. Lecture and laboratory. Liberal Education Goal Area 3 (LC).

BIOL 1120 General Biology: Evolution And Ecology (3 credits)
A general introduction to biology with an emphasis on evolution, ecology, and the diversity of life. Intended for nonbiology majors. Includes laboratory simulations and field exercises. Liberal Education Goal Area 3 and 10.

BIOL 1150 Aquatic Systems (3 credits)
An introduction to the physical characteristics, chemistry, and biology of lakes, streams, and rivers. Includes information on human impacts and alteration of these natural systems. Includes laboratory simulations and field exercises. Liberal Education Goal Area 3.

BIOL 1211 Introductory Biology I (4 credits)
An introduction to the structure and function of living systems, with an emphasis on basic mechanisms and concepts in biochemistry and in cellular and molecular biology. Intended for biology majors and minors, preprofessional students, and open to any student wishing to fulfill their Liberal Education requirement. Lecture and laboratory. BIOL 1211 and BIOL 1212 must be taken in sequence. Liberal Education Goal Area 3 (LC).

BIOL 1212 Introductory Biology II (4 credits)
An introduction to living organisms, with an emphasis on the basic mechanisms and concepts in organismal biology, ecology, and evolutionary biology. Topics include taxonomy and classification of the major groups of plants and animals, structure and function, development, and behavior. Intended for biology majors and minors, preprofessional students, and open to any student wishing to fulfill their Liberal Education requirement. Lecture and laboratory. Prerequisite: BIOL 1211 or consent of instructor. Liberal Education Goal Area 3 (LC).

BIOL 1300 Medical Terminology (2 credits)
A study of anatomical and medical terminology by examining word roots, prefixes, and suffixes. Designed to assist pre-professional and allied health students who desire to increase their usage and understanding of medical terminology. This course does not satisfy any Biology major or minor degree requirements.

BIOL 2110 Human Anatomy and Physiology (5 credits)
The structure, function, and development of the human body. Lecture and laboratory. Prerequisite: BIOL 1110 or BIOL 1211.

BIOL 2339 Ethics of Fish and Wildlife Management (3 credits)
This class is designed to explore the ethical aspects of various fish and wildlife management related topics in order to better understand how ethical viewpoints at both the social and political levels have influenced natural resource policy throughout history at the local, regional, and global scales. Liberal Education Goal Area 9.

BIOL 2360 Genetics (4 credits)
Fundamental principles of heredity in plants, animals, and microorganisms. Includes both classical and molecular genetic approaches to studying organisms. Prerequisites: BIOL 1211 and BIOL 1212.

BIOL 2610 General Ecology (3 credits)
Introduction to the interrelationships of organisms and their environments, emphasizing the historic development of fundamental principles at the levels of individual, population, community, and ecosystem through examination of theoretical and empirical findings. Prerequisites: BIOL 1110, 1120 or BIOL 1211, 1212 or consent of instructor.

BIOL 2620 Field and Laboratory Projects in Ecological Research (2 credits)
Introduction to the process of research in ecological science. The first part of the class consists of activities and lectures pertaining to basic issues of study design and execution. For the remainder of the class, students will design, carry out, and report on their own ecological study. Prerequisite or Corequisite BIOL 2610.

BIOL 2925 People & The Environment: Biological Perspectives on the Environment (3 credits)
Discussion and evaluation of current environmental biology topics, including biodiversity, ecosystems, biological resources, and human impact on the environment. This course fulfills Liberal Education requirements only and does not satisfy and Biology major or minor degree requirements. Liberal Education Goal Area 10.

BIOL 3120 Soils (4 credits)
Introduction to principles of soil genesis, classification, physical and chemical properties, and biological significance. Lecture and laboratory. Prerequisites: BIOL 1211 and BIOL 1212 or consent of instructor.

BIOL 3150 Animal Behavior (3 credits)
Introduction to the study of the diversity, physiology, ecological context, and evolutionary development of behavior of invertebrate and vertebrate animals. Prerequisite: BIOL 1211 and BIOL 1212, or PSY 1100.

BIOL 3250 Comparative Vertebrate Anatomy (4 credits)
Classification, adaptation, and evolutionary history of vertebrates; anatomy and functional morphology of vertebrates, including humans. Lecture and Laboratory. Prerequisites: BIOL 1211 and BIOL 1212.

BIOL 3260 Medical Physiology (4 credits)
Physiological and pathophysiological principles and control mechanisms of organ systems within humans. Lecture and laboratory. Prerequisites: BIOL 1211, BIOL 1212, BIOL 3250, and CHEM 3312.

BIOL 3300 Introduction to Hematology (4 credits)
Introduction to the principles of blood cell formation, function, and associated disorders. Lecture and Laboratory. Prerequisites: BIOL 1211, CHEM 2211, and CHEM 2212. BIOL 2360 or BIOL 3380 is recommended.

BIOL 3310 Entomology (4 credits)
The biology of insects, their natural history, morphology, classification, and economic importance. Lecture, laboratory, and field study. Prerequisites: BIOL 1211 and BIOL 1212, or consent of instructor.

BIOL 3361 Limnology I (4 credits)
Introduction to the biology, chemistry, geology, and physics of lakes and streams. Lecture, field, and laboratory work. Prerequisites: BIOL 1211, BIOL 1212, BIOL 2610, CHEM 2211, CHEM 2212, and PHYS 1101 (concurrent enrollment possible), or consent of instructor.

BIOL 3362 Limnology II (4 credits)
The second course of the Limnology sequence concentrating on the organisms commonly found in aquatic systems. Topics include physical, chemical, and biotic constraints of aquatic biota with an emphasis on ecological relationships within and between groups. Lecture and laboratory. Prerequisite: BIOL 3361.

BIOL 3380 Molecular Genetics: Theory and Practice (4 credits)
Study of the structure, replication, repair, expression, regulation, and change of genetic material. Introduction to theory and procedures by which recombinant DNA molecules are formed, cloned, and expressed. Lecture and laboratory. Prerequisites: BIOL 1211 and BIOL 1212. Might not be offered every year.

BIOL 3510 Ornithology (4 credits)
Morphology, ecology, behavior, classification, distribution, and evolution of birds. Lecture, laboratory, and field study (early morning field trips and one or two all-day field trips). Prerequisites: BIOL 1211 and BIOL 1212.

BIOL 3554 Readings in Aquatic Biology (1 credit)
In-depth review and focused group discussion of a selected topic or topics. Emphasis is on learning to access and synthesize relevant literature. Active participation in discussions and working groups is required. Prerequisite: Junior status in Aquatic Biology.

BIOL 3580 Immunology (4 credits)
The study of disease fighting mechanisms of the body. Lecture and laboratory. Prerequisites: BIOL 2360 or BIOL 3380, and one year of chemistry.

BIOL 3590 Cell Biology (4 credits)
Microscopic anatomy and physiological mechanisms of plant and animal cells. Gene control of cellular metabolism, mechanism of energy utilization in cells and pathways of synthesis of molecules. Lecture and laboratory. Prerequisites: BIOL 2360 or BIOL 3380; and CHEM 2211, CHEM 2212.

BIOL 3610 Principles of Wildlife Management (3 credits)
Introduction to the field of wildlife management, including the biological principles important to the understanding of wildlife populations and the management strategies implemented by natural resource managers. Prerequisites: BIOL 1211, BIOL 1212, and BIOL 2610. Might not be offered every year.

BIOL 3623 Forest Ecology (4 credits)
Fundamentals of forest ecology, including study of tree growth, tree demography, forest community dynamics, and ecosystem processes. Students also learn to identify forest trees native to the region and basic techniques of forest stand description. Prerequisite: BIOL 2610. (Might not be offered every year)

BIOL 3630 Conservation Biology (3 credits)
Methods and theory of conservation biology; species diversity, extinction rates, management of endangered species, and the economics of conservation strategies. Also GEOG 3630.

BIOL 3710 Microbiology (4 credits)
Structure, classification, and physiology of bacteria and related microorganisms. Lecture and laboratory. Prerequisites or Corequisites: One year introductory biology and one year introductory chemistry or consent of instructor.

BIOL 3720 Plant Form and Function (4 credits)
Structure, function, and development of vascular plants. Interrelationships between anatomical structures and physiological processes and how plants cope with environmental challenges. Lecture and laboratory. Prerequisites: BIOL 1211, 1212 and one year of college chemistry or consent of instructor.

BIOL 3723 Ecosystem Ecology (3 credits)
Fundamentals of the study of ecosystems, with emphasis on the integration of abiotic and biotic components in the development of ecosystem processes. Comparisons and interactions between terrestrial, wetland, aquatic, and atmospheric systems across the major biomes. Prerequisite: BIOL 2610.

BIOL 3730 Plant Diversity (4 credits)
Classification, phylogeny, collection, field identification, and uses of wild plants. Lecture and laboratory. Prerequisites: BIOL 1211 and BIOL 1212 or consent of instructor.

BIOL 3755 Medical Microbiology (3 credits)
Introduction to pathogenic microorganisms, the interaction of pathogens and the immune system, transmission of infections, and methods of controlling infections. The laboratory portion of the class covers aseptic technique, pure culture techniques, microscopy, and diagnostic microbiology. This course is intended primarily for Nursing and Clinical Laboratory Science majors. Prerequisites: (BIOL 1211 or BIOL 1110) and (CHEM 1110 or CHEM 1111 or CHEM 2211).

BIOL 3830 Aquatic Plants (4 credits)
Survey of the morphology, physiology, taxonomy, systematics, and ecology of algae and aquatic vascular plants. Lecture, laboratory, and field study. Prerequisites: BIOL 1211 and BIOL 1212.

BIOL 3840 Wetlands Ecology (3 credits)
Survey course develops a basic understanding of the terminology, classification, ecology, values, and conservation of wetlands. Covers wetland systems from around the world, with emphasis on wetlands in North America. Prerequisites: BIOL 1211 and 1212.

BIOL 3844 Wetlands Ecology Lab (1 credit)
Laboratory course to supplement BIOL/ENVR 3840 Wetlands Ecology. Intended to strengthen a basic understanding of the terminology, classification, ecology, values, and conservation of wetlands. Prerequisite or Corequisite: BIOL/ENVR 3840 or consent of instructor.

BIOL 3850 Marine Biology (3 credits)
Lecture course introducing major concepts and theories. Includes physical and chemical components of the oceans, with special interest paid to the major groups of organisms living in marine systems. Emphasis on the different types of marine systems (coral reefs, mangroves, open water, etc.). Prerequisites: BIOL 1211 and 1212. Might not be offered every year.

BIOL 3880 Wildlife Management Techniques (4 credits)
This course emphasizes application of ecological principles, knowledge, and practical field skills to data collection used in the management of wildlife resources and their habitats. Use of literature, development of basic field and laboratory skills, and application of management and research principles are integral. Designed for upper level students who have met prerequisites, and graduate students, who are preparing for professional careers in wildlife conservation, natural sciences, and related areas of natural resources management. The course helps fulfill The Wildlife Society professional certification requirements. Prerequisite: BIOL 3610.

BIOL 4030 Wetland Delineation and Classification (3 credits)
This training course for the identification, delineation, and classification of wetlands covers the major types of wetlands and their general delineation procedures. Hydrological, soil, and vegetation characteristics will be used to identify and map wetland boundaries. Focuses on current regulations as established by the US Army Corps of Engineers' 1987 Wetland Delineation Manual with additional regulations specific for the state of Minnesota. Satisfies the requirements for basic delineation training as specified by the Corps of Engineers and certification programs in many states. Prerequisites: BIOL 1211, 1212, or consent of instructor.

BIOL 4031 Advanced Wetland Delineation (2 credits)
Training course intended to develop an advanced understanding of wetland delineation and regulation. Includes review of hydrological, physiochemical, and vegetation characteristics used to identify wetland boundaries, as well as specifics of wetland regulation, comprehensive wetland delineations, and post-field reporting. Covers procedures and regulations used by federal and state agencies, with an emphasis on those in Minnesota. Prerequisite: BIOL 4030 or consent of instructor.

BIOL 4200 Freshwater Invertebrates (4 credits)
Morphology and functional roles of representative freshwater invertebrates and their ecological interrelationships. Lecture and laboratory. Prerequisite: BIOL 1211, BIOL 1212, BIOL 3361, BIOL 3362, and junior status, or consent of instructor.

BIOL 4210 Parasitology (4 credits)
The biology of animal parasites, their identification, biochemistry, immunology, and epidemiology. Lecture and laboratory. Prerequisites: BIOL 1211, 1212, or consent of instructor.

BIOL 4270 Histology (4 credits)
Microscopic anatomy of vertebrate tissues and organs with functional correlations. Lecture and laboratory. Prerequisites: BIOL 1211 and BIOL 1212, BIOL 3250, and BIOL 3260. Might not be offered every year.

BIOL 4330 Upland Wildlife Management (3 credits)
An advanced pre-professional course for majors in natural resources, biology, and related fields. Lectures cover the history, philosophy, evolution, and application of wildlife management with a focus on upland wildlife as a renewable, sustainable natural resource. The course fulfills some professional certification requirements of The Wildlife Society and is recommended for students planning graduate study or employment in natural resources management. Prerequisite: BIOL 3610.

BIOL 4360 Developmental and Tumor Biology (4 credits)
Investigation of the mechanisms leading to the development of multicellular animal organisms from a fertilized egg. In contrast, the course also investigates how cells within a multicellular organism can become misregulated, leading to cancer. Lecture and lab. Prerequisites: BIOL 1211 and BIOL 1212. BIOL 2360 or BIOL 3380 is highly recommended. Might not be offered every year.

BIOL 4520 Mammalogy (4 credits)
Morphology, ecology, behavior, classification, distribution, and evolution of mammals. Lecture and laboratory. Collection or paper by each student. Prerequisites: BIOL 1211 and BIOL 1212.

BIOL 4534 Ichthyology (4 credits)
An overview of morphology, physiology, behavior, taxonomy, systematics, and ecology of fishes. This course emphasizes the evolution of ecological adaptations and the origin and conservation of biodiversity. Lecture, laboratory, and field work. Prerequisites: BIOL 1211 and BIOL 1212.

BIOL 4545 Fisheries Management (4 credits)
Theory and methods of fisheries management with an emphasis on quantitative methods and ecosystem management. Lecture and extensive field and laboratory work. Prerequisites: BIOL 1211, BIOL 1212, BIOL 3362, and STAT 2610. BIOL 4534 strongly recommended.

BIOL 4620 Organic Evolution (3 credits)
Mechanisms and results of organic evolution. Lectures and discussion. Prerequisite: BIOL 2360 and junior status or consent of instructor.

BIOL 4894 Advanced Laboratory Projects in Biology I (2 credits)
Independent laboratory project work based on the background and interests of the students and the instructor. Students are normally expected to register for both semesters of the advanced laboratory projects (4894 and 4895). Prerequisites: Completion of the Area II required writing course for the B.S. or B.A. Biology major, junior status and consent of instructor.

BIOL 4895 Advanced Laboratory Projects in Biology II (2 credits)
Independent laboratory project work based on the background and interests of the students and the instructor. Students are normally expected to register for both semesters of the advanced laboratory projects (4894 and 4895). Prerequisites: Completion of the Area II required writing course for the B.S. or B.A. Biology major, junior status and consent of instructor.

BIOL 4896 Advanced Field Projects in Biology I (2 credits)
Independent field projects based on the background and interests of the students and the instructor. Students are normally expected to register for both semesters of the advanced field projects (4896 and 4897). Prerequisites: Completion of the Area II required writing course for the B.S. or B.A. Biology major, junior status and consent of instructor.

BIOL 4897 Advanced Field Projects in Biology II (2 credits)
Independent field projects based on the background and interests of the students and the instructor. Students are normally expected to register for both semesters of the advanced field projects (4896 and 4897). Prerequisites: Completion of the Area II required writing course for the B.S. or B.A. Biology major, junior status and consent of instructor.

All-University Courses

The course numbers listed below, not always included in the semester class schedule, may be registered for by consent of the advisor, instructor, or department chair, or may be assigned by the department when warranted. Individual registration requires previous arrangement by the student and the completion of any required form or planning outline as well as any prerequisites.

1910, 2910, 3910, 4910 DIRECTED INDEPENDENT STUDY
1920, 2920, 3920, 4920 DIRECTED GROUP STUDY
1930, 2930, 3930, 4930 EXPERIMENTAL COURSE
1940, 2940, 3940, 4940 IN-SERVICE COURSE
1950, 2950, 3950, 4950 WORKSHOP, INSTITUTE, TOUR
1960, 2960, 3960, 4960 SPECIAL PURPOSE INSTRUCTION
1970, 2970, 3970, 4970 INTERNSHIP
1980, 2980, 3980, 4980 RESEARCH
1990, 2990, 3990, 4990 THESIS

Geography Courses

GEOG 1224 Introduction to Map Use (3 credits)
This course is designed for the liberal education program and provides an introduction to common characteristics and use of map media. Topographic maps will be used for physical analysis as well as to discern cultural and economic features of landscapes. Thematic maps, their use and applications will be presented. Includes some study out-of-doors with map and compass. Liberal Education Goal Areas 5 & 11.

GEOG 1400 World Regional Geography (3 credits)
A survey of physical, cultural, and economic aspects of world regions. An introduction to how constituent parts of the world differ from one another in their associated resources, cultures and economics. Attention is given to the interrelationships, interdependencies, and associations that bind together the diverse communities of the world. Liberal Education Goal Areas 7 & 8.

GEOG 2100 Introduction to Physical Geography (3 credits)
This course is designed for the liberal education program and provides an introduction to spatial patterns derived from earth system processes. The course provides a systematic survey of land forms, weather and climate, soils and vegetation. This course utilizes a combination of in class discussion and laboratory-like exercises to investigate these topics. Liberal Education Goal Area 3.

GEOG 2200 Introduction to Human Geography (3 credits)
Emphasizes the study of geographical relationships and interactions of cultural, social, economic, ethnic, and political phenomena. Topical approach to population subgroups, religions, languages, urban and rural settlements, and other attributes of the cultural landscape. Liberal Education Goal Areas 7 & 8.

GEOG 2300 Economic Geography (3 credits)
Spatial structure of world economic activities; agriculture, forestry, fishing, mining, industry and trade. Liberal Education Goal Area 5.

GEOG 2400 Introduction to Planning (3 credits)
This course is designed for the liberal education program and provides information on the background and fundamentals of the community planning process. Includes discussion of contemporary issues in physical, environmental and social planning. Emphasis is on the local and subregional levels. Liberal Education Goal Areas 5 & 9.

GEOG 2925 People and the Environment: Geography Perspective (3 credits)
An integrative study of the natural, social, value-based, and citizen-action contexts for environmental awareness. The disciplinary component surveys geographic approaches to and institutional settings for environmental problems and decision making, including our spatial behaviors as either sources or recipients of environmental impacts. Interdisciplinary perspectives are evaluated in light of different geographic concepts of spatial distributions, physical geography, and regional planning. Liberal Education Goal Area 10.

GEOG 3125 Weather and Climate (3 credits)
Weather is the study of the atmosphere over short time scales, while climate is the study of long-term weather trends. The study of weather is commonly termed meteorology, which is actually a branch of physics associated with fluid dynamics. Climate is associated with statistical procedures and analyses. This course examines the geographic patterns and processes of global climate and weather, as well as topics such as global climate change, global climate models, and extreme weather events. Students learn about the Earths atmosphere; energy budgets and astronomical controls on weather processes; oceanic and atmospheric circulation; the basic atmospheric parameters; atmospheric hazards such as tornadoes, hurricanes, hail, and lightning; and global climate change issues. Prerequisite: GEOG 2100 or consent of instructor.

GEOG 3226 Cartography (3 credits)
This course provides a more integrated, practical link between cartographic theory and practice for users of GIS. This course blends theoretical discussion of GIS as a science and GIS as a software application and addresses through lecture and laboratory work map productions for a variety of audiences. A particular focus of this course is on quality communication through maps. Experience with GIS software is essential. Prerequisite: GEOG 3231.

GEOG 3231 Introduction to Geographic Information Systems (3 credits)
This course develops a proficiency in basic GIS skills for those new to GIS. Techniques for problem solving and cartographic mapping concepts are also introduced, as they are essential to quality cartographic representation and a marketable skill set. This course concentrates on learning to navigate the current version of ArcGIS software at a beginner's level and one developing and creating maps as communication tools.

GEOG 3232 Intermediate Geographic Information Systems (3 credits)
An intermediate course on the theories and application of GIS for spatial data management and analysis, thematic mapping, environmental modeling. This course expands on the concepts and methods presented in Introduction to GIS and guides students through a more comprehensive overview of principles and techniques used in GIS. Course objectives include (1) enhance and build knowledge of GIS as a system and science, (2) improve skills at GIS analysis, and (3) develop and improve problem solving skills. Prerequisite: GEOG 3231 or consent of instructor.

GEOG 3255 Introduction to Remote Sensing (3 credits)
Analysis of a special class of pictures that provide an overhead perspective. These images have unique properties that provide a distinct advantage to assessing spatial changes and patterns of change on the Earths surface. Students develop an understanding and the skills necessary for interpreting air photos, satellite, and remotely sensed images. Prerequisite: GEOG 3231 or consent of instructor.

GEOG 3410 Geography of North America (3 credits)
A regional analysis of the physical, demographic, economic and cultural characteristics of the nations in North America.

GEOG 3460 Teaching of Middle and Secondary School Social Studies (4 credits)
Objectives, activities, methods, and materials in teaching social studies in grades 5-12. Additional laboratory time is required. Prerequisite: ED 3110.

GEOG 3531 Political Geography (3 credits)
This course utilizes "World Systems Theory" to investigate 1) theories of State formation and organization; 2) historical processes of imperialism, colonialism, and decolonization; 3) major issues of the emerging political economy; 4) historical and contemporary geopolitics; and 5) the political geography of everyday life.

GEOG 3532 Political Ecology (3 credits)
Political ecology utilizes a necessary geographical perspective to understand and analyze the biophysical processes that shape issues otherwise inadequately conceptualized as political, economic or social. This spatial understanding developed by political geographers reveals relationships of the ecological and the political that are simultaneously mutually reinforcing and, often, mutually antagonistic. Prerequisite: GEOG 3531 or consent of instructor.

GEOG 3550 Site and Resource Analysis in Planning (3 credits)
This course emphasizes techniques and methods in the location, analysis, evaluation, and design of sites, focusing on identifying use potentials and impact limitations for planning and management. Prerequisite: GEOG 2400 or consent of instructor.

GEOG 3560 Metropolitan Land Use Planning (3 credits)
An examination of the identification and inventory methods of land use analysis including the designing of land use models which are compatible with environmental, social, and economic goals. Prerequisites: GEOG 2100, GEOG 2400, or consent of instructor. Prior completion of or concurrent enrollment in either GEOG 3550 or GEOG 3570 is recommended.

GEOG 3570 Public Lands Planning (3 credits)
Comparison and evaluation of natural resource management policies and analytical techniques of the U.S. Forest Service, Bureau of Land Management, National Park Service and U.S. Fish and Wildlife Service. Attention is paid to the historical and contemporary land management approaches used to protect, exploit, manage, and/or use public lands in the United States. Especially relevant are jurisdictional issues over public land, federal agencies involved in land management, state and local issues and land management, and contemporary issues associated with land management in the 21st Century. Prerequisites: GEOG 2400 and GEOG 3550, or consent of instructor.

GEOG 3580 Regional Development Planning (3 credits)
An examination of methods and processes emphasizing contemporary relationships between planners and governments, the private sector, and nongovernmental organizations regarding relationships between regions nationally and internationally, with special attention to environmental sustainability. Prerequisite(s): GEOG 2400 and GEOG 3570, and either GEOG 2300 or GEOG 3560. Students are strongly recommended to have previously completed GEOG 4265 or to be enrolled in GEOG 4265 concurrently with GEOG 3580.

GEOG 3630 Conservation Biology (3 credits)
Methods and theory of conservation biology; species diversity, extinction rates, management of endangered species, and the economics of conservation strategies. Also BIOL 3630.

GEOG 3800 Regional Geography (1-3 credits)
A regional and topical analysis of the cultural and physical features of a continent or major region of the earth. May be repeated provided different regions are involved. Note: Recommended for students in international studies, foreign languages, and for prospective teachers in the humanities or social studies.

GEOG 3810 Geography of Europe (3 credits)
A regional analysis of the cultural, economic, physical and landscape patterns of the European cultural region. NOTE: Recommended for students in Euro-Spring, International Studies, foreign languages, and prospective teachers. Liberal Education Goal Area 5.

GEOG 3820 Geography of East, South, and Southeast Asia (3 credits)
This course is designed to provide a more in depth look at Asian sub regions of South, East and Southeast Asia. Geographically, we will examine and analyze activities in this part of the world through cultural, demographic, political, economic, urban and geopolitical lenses. Liberal Education Goal Area 8. Might not be offered every year. Prerequisite: GEOG 1400 or GEOG 2200.

GEOG 3840 Geography of Africa (3 credits)
Despite persistent bias about it, Africa's cultural complexity, social dynamism, and political/economic struggle have tremendous relevance for the study of global trends at the start of the twenty-first century. The central purpose of this course is to demonstrate that relevance by investigating the cultural, historical, economic, and political dimensions of change in Africa.

GEOG 3850 Geography of the Middle East (3 credits)
This course is designed to provide a more in depth look at the region we routinely describe as the Middle East. Geographically, we will examine activities in SW Asia and the nations of North Africa. We may extend our discussion to the countries of Afghanistan, the Sudan, South Sudan and Turkey to provide a more comprehensive analysis of a particular topic or subtopic. This is a highly complex region and may be looked at from numerous perspectives. Our objective thus is to examine the region through economic, cultural, environmental, urban and geopolitical lenses. Prerequisite: GEOG 1400 or GEOG 2200.

GEOG 3860 Geography of Latin America and the Caribbean (3 credits)
This course is designed to provide a more in depth look at the region of Latin America and the Caribbean. We recognize at the outset that this is a broad subject and may be looked at from numerous perspectives. Our objective thus is to examine this geographic region through economic, cultural, environmental, urban and political lenses. The text book provides the basis for our study which is further complemented by each students (1) research into an issue or event that had a far reaching impact on this region or within its sub-regions, (2) reading of works of fiction set in Latin America and (3) viewing feature films with Latin American themes. Prerequisite: GEOG 1400 or GEOG 2200.

GEOG 4120 Urban Geography (3 credits)
Functions and distribution of cities. Urban sizes, hierarchies, and external relations with the countryside. The central place and other theories of the spacing of cities. Internal structures and functions of cities, the growth of cities, urban slums, urban sprawl, and city planning. Systematic. Prerequisite: GEOG 2200 or consent of instructor.

GEOG 4130 Biogeography (3 credits)
This course examines the distribution and diversity of flora and fauna across multiple scales. It will focus on the factors that shape and influence these patterns and investigate the role of disturbance in this process. It will also incorporate both field and lab experiences to further examine the key concepts of biogeography. Prerequisites: GEOG 2100 and GEOG 3231.

GEOG 4140 Landscape Ecology (3 credits)
This course examines the connection of pattern and process at the scale of the landscape. Students will utilize several analytical methods to examine and explain how humans, disturbance and natural process work in concert to create landscape-level dynamics and change. The course will also cover how landscape ecology is applied to assist in conservation efforts. Prerequisites: GEOG 2100 and GEOG 3231.

GEOG 4190 Qualitative Methods in Geographic Research (3 credits)
As a geographic perspective becomes increasingly important in analysis of critical issues at multiple scales from the local to the global, this course demonstrates how research grounded in qualitative methodologies encourages innovative approaches and yields significant insights. Prerequisite: GEOG 2200. While not required, it is highly recommended that GEOG 4210 and GEOG 4265 be taken previously or concurrently.

GEOG 4210 The History and Development of Geographic Thought (3 credits)
Development of the discipline of Geography with emphasis on both the historical and recent developments in the field. Includes a critical analysis of writing of representative geographers.

GEOG 4265 Spatial Analysis (3 credits)
An examination in the concepts and application of advance spatial statistical methodologies. These include, kriging, spatial autocorrelation, spatial regression models, and cluster analysis. Prerequisites: STAT 2610 or PSY 3401 or BUAD 2231 and GEOG 3231.

GEOG 4275 Advanced Geographic Information Systems (3 credits)
This course will give students hands on experience working with advanced geodatabases, the basic automation and scripting of geospatial processes, web mapping, and server side application in GIS. Prerequisites: GEOG 3231 and GEOG 3232.

GEOG 4910 Directed Independent Study (4 credits)
Arranged individual study.

GEOG 4970 Internship (4 credits)
Graded Satisfactory/Unsatisfactory only. Student internships may be either full-time or part-time in a public or private agency appropriate to the degree objective. Internships consist of closely supervised periods of service that are arranged in advance of the course registration. Students should consult their advisor concerning prerequisites.

GEOG 4990 Thesis (3 credits)
Working individually with a thesis advisor, the student produces a Geography thesis. The thesis must be a scholarly piece of work, based on empirical or archival research of a geographical issue (physical, demographic, economic, cultural, and/or political) of present or future relevance. The end product is a documented essay of at least minimally required length and format that must be approved by the advisor and at least one other member of the Geography Department after a brief oral defense.

All-University Courses

The course numbers listed below, not always included in the semester class schedule, may be registered for by consent of the advisor, instructor, or department chair, or may be assigned by the department when warranted. Individual registration requires previous arrangement by the student and the completion of any required form or planning outline as well as any prerequisites.

1910, 2910, 3910, 4910 DIRECTED INDEPENDENT STUDY
1920, 2920, 3920, 4920 DIRECTED GROUP STUDY
1930, 2930, 3930, 4930 EXPERIMENTAL COURSE
1940, 2940, 3940, 4940 IN-SERVICE COURSE
1950, 2950, 3950, 4950 WORKSHOP, INSTITUTE, TOUR
1960, 2960, 3960, 4960 SPECIAL PURPOSE INSTRUCTION
1970, 2970, 3970, 4970 INTERNSHIP
1980, 2980, 3980, 4980 RESEARCH
1990, 2990, 3990, 4990 THESIS

Geology Courses

GEOL 1110 Physical Geology (4 credits)
Introduction to modern geology. Study of rocks and minerals and the processes operating on Earth. Lecture and laboratory. Liberal Education Goal Areas 3 (LC) & 10.

GEOL 1120 Historical Geology (4 credits)
Introduction to the history of Earth. Includes study of major fossil groups and significant geologic events with an emphasis on North America. Lecture and laboratory. Liberal Education Goal Area 3 (LC).

GEOL 2110 Mineralogy and Petrology (4 credits)
Identification and occurrence of minerals and igneous, metamorphic and sedimentary rocks. Introduction to diagnostic tests including spectrometer and polarizing microscope. Lecture and laboratory. Prerequisites: GEOL 1110 and GEOL 1120.

GEOL 2730 Introduction to Planetary Science (4 credits)
An introduction and examination of the solar system, planets, satellites, asteroids, comets, and meteorites. Atmospheric pheomena, magnetic fields, cosmic particles and the human presence in Space are included. Includes laboratory-like activities and exercises. Liberal Education Goal Area 3.

GEOL 2925 People and the Environment: Earth Science Perspective (3 credits)
Application of the Earth Sciences in understanding the causes of, and solutions to, environmental problems. Environmental perspectives on geologic hazards. Liberal Education Goal Area 10.

GEOL 3120 Soils (4 credits)
Introduction to principles of soil genesis, classification, physical and chemical properties, and biological signifigance. Lecture and laboratory. Prerequisites: BIOL 1211 and BIOL 1212 or consent of instructor. May not be offered every year.

GEOL 3211 Environmental Hydrology (3 credits)
Factors affecting the occurrence and availability of ground and surface waters. Water budgets and the hydrologic cycle, watershed behavior and flood prediction. Types of aquifers and confining beds, aquifer properties, groundwater flow, introduction to groundwater chemistry; water law and management. Prerequisites: GEOL 1110 or GEOL 1120, MATH 1170 or equivalent, or consent of instructor.

GEOL 3212 Hydrogeology (3 credits)
Groundwater flow to wells, aquifer test analysis, groundwater exploration techniques, application of computer models in groundwater studies, hydrogeologic field methods, contaminant hydrogeology, vadoze zone hydrology. Lecture and laboratory. Prerequisites: GEOL 3211 or consent of instructor. May not be offered every year.

GEOL 3400 Glacial and Pleistocene Geology (3 credits)
Modern concepts of glaciology and glacial geology. Interpretation of the phenomena and effects on the landscape. Lecture and laboratory. Prerequisite: GEOL 1110.

GEOL 3500 Topics in Paleontology (3 credits)
Introduction to major groups of organisms that are commonly preserved as fossils. Focus of class may vary between offerings; including invertebrate and vertebrate paleontology, introductory micropaleontology, palynology and pollen analysis. May be repeated as topics change. Lecture and laboratory. Prerequisite: GEOL 1120. (May not be offered every year.)

GEOL 3600 Stratigraphy and Sedimentation (3 credits)
Study of sedimentary rocks. Recognition of the physical and biologic factors affecting deposition. Introduction to stratigraphic principles. Lecture and laboratory. Prerequisites: GEOL 1110, GEOL 1120, and GEOL 2110 (Might not be offered every year.)

GEOL 3700 Environmental Geophysics (3 credits)
Introduction to geophysical processes and geophysical field methods commonly used in environmental evaluation. Interdisciplinary approach to an understanding of the physical environment. Lecture and laboratory. (Might not be offered every year.)

GEOL 4910 Directed Independent Study (3 credits)
Arranged individual study.

GEOL 4970 Internship (3 credits)
Graded Satisfactory/Unsatisfactory only. Student internships may be either full-time or part-time in a public or private agency appropriate to the degree objective. Internships consist of closely supervised periods of service that are arranged in advance of the course registration. Students should consult their advisor concerning prerequisites.

GEOL 4980 Research (3 credits)
Research carried out by the student that is based on appropriate methodology and scholarship.

All-University Courses

The course numbers listed below, not always included in the semester class schedule, may be registered for by consent of the advisor, instructor, or department chair, or may be assigned by the department when warranted. Individual registration requires previous arrangement by the student and the completion of any required form or planning outline as well as any prerequisites.

1910, 2910, 3910, 4910 DIRECTED INDEPENDENT STUDY
1920, 2920, 3920, 4920 DIRECTED GROUP STUDY
1930, 2930, 3930, 4930 EXPERIMENTAL COURSE
1940, 2940, 3940, 4940 IN-SERVICE COURSE
1950, 2950, 3950, 4950 WORKSHOP, INSTITUTE, TOUR
1960, 2960, 3960, 4960 SPECIAL PURPOSE INSTRUCTION
1970, 2970, 3970, 4970 INTERNSHIP
1980, 2980, 3980, 4980 RESEARCH
1990, 2990, 3990, 4990 THESIS

Science Courses

SCI 1110 Physical Science I (4 credits)
A single-semester survey of Physical Science, with laboratory. Includes selected topics in physics, chemistry, geology, astronomy, and meteorology. Includes laboratory and computer sessions. Liberal Education Goal Area 3 (LC).

SCI 1120 Physical Science II (4 credits)
Science and Technology in Society (STS). An alternative perspective on Physical Science, using selected topics to discuss societal concerns and responsibilities. Includes laboratory and related computer-based small group sessions. Liberal Education Goal Area 3 (LC).

SCI 2100 Astronomy (3 credits)
A one-semester survey course, with emphasis on the history of astronomy, the science of stellar and solar system formation, the evolution of stars and galaxies, and modern cosmology and the fate of the universe. Includes laboratory simulations and field exercises. Liberal Education Goal Area 3.

SCI 2200 Meteorology (3 credits)
A one-semester survey course, with emphasis on the science of the atmospheric dynamics of weather and climate, precipitation, storms, and forecasting. Includes laboratory simulations and field exercises. Liberal Education Goal Area 3.

SCI 2651 Study-Travel Natural Science (1-6 credits)
Study Travel course in Science for Lab Ed Goal Area 3.

SCI 2925 People and the Environment: Science Perspective (3 credits)
The discussions of this section will include the specific relation between air, water, and solid waste pollution and the effect on the environment, including the following: acid rain, smog, global warming, measurement of environmental pollutants, and the role of science in solving pollution problems. Liberal Education Goal Area 10.

SCI 2951 Study-Travel Natural Science (1-6 credits)
Study Travel course in Science for Lib Ed Goal Area 3.

SCI 3100 Integrative Science for Teachers (4 credits)
An interdisciplinary laboratory-based course incorporating the areas of biology, chemistry, earth science, and physics. Focuses on conducting a series of investigations by Science Inquiry and demonstrating the connection between the various disciplines. Prerequisites: 2 courses each in the life sciences and physical sciences.

SCI 3450 Science Methods For Grades 5-8 (4 credits)
Strategies for implementation of the Minnesota Graduation Standards in the areas of Science and Inquiry for grades 5-8. Strategies include laboratory activities, discussions, the development of classroom activities, and the adaptation of these strategies for use in the elementary and high school science classroom. Prerequisite: Senior status or consent of instructor.

All-University Courses

The course numbers listed below, not always included in the semester class schedule, may be registered for by consent of the advisor, instructor, or department chair, or may be assigned by the department when warranted. Individual registration requires previous arrangement by the student and the completion of any required form or planning outline as well as any prerequisites.

1910, 2910, 3910, 4910 DIRECTED INDEPENDENT STUDY
1920, 2920, 3920, 4920 DIRECTED GROUP STUDY
1930, 2930, 3930, 4930 EXPERIMENTAL COURSE
1940, 2940, 3940, 4940 IN-SERVICE COURSE
1950, 2950, 3950, 4950 WORKSHOP, INSTITUTE, TOUR
1960, 2960, 3960, 4960 SPECIAL PURPOSE INSTRUCTION
1970, 2970, 3970, 4970 INTERNSHIP
1980, 2980, 3980, 4980 RESEARCH
1990, 2990, 3990, 4990 THESIS