

UG 494 Seminar Variable cr. (R-6) Prereq., EVST 101N or consent of instr. A seminar on a current environmental topic.

UG 495 Special Topics Variable cr. (R-9) Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 496 Independent Study 1-6 cr. (R-6) Offered autumn and spring.

G 501 Scientific Approaches to Environmental Problems 3 cr. Offered autumn. Prereq., graduate standing in EVST or consent of instr. The strength and limitations of the scientific approach to investigating and solving selected environmental problems with an emphasis on the natural sciences.

G 502 Environmental Law for Non-Lawyers 3 cr. Offered spring. Prereq., graduate standing. Review of major substantive environmental laws with an emphasis on areas of citizen involvement in the legal process.

G 504 Topics in Environmental Philosophy 3 cr. (R-9) Offered autumn and spring. Same as PHIL 504. Critical study/discussion of current (as well as benchmark) texts and issues in environmental ethics, environmental politics, and the philosophy of ecology, Interdisciplinary; open to concerned students from all disciplines.

G 505 The Literature of Nature Writing 3 cr. Offered spring. Study of nature, environmental, and place-based writing, from classical times to the present, with emphasis on the American tradition and its relationship to twenty-first century environmental concerns, challenges, and opportunities, and to the current practice of nature writing and natural history.

G 513 Natural Resource Dispute Resolution 3 cr. Offered spring. Same as LAW 613 and FOR 513. Provides a conceptual framework for understanding the history of ideas that have shaped the policies, institutions, and strategies used to resolve natural resource and other public policy conflicts in the American West. Focus on natural resource and environmental dispute resolution.

G 520 Environmental Organizing 3 cr. Offered spring. Developing understanding of and skills in community and environmental organizing. Emphasis on theory and practice of civic engagement and social change with a focus on developing and running campaigns and working in a group. Team projects.

G 521 Foundations in Environmental Education 3 cr. Offered autumn. Prereq., graduate standing in environmental studies. Same as C&I 521. Problem-solving approaches to environmental education; problem identification, research and design and implementation of an educational approach to selected environmental issues.

G 525 Teaching Environmental Science 1-3 cr. (R-6) Offered autumn and spring. Prereq., consent of instr. Same as C&I 525. Identification and examination of potential solutions to environmental problems and their impact on society. Major emphasis on teaching methods as they apply to environmental science.

G 531 Citizen Participation in Environmental Decision Making 3 cr. Offered spring. Review of the modes and methods of citizen participation in governmental and corporate decision making. Review of the National and Montana Environmental Policy Act; administrative rule making and appeals, strategic planning, lobbying and corporate governance. Students complete a project with an outside group.

G 537 Building Effective Environmental Organizations 3 cr. Offered spring. Prereq., graduate standing. Focus on the tasks and skills necessary to building and managing effective environmental organizations, particularly non-profit. Budgeting, fund-raising, grant-writing, attracting and utilizing volunteers, working with the media. Strategic approaches and how they are shaped by issue, context, and structure.

G 540 Watershed Conservation Ecology 3 cr. Offered autumn. Prereq., college ecology course or consent of instr. Integrates watershed science, policy, planning, action and organizing. The science component explores watershed connections, evaluating change and assessing watershed condition. The policy component explains the scientific basis of national, state and local laws, programs and agencies that affect watersheds. The planning and action component discusses developing watershed conservation plans and selecting actions likely to address problems without creating other problems. The organizing component covers how to help watershed communities make choices, resolve conflicts, build commitment and find funding. Students work individually or in teams to assist Montana groups in developing watershed CPR plans, initiating monitoring projects, and/or conducting education projects.

G 542 Transboundary Environmental Issues 3 cr. Offered intermittently in autumn. Prereq., graduate standing in environmental studies program. Review of the political systems and administrative systems of each country relevant to natural resource policy decision-making and ecological systems. Review pertinent literature, interact with stakeholders, and produce group reports.

G 548 Supervision and Teaching in Environmental Education 3 cr. Offered intermittently. Prereq., EVST 521 or C&I 521. Design, selection and evaluation of materials for the teaching of environmental education.

G 550 Pollution Ecology 3 cr. Offered spring even-numbered years. Prereq., college ecology course or consent of instr. Same as BIOL 550. Examines sources, fate, and effects of pollutants on organisms and ecosystems; methods of measuring and predicting pollutant fate and effects, assessing and reducing risks, estimating ecosystem assimilation capacity; setting standards and restoring ecosystems damaged by pollution. Briefly examines some relevant laws and policies at the federal, state and local level.

G 551 Environmental Field Study 1-3 cr. (R-3) Offered intermittently. Prereq. or coreq., EVST 540 or 550 or 560. Same as BIOL 551.

Designing, executing and interpreting environmental field studies. Oriented to studies of aquatic systems and watersheds. Students will assist with a class project and may also pursue their own projects. Projects focus on the Clark Fork, Bitterroot and Blackfoot River basins.

G 555 Research Methods for Social Change 3 cr. Offered spring. Introduction to qualitative methods of research design, data collection, and analysis. Emphasis on research that facilitates and documents social change processes. Hands-on research experience through fieldwork projects. Includes instruction on writing social science and on research ethics.

G 560 Environmental Impact Analysis 3 cr. Offered spring odd-numbered years. Prereq., graduate standing in EVST or consent of instr. Covers legal and scientific aspects of the Environmental Impact Analysis (EIA) including: What is required by international, national and state law and regulations? How does one organize an effective interdisciplinary team research effort and public participation program? What scientific tools are used in EIA? How could EIA process be improved.

G 561 Land Use Planning Law 3 cr. Offered autumn. Same as GPHY 561 (GEOG 561) and LAW 687. Basic overview of the law of land use planning including background in the traditional governmental regulatory, proprietary, and fiscal land use tools. Examination of modern techniques for land use planning; consideration of constitutional limits of authority of state and local governments. Focus on skills in interpreting, drafting and applying state legislation and local ordinances.

G 562 Land Use Planning Clinic 2 cr. Offered every term. Prereq. or coreq., EVST 561. Same as GPHY 562 (GEOG 562). Students assist local communities in long-range planning efforts and development of growth management plans as required by Montana law; ordinance drafting, development proposals, and land use issues.

G 563 Introduction to Environmental Law 3 cr. Offered autumn. Prereq., graduate standing in EVST. Same as LAW 650. Philosophy and values underlying environmental regulation, basic introduction to administrative law, in-depth study of air and water pollution and the environmental policy acts.

G 564 Environmental Law II 3 cr. Offered autumn. Prereq., graduate standing in EVST. Same as LAW 649. In-depth study of the laws addressing toxic substances and solid and hazardous waste, and the Endangered Species Act. Exploration of interaction between land use regulation and environmental law.

G 565 Public Land and Resources Law 3 cr. Offered spring. Prereq., graduate standing in EVST and consent of instr. Same as LAW 654. Historical development of United States public land law, state-federal relations, and the roles of Congress, the executive and the courts; the law applying to specific public land resources: water, minerals, timber, range, and preservation.

G 566 Advanced Public Land Law 2 cr. Offered spring. Prereq., graduate standing in EVST and consent of instr. Same as LAW 619. Collaborative work on practical problems arising in public land and resources law and individual research and writing projects.

G 567 Water Law 3 cr. Offered spring. Same as LAW 663. Interstate water problems; federal/state powers; federal/Indian water rights/Montana water law.

G 573 Environmental Writing 3 cr. Offered autumn. Prereq., graduate standing. Writing workshop designed to improve skills in writing on environmental topics for general audiences. Approaches include personal narrative, natural history, science interpretation, advocacy/argument, place-based essays. Includes analysis of published work from the perspective of technique and craft.

G 575 Seminar in Rhetoric and Environmental Controversy 3 cr. Offered intermittently. Same as COMM 575. The study of how advocates use symbols to influence meaning and action in environmental controversies. Rhetorical concepts used to examine recurring strategies and tactics in specific controversies.

G 579 Advanced Natural Resources Conflict Resolution 3 cr. (R-4) Offered autumn. Same as FOR 579 and LAW 679. Prereq., EVST 513 or consent of instr. Current topics in theory and practice. Development and discussion of research topics. Topics vary.

G 590 Supervised Internship PEAS Variable cr. (R-8) Spring and autumn, 2 cr.; Summer intensive, 3 cr. Students learn small scale sustainable vegetable farming in a hands-on work environment at the PEAS farm (15 minute bike ride from campus). Lectures, readings and reflection inform the work. Summer students also visit local farms on a once-a week field trips. PEAS is repeatable, as the curriculum changes across the season, and students can attend any semester, though the 3 credit (grad level) summer intensive course is the heart of the program.

G 593 Professional Paper Variable cr. (R-6) Offered autumn and spring. Prereq., graduate standing in EVST.

G 594 Graduate Seminar 3 cr. (R-15) Offered autumn and spring. Prereq., graduate standing in EVST or consent of instr. In-depth analysis of a current environmental topic. Different topics offered each semester.

G 595 Special Topics Variable cr. (R-9) Offered autumn and spring. Prereq., graduate standing in EVST or consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

G 596 Independent Study Variable cr. (R-12) Offered autumn and spring. Prereq., graduate standing in EVST. Work on selected problems by individual students under direct faculty supervision.

G 597 Research Variable cr. (R-12) Offered autumn and spring. Prereq., graduate standing in EVST. Directed individual graduate

research and study appropriate to background and objectives of the student.

G 598 Internship Variable cr. (R-8) Offered autumn and spring. Prereq., graduate standing in EVST. Practical application of classroom learning during placements off campus.

G 599 Thesis Variable cr. (R-6) Offered autumn and spring. Prereq., graduate standing in EVST.

Faculty

Professors

- Leonard Broberg, Ph.D., University of Oregon, 1995 (Director)
- Vicki Watson, Ph.D., University of Wisconsin, 1981

Associate Professors

- Fletcher Brown, Ph.D., Miami University, 1994
- Phil Condon, M.F.A., M.S., The University of Montana, 1989, 2000
- Neva Hassanein, Ph.D., University of Wisconsin, 1997
- Robin Saha, Ph.D., University of Michigan, 2002
- Daniel Spencer, Ph.D., Mater of Divinity, Union Theological Seminary, New York, 1994, 1983

Emeritus Professor

- Thomas M. Roy, M.A., University of Chicago, 1966

Department of Geography

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Sarah J. Halvorson, Chair

Geography provides a broad-ranging perspective on humans as inhabitants and transformers of the face of the earth. The search for this understanding involves thorough study of the physical earth, its habitation by humans, and the resulting diversity of regions and places. Geographers study the physical earth by examining the interlocking systems of the natural environment, including climate, landforms, soils, and biota. Humans are studied by examining those diverse historical, cultural, social, economic, and political structures and processes which affect the location and spatial organization of population groups and their activities. Regions and places, whether described as nations, cities, ecological units, or landscapes, are studied by integrating and interpreting their physical and human relationships in an effort to better understand them and the problems that they face.

Geographers are often found working in business, industry, government, and education. Those in planning might be called upon to determine the most satisfactory location for a new school or an airport, or undertake the environmental or socioeconomic studies required for community and regional planning. Others enter fields such as environmental law, diplomacy, intelligence, and teaching. Graduates trained in cartography and

Geographical Information Systems find professional opportunities in map-making and spatial analysis. No academic discipline offers a greater range of employment opportunities.

The Department of Geography maintains particular strengths in each of the following major branches within the discipline: 1) physical geography (geomorphology, palaeo-environments, climate and global change); 2) human–environment interaction (environmental rehabilitation, water policy, and environmental hazards); 3) geography and society (geography of towns and settlements, economic geography, and migration and population change); 4) regional geography (with particular strengths in the geography of North America, Africa, Asia, and Europe); 5) geographical techniques (remote sensing, cartography and GIS, transport planning and GIS-T, field methods, quantitative and qualitative method).

The Department of Geography offers the Bachelor of Arts, Bachelor of Science, Master of Arts and Master of Sciences degrees in geography. For a B.A. in geography, options in physical geography, community and environmental planning; and cartography and GIS are available. Also offered are a minor in geography and a teaching major and minor in geography. The bachelor degree program provides a broad liberal education; it qualifies graduates for a variety of professional jobs; and it prepares students who excel for graduate studies in geography, planning, cartography, or related fields. Graduate programs prepare candidates for a somewhat greater range of employment, including teaching in community and junior colleges, and for doctoral studies in geography and allied disciplines. In addition to a general degree in geography without option, students may pursue an option within the Master of Sciences program--community and environmental planning, or cartography and GIS. See the graduate catalog for more information concerning the M.A. and M.S. programs.

A certificate in GIS Sciences and Technologies, jointly offered by the Department of Geography, (College of Arts and Sciences), and the Department of Forest Management (College of Forestry and Conservation) is also available. This GIS certificate is a complement to an existing major or to a bachelor's degree already obtained. For details, please see the College of Arts and Sciences and the College of Forestry and Conservation sections of the catalog.

Special Degree Requirements

Refer to graduation requirements listed previously in the catalog. See index.

General Education Requirements for Geography Majors

Geography majors must meet the mathematical literacy requirement by taking M 115 (MATH 117). Students obtaining a geography degree without an option, may meet the university-wide symbolic system requirement either by taking one year of foreign language instruction (100-level or higher) or by taking M 115 (MATH 117) and STAT 216 (MATH 241). Students obtaining a degree in geography with an option must meet the university-wide symbolic system requirement by taking M 115 (MATH 117) and STAT 216 (MATH 241). The upper-division writing expectation must be met by successfully completing an upper-division writing course from the approved list in the Academic Policies and Procedures section of this catalog (see index), or by writing a senior thesis in geography.

Requirements for a Major in Geography

A major in geography requires a minimum of 36 (maximum of 60) credits. All geography majors take a 26-credit core consisting of the following courses: GPHY 121S (GEOG 101S), GPHY 111N (GEOG 102N), GPHY 112 (GEOG 105), GPHY 385 (GEOG 385), GPHY 381 (GEOG 387) and GPHY 382 (GEOG 389), GPHY 141S (GEOG 103S) or other regional course, three 300- or 400-level courses, one each from the systematic emphases of physical geography, human-environment interaction, and geography and society.

Students who pursue a geography degree without option (general geography) elect a minimum of 10 (maximum of 34) additional credits in geography. Students who pursue an option in physical geography, in community and environmental planning, or in cartography and GIS also must meet the course requirements of the option (see below).

General Geography

The general geography degree (without option) is very flexible. In addition to meeting the core requirements for all geography majors, students may take a wide range of electives in geography (minimum 10, maximum 34 elective credits). Electives may be chosen from the fields of regional geography, geographic methods and techniques, or systematic geography (physical geography, human-environment interaction or geography and society).

Physical Geography Option

In addition to satisfying the general requirements for a degree in geography, a student pursuing the option in physical geography must complete a minimum of 24 additional credits as follows: six additional credits of upper-division coursework in physical geography, geology, hydrology, and/or ecology, and three credits of undergraduate thesis devoted to a theme in physical geography. Coursework and thesis topic should be determined in consultation with the student's advisor. In addition, a student must complete a course in applied calculus (M 162 (MATH 150) or equivalent) or an upper-division course in statistics (STAT 451 (MATH 444) or equivalent), and two two-course sequences in science (such as CHMY121N-123N (CHEM 151N-152N)), PHYS 121N-122N, BIOL 120N, 121N, or their equivalents).

Community and Environmental Planning Option

In addition to satisfying the general requirements for a degree in geography, the student desiring to achieve an option in community and environmental planning must complete a minimum of 13 additional credits as follows: GPHY 465 (GEOG 465), at least one of the following two courses: GPHY 468 (GEOG 468) or GPHY 486 (GEOG 486) (with corequisite laboratories GPHY 460 (GEOG 469) or GPHY 489 (GEOG 489)), plus four of the following five courses: GPHY 323S (GEOG 315S), GPHY 335 (GEOG 335), GPHY 421 (GEOG 412S), GPHY 432 (GEOG 432), GPHY 435 (GEOG 435). (These courses can be used to satisfy the 300- or 400-level core requirement in geography and society, and human-environment interaction.) An internship is strongly recommended.

Cartography and GIS Option

In addition to satisfying the general requirements for a degree in geography, the student desiring to pursue an option in cartography and GIS must complete a minimum of 18-20 additional credits as follows: CS 101, GPHY 487 (GEOG 487) and 489, GEOG 488 and 489, plus two courses from the following four; GPHY 468 (GEOG 468) and 469, GPHY 486 and 489 (GEOG 486 and 489), GPHY 482 (GEOG 484), GPHY 485 and 489 (GEOG 485 and 489).

Certificate in GIS Sciences and Technologies

The Certificate in GIS Sciences and Technologies is a complement to an existing major at The University of Montana or as a complement to a bachelor's degree obtained at another university. The purpose of the Certificate is to ensure the knowledge, understanding, and training necessary to acquire, process, analyze, and properly display geographical data.

Special Requirements for the Certificate

To earn a Certificate in GIS Sciences and Technologies, students must either complete or have completed an undergraduate degree and complete a minimum of twenty semester credit hours of course work including 11 to 13 required credits and 7 to 9 elective credits as described below. Students must achieve at least an overall grade point average of 3.0 for courses within the program in order to earn a certificate. The certificate will be awarded upon the successful completion of all of the requirements of the certificate and the undergraduate degree.

General Requirements:

To earn the Certificate in GIS Sciences and Technologies, students must complete 11 to 13 required credits and 7 to 9 elective credits totaling a minimum of 20 credits as described below.

Required Courses(11-13 cr.):

- FOR 250 Geographic Information Systems Practicum - 2 cr.
- FOR 350 Geographic Information Systems and Applications - 3 cr.

or

- GPHY 381/382 Principles of Digital Cartography (3 cr.) & Lab (1 cr.)
- FOR 351 Photogrammetry and Remote Sensing - 3cr

or

- GPHY Remote Sensing & Raster GIS (3 cr.) & Lab (1 cr.)
- GPHY 488/489 Thematic Cartography and GIS (3 cr.) and Lab (1 cr.)

Advanced Elective Courses (7-9 cr.): (Although elective courses are organized by topical specialty, no specialization is necessary). Additional and experimental courses are offered intermittently; please see faculty or website for current semester offerings. Faculty may submit course syllabi to the GIS Certificate Committee for possible inclusion in the Certificate.

Raster GIS, Remote Sensing, and Image Analysis

- GPHY 587/589 Digital Image Analysis & Modeling (3 cr.) and Lab (1 cr.)
- FOR 551 Digital Image Processing - 3 cr.

Vector GIS and Networks

- GPHY 486/489 Transport, Planning, and GIS 3 (3 cr.) and Lab (1 cr.)
- GPHY 588/589 Vector GIS (3 cr.) and Lab (1 cr.)
- GPHY 580 Seminar in GIS and Cartography

Data Management and Collection

- GPHY 468/469 Community and Regional Analysis (3 cr.) and Lab (1 cr.)
- FOR 505 Sampling Methods

GIS Applications

- GPHY 385 Field Techniques - 3 cr.
- GPHY 491 Digital Mapping & Design - 3 cr.
- GPHY 564 Planning Design - 3 cr.
- FOR 503 GIS: Methods and Applications I - 3 cr.
- FOR 504 GIS: Methods and Applications II - 3 cr.

Teacher Preparation in Geography

Students who want to be licensed to teach geography at the middle and high school level must complete the BA degree requirements in geography (general geography, no option required). They also must complete a teaching minor in a second field of their choice and the professional licensure program in the School of Education. Students may also earn a teaching minor in geography. See the Department of Curriculum & Instruction for information about admission to the Teacher Education Program and completion of the licensure program.

Additional Information

Advisor

Every geography major will be assigned a geography faculty member to act as advisor. The advisor offers assistance in designing a program and in monitoring progress. In addition to guiding students toward meeting degree requirements, advisors also can direct students toward special opportunities, such as study abroad and field experiences, as well as scholarship and internship opportunities. All course

substitutions must be approved by the advisor. The advisor also reviews and initials a student's application for graduation before the application is signed by the chairman.

International and Field Experience for Geographers

Students obtaining a degree in geography are strongly encouraged to explore study-abroad options and field experiences. Geography credits obtained through approved studies abroad will be applied toward the geography degree. With approval of the student's advisor, additional credits obtained through studies abroad and field experiences may count toward geography electives.

Suggested Course of Study

Geography major: General Geography without option:

	A	S
First Year		
GPHY 121S (GEOG 101S) Introduction to Human Geography	3	–
GPHY 111N (GEOG 102N) Introduction to Physical Geography	–	3
GPHY 112 (GEOG 105) Geography Laboratory	–	1
M 095 (MATH 100) Intermediate Algebra	3	–
M 115 (MATH 117) Probability and Linear Math	–	3
WRIT 101 (ENEX 101) College Writing I	3	–
Electives and General Education	6	8
Total	15	15
Second Year		
GPHY 141S (GEOG 103S) Geography of World Regions or other regional geography course	3	–
STAT 216 (MATH 241) or 100-level foreign language	0–5	3–5
Electives and General Education	V	V
Total	15	15
Third Year		
GPHY 385 (GEOG 385) Field Techniques	3	–
GPHY 381 (GEOG 387) and 389 Principles of Digital Cartography and Laboratory	4	–
Upper division courses in Geography & Society, Physical Geography and Human–Environment Interaction	3–6	3–6
*Upper-division writing course	–	3
Electives including study abroad/internship	2–5	6–9
Total	15	15
Fourth Year		
Electives including study abroad/internship/ senior thesis	15	15
Total	15	15

Geography with option in Physical Geography

	A	S
First Year		
WRIT 101 (ENEX 101) College Writing I	3	–
GPHY 121S (GEOG 101S) Introduction to Human Geography	3	–
GPHY 111N (GEOG 102N) Introduction to Physical Geography	–	3
GPHY 112 (GEOG 105) Geography Laboratory	–	1
M 115 (MATH 117) Probability and Linear Math	3	–
M 151 (MATH 121) Precalculus	–	3
General Education and electives	6	8
	15	15
Second Year		
GPHY 141S (GEOG 103S) Geography of World Regions or other regional geography course	–	3
M 162 (MATH 150) Applied Calculus	4	–
STAT 216 (MATH 241) Statistics	–	3
Two 100-level science sequences	6	6
General Education and electives	5	3
	15	15
Third Year		
GPHY 385 (GEOG 385) Field Techniques	3	–

GPHY 381 and 382 (GEOG 387 and 389) Principles of Digital Cartography and Laboratory	4	–
Upper–division courses in Geography & Society and Human–Environment Interaction	3	3
Upper–division courses in Physical Geography	3	3
Electives including study abroad/internship	2	9
	15	15

Fourth Year **A S**

GPHY 487 (GEOG 487) and 489 Raster GIS and Laboratory	4	–
Upper–division course in Physical Geography	3	–
Electives including study abroad/internship	8	15
	15	15

Geography with option in Community and Environmental Planning:

First Year: Same as General Geography

Second Year

GPHY 141S (GEOG 103S) Geography of World Regions, or other regional geography course	3	–	A S
STAT 216 (MATH 241) Statistics	–	3	
General Education and electives		12	12
		15	15

Third Year: Same as General Geography

Fourth Year

GPHY 465 (GEOG 465) Planning Principles and Processes	3	–	A S
GPHY 468 and 469 (GEOG 468 and 469) Community & Regional Analysis and Laboratory or GPHY 486 and 489 (GEOG 486 and 489) Transport, Planning, and GIS and Laboratory	4	–	
Upper–division courses in Geography & Society, and Human–Environment Interaction	3	3	
Electives including study abroad, internship/senior thesis	5	12	
		15	15

Geography with option in Cartography and GIS:

First Year: Same as General Geography

Second Year

GPHY 141S (GEOG 103S) Geography of World Regions, or other regional geography course	3	–	A S
STAT 216 (MATH 241) Statistics	3	–	
CS 101 Introduction to Programming	–	3	
General Education and electives	9	12	
		15	15

Third Year: Same as General Geography

Fourth Year

GPHY 487 and 489 (GEOG 487 and 489) Remote Sensing and Raster GIS & Image Analysis and Laboratory	3	–	A S
GPHY 488 and 489 (GEOG 488 and 489) Thematic Cartography and GIS Laboratory	–	4	
GPHY 468 and 469 (GEOG 468 and 469) Community & Regional Analysis and Laboratory or 484 Spatial Analysis in GIS	4	–	
GPHY 486 (GEOG 486) Transport, Planning and GIS and Laboratory or GPHY 485 and 489 (GEOG 485 and 489) Internet GIS and Laboratory	–	4	
Electives including study abroad/internship/ senior thesis	8	7	
		15	15

Requirements for the Certificate in GIS Sciences and Technologies

To earn a certificate in GIS Sciences and Technologies, students must either complete or have completed an undergraduate degree and complete a minimum of 20 semester credit hours of course work, including 11 to 13 required credits and 7 to 9 elective credits as described below. Students must achieve at least an overall grade point average of 3.0 for courses within the program in order to earn a certificate. The certificate will be awarded upon the successful completion of all of the requirements of the certificate and the undergraduate degree. It is recommended that students complete the University’s symbolic systems requirements before beginning this program, as these courses promote basic qualitative reasoning (M 115 (MATH 117), STAT 216 (MATH 241), FOR 201, SOCI 202 (SOC 202). CS 101, Introduction to Programming, is also strongly recommended.

Required Courses (11–13 cr.):

- FOR 303 Introduction to Geographic Information Systems, or
- GPHY 381 (GEOG 387) Principles of Digital Cartography and GEOG 389 Digital Cartography Lab
- FOR 351 Photogrammetry and Remote Sensing or GPHY 487 (GEOG 487) Remote Sensing and Raster GIS and GPHY 489 (GEOG 489) Cartography/GIS Lab
- GPHY 488 (GEOG 488) Thematic Cartography and GIS and GPHY 489 (GEOG 489)
- Cartography/GIS Lab

Elective Courses (7–9 cr.):

- Raster GIS, Remote Sensing, and Image Analysis
- GPHY 587 (GEOG 587) Digital Image Analysis and Modeling and GPHY 589 (GEOG 589) Cartography/GIS Lab FOR 551 Digital Image Processing
- Vector GIS and Networks
- GPHY 486 (GEOG 486) Transport Planning and GIS and GPHY 489 (GEOG 489) Cartography/GIS Lab
- GPHY 580 (GEOG 580) Seminar in GIS and Cartography
- GPHY 588 (GEOG 588) VECTOR GIS and GPHY 589 (GEOG 589) Cartography/GIS Lab
- Data Management and Collection
- GPHY 468 (GEOG 468) Community and Regional Analysis and GPHY 489 (GEOG 489) Cartography/GIS Lab
- FOR 505 Sampling Methods
- GIS Applications
- GPHY 385 (GEOG 385) Field Techniques
- GPHY 491 (GEOG 495) GIS in Geology
- GPHY 491 (GEOG 495) Planning Decision Support Systems
- GPHY 564 (GEOG 564) Planning Design
- FOR 503 GIS: methods and Applications I
- FOR 504 GIS: Methods and Applications II
- (Although elective courses are organized by topical specialty, no specialization is necessary)

Minor in Mountain Studies

Mountain studies is an interdisciplinary field of study focusing on the physical and human dimensions of mountain environments. Coursework in the minor emphasizes physical geography and mountain-society interactions, including a critical analysis of the processes of change and influence shaping local and regional mountain environments today. The minor in mountain studies takes advantage of existing faculty expertise and an array of courses to provide students with a science-based curriculum and global perspective. Students pursuing the minor in mountain studies will develop knowledge and skills appropriate for graduate study and for working with government and non-government agencies and groups.

Requirements

In addition to completing the requirements for a major in any discipline, students electing the minor in mountain studies must complete a minimum of 18 additional credits as follows:

1. Nine credits must be core courses:

- GPHY 144 (GEOG 138) Montana's Mountains (3 cr.)
- GPHY 214 (GEOG 222) Global Mountain Environments (3 cr.)
- GPHY 338 (GEOG 338) Mountains and Society (3 cr.)

2. Six credits must be selected from the following list of upper-division advanced mountain studies courses:

- BIOL 350 Rocky Mountain Flora (3 cr.)
- BIOL 451 Landscape Ecology of Mountain Ecosystems (3 cr.)
- BIOL 450 Alpine Ecology (3 cr.)
- FOR 495 Montana Wilderness Field Studies in Winter (3 cr.)
- GPHY 344 (GEOG 310) Crown of the Continent (3 cr.)
- GPHY 442 (GEOG 401) Regionalism and the Rocky Mountain West (3 cr.)
- GPHY 438 (GEOG 438) Mountains Field Study (3 cr.)
- GEO 425 (GEOG 425) Geology of the Pacific Northwest (3 cr.)
- GPHY 488 (GEOG 488) (Snow, Ice and Climate (3 cr.)

3. Three credits must be chosen from the following list of electives, or alternatively, from the advanced mountain studies course listing above.

- BIOL 201 Montana Wildlife (3 cr.)
- FOR 330 Forest Ecology (3 cr.)
- FOR 385 Watershed Hydrology (3 cr.)
- GPHY 291 (GEOG 295) Mountain Cultures & Economies (3 cr.)
- GPHY 317 (GEOG 324) Geomorphology (3 cr.)

- GPHY 411 (GEOG 426N) Biogeography (3 cr.)
- GEO 107N (GEOS 103) Volcanoes, Earthquakes, and Other Natural Hazards (3 cr.)
- GEO 231 (GEOS 230) Field Methods and Maps (3 cr.)
- GEO 391 (GEOS 395) Appropriate Topics (3 cr.)
- GEO 433 (GEOS 430) Global Tectonics (3 cr.)
- RECM 482 Wilderness and Protected Area Management (3 cr.)

Requirements for a Minor in Geography

To earn a minor in Geography, the student must complete a minimum of 19-20 credits including: GPHY 121S and 111N(GEOG 101S and 102N; GPHY 141S (GEOG 103S) or other regional course; GPHY 112 (GEOG 105), GPHY 385 (GEOG 385) or GPHY 381 and 382 (GEOG 387 and 389); two upper-division systematic courses from the fields of geography and society, physical geography, and human-environment interaction.

Courses

U = for undergraduate credit only, UG = for undergraduate or graduate credit, G = for graduate credit. R after the credit indicates that the course may be repeated for credit to the maximum indicated after the R. Credits beyond this maximum do not count toward a degree.

Geography (GPHY)

U 111N (GEOG 102N) Introduction to Physical Geography 3 cr. Offered autumn and spring. Prereq., M 095D (MATH 100) or above, or appropriate score on mathematics placement examination. Introduction to the earth's major natural environmental systems, their spatial distribution and interrelationships, including weather and climate, vegetation and ecosystems, soils, landforms, and earth-surface processes.

U 121S (GEOG 101S) Introduction to Human Geography 3 cr. Offered autumn and spring. Introduction to Human Geography focuses upon the linkages between geography and society including analysis of regions, ethnic groups, urban landscapes, migration and population change, geopolitics, economics, and cultural differences.

U 122 (GEOG 105) Geography Laboratory 1 cr. Offered autumn and spring. Prereq. or coreq., a 100-level GPHY course. Introduction to concepts and techniques needed to understand and analyze the information contained in various types of maps, graphs, aerial photos, imagery, and other graphics and geographic data sets. This is prerequisite to GPHY 385 and 381 (GEOG 385 and 387).

U 141S (GEOG 103S) Geography of World Regions 3 cr. Offered autumn and spring. An overall view of how the lands and peoples of the world are organized into coherent geographical regions, how landscapes differ from region to region, and how the people differ in terms of their traits, beliefs, ways of life, and economic livelihood.

U 191 (GEOG 195) Special Topics Variable cr. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 291 (GEOG 295) Special Topics Variable cr. (R-6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 378 Preceptorship in Geography 1-3 cr. (R-6) Offered autumn and spring. Prereq., two of the following three: GPHY 121S (GEOG 101S), GPHY 111N (GEOG 102N), GPHY 141S (GEOG 103S); plus GPHY 112 (GEOG 105), and consent of instr. Assisting a faculty member by tutoring, conducting review sessions, helping students with research projects, and carrying out other class-related responsibilities. Open to juniors and seniors who apply to instructor for consent.

U 391 (GEOG 395) Special Topics Variable cr. (R-12) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

UG 491 (GEOG 495) Special Topics Variable cr. (R-9) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 492 (GEOG 498) Internship Variable cr. Offered every term. Prereq., consent of instr. Extended classroom experience which provides practical application of classroom learning during placements within governmental agencies or the business community. A maximum of 6 credits of Internship (192, 292, 392, 492) may count toward graduation.

UG 496 Independent Study Variable cr. (R-9) Offered every term. Prereq., consent of instr. Independent study in any subfield of geography.

U 499 Undergraduate Thesis 3 cr. (R-6) Offered autumn and spring. Prereq., senior standing or consent of instr. Independent research project in any geographical topic supervised by a faculty member, and leading to completion of the baccalaureate degree.

Earth Systems (ERTH)

UG 303N (GEOG 322N) Weather and Climate 3 cr. Offered autumn odd-numbered years. Prereq., GPHY 111N (GEOG 102N) or

consent of instr. Origin, composition, structure, and dynamics of the atmosphere, gas and radiation laws, energy budget and balance, weather elements and North American weather systems.

Physical Geography

U 214 (GEOG 222) Mountain Environments 3 cr. The study of mountain environments and their physical processes around the globe: Andes, Appalachians, East African Mountains, European Alps, Hindu Kush-Himalaya-Karakoram, Pamir, Rocky Mountains, Southern Alps of New Zealand, Tien Shan, and others. Topics include mountain building, alpine glaciers, mountain geomorphology and climatology, mountain watersheds, mountain biogeography, and mountain hazards such as earthquakes and mass movements.

UG 317 (GEOG 324) Geomorphology 3 cr. Offered intermittently. Prereq., GPHY 111N (GEOG 102N) or equiv. Important landforms and landscapes, their biophysical processes, and their formative elements.

UG 411 (GEOG 426N) Biogeography 3 cr. Offered intermittently. Prereq., GPHY 111N (GEOG 102N) or equiv. Changing patterns of plant and animal distributions in space and time. Combination of historical and ecological approaches to biological species and communities. Study of external causes of plant and animal distributions, especially climatic change and human impacts.

UG 413 (GEOG 423) Soil Geomorphology 3 cr. Offered intermittently. Prereq., GPHY 111N (GEOG 102N) or FOR 210N or consent of instr. Morphology and classification of soils and their relationships to landforms and geomorphic processes.

UG 438 Mountains Field Study 3 cr. Prereq., junior or senior standing or graduate student. Examination of aspects of the study of mountain geography through a two-week field course based in a mountainous country and/or region. Possible areas of focus include, but are not limited to, the Northern Rocky Mountains, the Alps, the Himalaya, and the Andes.

G 525 Advanced Physical Geography 3 cr. (R-9) Offered intermittently. Prereq., consent of instr. Advanced topics in climate and global change, paleo-environments and biogeography, landform analysis, soils, and other selected topics. Topic titles will appear in the Class Schedule.

G 538 Mountain Studies Seminar 3 cr. Offered intermittently. Prereq., consent of instr. In-depth treatment of the physical and cultural geography of mountainous regions, including attention to the theory and methodology of mountain geography.

Human-Environment Interaction

U 335 Water Policy 3 cr. Offered autumn. Prereq., upper-division standing. Exploration of water resources issues facing the public, resource managers, and water users in the western United States today. Examines concepts, terms, and regulatory environment which provide the foundation for modern water management and policy.

UG 336 Exploration and Discovery 3 cr. Offered autumn intermittently. Emphasis on the evidence of language, genetics, material culture, and transoceanic plant and animal exchanges in assessing mobility and population distributions in prehistory; factors that motivate exploration; the history of navigation; the impacts of exploration upon science, society, economics, and government.

U 338 Mountains and Society 3 cr. Offered autumn. Physical and cultural aspects of the mountains of North and South America, Europe, Africa, and Asia. Emphasis on combining the physical landscape with an overview of the indigenous people who inhabit the worlds' heights.

UG 432 The Human Role in Environmental Change 3 cr. Offered autumn even-numbered years. Prereq., upper-division or graduate standing. Same as EVST 432. A systematic examination of the ways in which the major physical systems and ecosystems of the earth have been modified by human activity, and approaches to the rehabilitation of these systems.

UG 433 Cultural Ecology 3 cr. Offered spring. Examines issues related to culture and the natural environment. Topics include cultural origins and diversity, geography of religion, geolinguistics, plant and animal domestication, livelihood systems, folk and popular culture, ethnic geography, political patterns, demography, industries, urban genesis, and the transformation of environmental systems.

UG 434 Food and Famine 3 cr. Offered autumn intermittently. Exploration of the production, distribution, and consumption of food; the causes and consequences of hunger; and measures that might be taken to relieve hunger.

UG 435 Environmental Hazards and Planning 3 cr. Offered spring. Prereq., upper-division or graduate standing. Surveys the characteristics and impacts of selected natural and technological hazards. Emphasizes risk and vulnerability assessment procedures, mitigating measures to reduce damage, and strategies for planning community response.

Geography and Society

U 323S (GEOG 315S) Economic Geography of Rural Areas 3 cr. Offered spring odd-numbered years. Study of the location of economic activities, including agriculture, industry, and services. Focus on the changing nature of rural areas.

UG 421 (GEOG 412S) Towns and Rural Settlement 3 cr. Offered spring even-numbered years. Prereq., upper-division or graduate standing. The spatial, functional, and locational attributes of regional centers and towns within the context of patterns of rural settlement.

UG 423 (GEOG 415) Migration and Population Change 3 cr. Offered autumn odd-numbered years. Prereq., senior standing or graduate standing or consent of instr. Focus on internal migration and population change in the U.S., in particular in the Mountain West. Review of migration theories and empirical research; development of practical skills for conducting empirical research related to migration and population change.

UG 443 (GEOG 417) Cultural and Global Competence–Key Components for Success in Global Economy and Society 3 cr. Offered autumn. Prereq., upper-division or graduate standing. Designed to increase awareness of student’s own culture and increase cross-cultural sensitivity. Understanding the perspectives of other cultures and resolving possible conflicts. Examination of the role of perception, belief systems, social structures, and culture practices.

G 515 Advanced Human Geography 3 cr. (R-9) Offered intermittently. Prereq., consent of instr. Advanced topics in cultural and historical geography, gender issues, migration and population change, economic geography, urban and settlement geography, and other selected topics. Topic titles will appear in the Class Schedule.

Regional Geography

U 144 (GEOG 138) Montana’s Mountains 3 cr. Prereq., freshman or sophomore standing or consent of instructor. A field-based course offered during winter session in the winter splendor of the North Fork of the Flathead River and Glacier National Park. Topics addressed include physical geography, geology, winter ecology, national park management, environmental history, and the changing economy of the region.

U 241S (GEOG 201S) Montana 3 cr. Offered autumn. The physical, cultural, economic, political, and historical geography of the state including Montana’s mountains and the prairies.

U 243X (GEOG 207S) Africa 3 cr. Offered autumn even numbered years. A survey of the biophysical and cultural geography of Sub-Saharan Africa. Emphasis is on the region's cultural-historical development and current ecological, demographic, and economic patterns.

U 245X (GEOG 213S) The Middle East 3 cr. Offered autumn odd-numbered years. Same as AS and LS 213. A survey of the biophysical and cultural geography of Southwest Asia and North Africa. Emphasis on environmental change; prehistory; patterns of cultural and historical change; issues of socio-economic, religious, and political diversity; and the broader political significance of the region.

U 342 (GEOG 301) North America 3 cr. Offered intermittently. Physiographic regions of North America; highlights of historical geography blended with physical and cultural aspects of the continent. Lesser known places are explored.

U 344 (GEOG 310) Crown of the Continent 3 cr. The study of the geographical setting of the Crown of the Continent of North America, including the richness of physical geography, history, culture, and models of conservation. Examines ongoing research initiatives, impacts of climate change, regional transformations, and the relationship between people and this mountainous environment.

UG 347 (GEOG 308) Regional Geography (Multiple Regions) 3 cr. (R-9) Offered intermittently. Selected regions will be listed as appropriate in each Class Schedule.

U 348 (GEOG 307) Field Studies in Geography 3 cr. (R-12) Offered autumn and spring. Through extended backcountry travel, experiential examination of regional landforms, climate, hydrology, soils, and patterns of vegetation and wildlife. Local landscapes, natural-resource endowment, and societies with particular emphasis on human-environmental interaction. Geographical skills and techniques, including map reading and navigational skills. Offered by the Wild Rockies Field Institute as part of a semester-long, 12-credit field experience with corequisite courses in allied fields.

UG 442 (GEOG 401) Regionalism and the Rocky Mountain West 3 cr. Offered spring. Same as HSTA 462 (HIST 401). Investigation of regionalism as a concept and its future in the Rocky Mountain West. Regionalism as a geographical, economic, political, and cultural entity.

UG 444 (GEOG 410) High Asia 3 cr. Offered intermittently. A study of the geography and mountain-society interactions in High Asia. The course includes attention to the theory and methodology of mountain geography, with attention to physical and human systems and their interaction.

UG 445 (GEOG 408) Advanced Regional Geography 3 cr. (R-9) Offered intermittently. Prereq., consent of instr. In-depth treatment of a geographic region, a particular regional problem, or the methodology of regional geography. Topics vary.

Geographical Thought, Methods, Planning and GIS

U 381 (GEOG 387) Principles of Digital Cartography 3 cr. Offered autumn. Prereq., GPHY 112 (GEOG 105) or consent of instr.; coreq., GEOG 389. Concepts, principles, and methods of cartography as applied to computerized mapping and geographical information systems. Topics include history of cartography, basic geodesy, map projections, coordinate systems, map compilation, generalization, and design.

U 382 (GEOG 389) Digital Cartography Laboratory 1 cr. Offered autumn. Prereq., GPHY 112 (GEOG 105); coreq., GPHY 381 (GEOG 387). Laboratory to accompany GPHY 381 (GEOG 387).

UG 385 Field Techniques 3 cr. Offered autumn. Prereq., M 115 (MATH 117), GPHY 111N (GEOG 102N), and GPHY 112 (GEOG 105) or consent of instr. Field techniques used by geographers and planners in making field observations and in collecting data. One hour of lecture and four hours of field/laboratory-based work.

UG 465 Planning Principles and Processes 3 cr. Offered autumn. Prereq., upper-division or graduate standing. Surveys planning principles, practices and issues in urban and rural environments. Attention is devoted to Montana, state planning programs in the United States., and federal programs and policies that influence land-use planning. Emphasizes skills and techniques used in plan development and implementation.

UG 466 Environmental Planning 3 cr. Offered spring. Introduction to practice of environmental planning which includes elements of physical planning, planning design at the landscape scale, and conservation planning. Includes field visits and project-based work.

UG 467 Planning Decision Support Systems 3 cr. Offered spring even numbered years. Introduction to use of computer software tools for modeling and analyzing land use.

UG 468 Community and Regional Analysis 3 cr. Offered autumn. Prereq., M 115 (MATH 117) (or higher) or consent of instr. Coreq., GPHY 460 (GEOG 469). Socio-demographic analysis of communities and regions: population, employment, and spatial interaction. Hands-on course designed for future planners, GIS analysts, and others interested in socio-demographic change.

UG 469 Planning and Analysis Laboratory 1 cr. Offered autumn. Coreq., GPHY 468 (GEOG 468). Laboratory to accompany GPHY 468 (GEOG 468).

UG 486 (GEOG 483) Transport, Planning, and GIS 3 cr. Offered spring. Prereq., M 115 (MATH 117) or higher or consent of instr. Coreq., GPHY 489 (GEOG 489). A project-oriented course focusing on patterns and trends in urban passenger transportation, principles of transport planning, and modeling in GIS-T.

UG 482 (GEOG 484) Spatial Analysis and GIS 3 cr. Offered intermittently. Prereq., GPHY 381 (GEOG 387) and 389 and STAT 216 (MATH 241) (or higher) or consent of instr. Quantitative analysis of spatial data, including techniques for pattern analysis, classification, and interpolation within a GIS environment.

UG 485 Internet GIS 3 cr. Offered intermittently. Prereq., GPHY 381 (GEOG 387); coreq., GPHY 489 (GEOG 489). Principles and techniques for distributing GIS and mapping applications through the Internet.

UG 487 Remote Sensing and Raster GIS 3 cr. Offered autumn. Prereq., GPHY 381 (GEOG 387) and 389 and STAT 216 (MATH 241) (or higher) or consent of instr. Coreq., GPHY 489 (GEOG 489). Basic principles of remote sensing and analyzing images within a raster GIS. Review current data sources.

UG 488 Thematic Cartography and GIS 3 cr. Offered spring. Prereq., GPHY 381 (GEOG 387) or consent of instr.; coreq., GPHY 489 (GEOG 489). Communicating and analyzing topical information with maps. Choropleth maps, dot maps, proportional figure maps, isarithmic maps, and others. Includes computer mapping and GIS exercises.

UG 489 Cartography/GIS Laboratory 1 cr. (R-4) Offered autumn and spring. Coreq., GPHY 486 (GEOG 486), 485, 487 or 488. Lab to accompany cartography and GIS courses.

UG 497 (GEOG 471) Workshop in Teaching Geography 2-3 cr. Offered summer. Prereq., upper-division or graduate standing. Modern concepts and techniques in geography, with emphasis on their use in teaching geography in Montana schools. Students are required to prepare and present a teaching unit project.

G 500 Geography Graduate Colloquium 1 cr. (R-3) Offered autumn. Presentation of faculty and student research interests. Guest lecturers. Graded pass/not pass only. Enrollment required every autumn graduate students are in residence.

G 504 Introduction to Geographical Research 1 cr. Offered autumn. To be taken during first semester of graduate studies. Understanding of diverse research approaches in geography and development of a thesis topic. To be continued in spring in GEOG 505.

G 505 Research Design 2 cr. Offered spring. Prereq., graduate standing and GEOG 504. Preparation of a thesis proposal: research design, data collection, analysis, interpretation, and presentation. Recommended to be taken during the second semester of graduate studies.

G 520 Seminar in Geographical Thought 3 cr. Offered autumn. Geographical ideas, concepts, approaches, and techniques from ancient to modern times. Recommended to be taken during first semester of graduate studies.

G 550 Seminar in Geography 3 cr. (R-9) Offered intermittently. Prereq., consent of instr. Seminar topics in geography and society, human-environmental interaction, physical geography, regional geography, or geographical techniques.

G 560 Seminar in Planning 3 cr. Offered spring odd-numbered years. A critical analysis of land planning history, theory, approaches, and practice. Emphasis is on the United States and England.

G 561 Land Use Planning Law 3 cr. Offered autumn. Same as EVST 561 and LAW 687. Basic overview of the law of land-use planning including, background in the traditional governmental regulatory, proprietary, and fiscal land use tools. Examination of modern techniques

for land-use planning; consideration of constitutional limits of the authority of state and local governments. Focus on skills in interpreting, drafting, and applying state legislation and local ordinances.

G 562 Land Use Planning Clinic 1-6 cr. (R-6) Offered every term. Prereq. or coreq., GEOG 561. Same as EVST 562. Students assist local communities in long-range planning efforts and development of growth management plans as required by Montana law; ordinance drafting, development proposals, and land use issues.

G 564 Planning Design 3 cr. Offered spring even-numbered years. Prereq., graduate standing or qualified seniors. Analysis of land-use problems and design.

G 578 Preceptorship in Geography 1-3 cr. (R-6) Offered autumn and spring. Prereq., graduate standing, suitable coursework, and consent of instr. Assisting a faculty member by tutoring, helping students with research projects, and carrying out other class-related activities.

G 580 Seminar in GIS and Cartography 3 cr. (R-9) Offered spring. Prereq., consent of instr. Seminar topics in cartography and GIS. Applications to advanced studies in human and physical geography.

G 587 Digital Image Analysis and Modeling 3 cr. Offered spring. Prereq., GPHY 487 (GEOG 487) or FOR 351 or consent of instr.; coreq., GPHY 589 (GEOG 589). Advanced topics in image analysis (e.g., hyperspectral images and pattern-recognition-based classification) and foundations of simple raster-based models.

G 588 Vector GIS 3 cr. Offered autumn. Prereq., consent of instr.; coreq., GPHY 589 (GEOG 589). Applications of GIS in human geography. Mapping and map analysis methods employing census data, TIGER Files, city and county data bases, county surveyors maps, and others. Theory, concepts, and practices of GIS focusing on the vector data model.

G 589 Cartography/GIS Laboratory 1 cr. (R-4) Offered autumn and spring. Laboratory to accompany GPHY 587 or 588.

G 595 Special Topics Variable cr. (R-9) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

G 596 Independent Study Variable cr. (R-9) Offered every term. Prereq., consent of instr. Independent research in geography or planning.

G 598 Internship Variable cr. (R-9) Offered every term. Prereq., consent of instr. Extended classroom experience which provides practical application of classroom learning during placements off campus.

G 599 Thesis Variable cr. (R-6) Offered every term. Prereq., consent of advisor.

Faculty

Professors

- Jeffrey A. Gritzner, Ph.D., The University of Chicago, 1986
- Christiane von Reichert, Ph.D., University of Idaho, 1992
- Paul B. Wilson, Ph.D., University of Nebraska, 1972

Associate Professor

- Sarah J. Halvorson, Ph.D., University of Colorado-Boulder, 2000
- Ulrich Kamp, Doktor der Naturwissenschaften, Technical University of Berlin, 1999
- David D. Shively, Ph.D., Oregon State University, 1999

Assistant Professor

- Anna Klene, Ph.D., University of Delaware, 2005

Lecturers and Adjuncts

- Udo Fluck, Ph.D., The University of Montana, 2003 (Director, Multicultural Learning Solutions)
- Richard Graetz, D.H.L. (Hon), The University of Montana, 2004
- Thomas Sullivan, M.A., The University of Montana, 1995

Emeritus Professors

- John M. Crowley, Ph.D., University of Minnesota, 1964
- Evan Denney, Ph.D., University of Washington, 1970
- John J. Donahue, Jr., Ph.D., Syracuse University, 1971
- Chris Field, Ph.D., University of California, Los Angeles, 1966

- **Darshan S. Kang, Ph.D., University of Nebraska, 1975**

Department of Geosciences

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William Woessner, Chairman

The Science of Earth directly involves the study of natural geological processes and the interactions of these processes with the environment. The major in Geosciences prepares students to assist society in understanding and addressing complex science-based challenges such as climate change and the utilization of finite energy, mineral, and water resources. Geoscientists are involved in deciphering both ancient and modern records that record Earth history.

Geoscientists advance our understanding of earthquakes, landslides, severe storms, and volcanic eruptions; explore the history of life; investigate changing glacial landscapes and watersheds; evaluate the inner-workings of our planet; and search for natural resources including oil, gas, water, and minerals. Our classrooms include field and laboratory settings in which inquiry-based learning helps students develop skills in creative thinking and problem solving. Geoscientists completing our program are employed by private industry; federal, state, and local governmental agencies; environmental consulting firms; non-profit organizations; and by secondary schools needing earth science teachers. Our graduates have a wide range of educational employment opportunities. They are sought after to work in other natural science fields and as graduate students. Jobs in geosciences are available at the B.S., M.S. and Ph.D. levels. The M.S. degree is highly prized by employers and is considered the working professional degree. The Ph.D. degree is required for positions at universities and with companies specializing in research.

The Department of Geosciences offers five B.S. degree options, an M.S. degree, and a Ph.D. degree. The B.S. degrees include Interdisciplinary Geosciences, Geosciences, Earth Science Education, and two transatlantic institutionally shared degrees: International Field Geosciences Joint B.S. Degree with the University College of Cork (Ireland), and an International Field Geosciences Dual B.S. Degree with Potsdam University (Germany). All degree programs in the department require a student to develop a strong background in geosciences and a sound foundation in other sciences.

High School Preparation: In addition to the general requirements for University admission, recommended high school preparation includes a solid background in mathematics and science.

Special Degree Requirements

See index.

Science courses designed for education majors may not be counted toward Geosciences Department science requirements. Geosciences courses and allied science courses must be taken for a traditional grade.

The Upper-division Writing Expectation must be met by successfully completing an upper-division writing course from the approved list in the Academic Policies and Procedures section of this catalog or by completing GEO 499 (GEOS 499). See index.

The Geosciences Department offers four options for students wishing to major in geosciences. The first option is a highly flexible program designed for those who wish to double major in another science or who simply wish to acquire a broad education of their own design. It features a minimum number of specifically required courses in geosciences and other sciences. The remaining three options are designed for students who desire a more defined path through our curriculum or who are seeking certification to teach. Some paths in each of the options may require prerequisites that are not specifically listed or required.

Interdisciplinary Geosciences B.S.

This flexible option requires the following courses in Geosciences: GEO 101N (GEOS 100N), GEO 102N (GEOS 101N), GEO 211 (GEOS 200), GEO 226 (GEOS 226), and GEO 231 (GEOS 230). In addition, thirteen credits of Geoscience coursework must be taken, relevant to student interests, at the 200, 300, or 400 levels. A minimum of 27 credits from the Geosciences curriculum is required to earn this degree. In addition to 27 credits in Geosciences, at least 27 credits from recognized cognate science classes are required to earn this degree. Required classes include CHMY 121N (Chemistry 151N) or CHMY 141N (Chemistry 161N); M 151 (Math 121) or a more advanced math class; and three credits in Computer Science (modeling or programming), or GIS or Statistics. Additional cognate science courses must be completed from the list below such that the sum of all cognate science classes is a minimum of 27 credits. Student curricular planning should include awareness of prerequisites as listed in this catalog.

CHMY above 121N (CHEM 151N); MATH above M 151 (MATH 121); CS 131 or above; PHYS 111N or above; BIOL 100N or above; FOR 210N Introductory Soils, FOR 360 Range Management; FOR 380S Environmental Conservation

At the discretion of the academic advisor, other sciences courses such as some courses in physical geography may also be acceptable.

Geosciences B.S.

This option is designed for students who seek post-graduate employment as a professional geoscientist and has two major suggested courses of study; Earth History, Evolution and Earth Resources, and Water, Climate, and Environment. The following Geosciences courses are required to earn this degree: GEO 101N (GEOS 100N), GEO 102N (GEOS 101N), GEO 211 (GEOS 200), GEO 226 (GEOS 226), and GEO 231 (GEOS 230).

Earth History, Evolution, and Earth Resources

- GEO 305 (GEOS 306) Igneous and Metamorphic Petrology..... 4
- GEO 310 (GEOS 310) Invertebrate Paleontology..... 3
- GEO 311 (GEOS 311) Paleobiology..... 3
- GEO 327 (GEOS 327) Geochemistry..... 4
- GEO 315 (GEOS 330) Structural Geology..... 3
- GEO 429 (GEOS 429) Field Geology..... 6
- GEO 433 (GEOS 430) Global Tectonics..... 3
- GEO 442 (GEOS 432) Architecture of Sedimentary Deposits..... 4
- GEO 443 (GEOS 433) Sedimentary Petrology..... 4
- GEO 437 (GEOS 437) Seismology and Magnetics..... 4
- GEO 438 (GEOS 438) Gravity and Magnetics..... 4
- GEO 460 (GEOS 460) Process Geomorphology..... 4

Water, Climate, and Environment

- GEO 320 (GEOS 320) Global Water..... 4
- GEO 327 (GEOS 327) Geochemistry..... 4
- GEO 315 (GEOS 382) Structural Geology..... 3
- GEO 382 (GEOS 302) Global Change..... 3
- GEO 391 (GEOS 395) Special Topics..... 3
- GEO 442 (GEOS 432) Architecture of Sedimentary Deposits..... 4
- GEO 443 (GEO 433) Sedimentary Petrology..... 4
- GEO 437 (GEOS 437) Seismology and Magnetics..... 4
- GEO 438 (GEOS 438) Gravity and Magnetics..... 4
- GEO 460 (GEOS 460) Process Geomorphology..... 4
- GEO 420 (GEOS 480) Hydrogeology..... 4

At least 32 credits of Geoscience courses must be completed, of which 18-24 are upper-division (300-400 level) credits.

In addition to completing the coursework in Geosciences, students must also complete a minimum of 30 credits in cognate sciences classes. Required are the following: PHYS 111N/113N-112N/114N or PHYS 211N/213N-212N/214N; CHMY 121N/122N/123N/124N (CHEM 151N/152N/154N) or CHMY 141N/143N (CHEM 161N/162N); M 162/274 (MATH 150/158) or M 171/172 (MATH 152/153); three credits in Computer Science (modeling or programming), or GIS, or Statistics.

Additional cognate science courses must be completed such that the sum is a minimum of 30 credits. These may include additional courses in Chemistry, Computer Science, Math, and Physics above the listed minimum levels specified above. Biology 100N or above is also appropriate, but substitutions or other science courses must be approved by the student's advisor.

International Field Geosciences Joint B.S. Degree with University College of Cork (Ireland)

This option is designed specifically for students who seek to combine a rigorous education in the Geosciences with a year long international geosciences experience and an emphasis on field-based learning. It requires attending classes and living overseas. Student demonstrating a high level of performance at the University will be eligible for partial financial support as funds are available. Although most of the course work completed during the year abroad will take place at University College Cork in Ireland, additional course work is required at Potsdam University in Germany. For students who satisfy all degree requirements, a B.S. degree in International Field Geosciences will be jointly awarded by The University of Montana and the University College Cork.

The following UM Geoscience courses are required to earn this degree: GEO 101N (GEOS 100N); GEO 102N (GEOS 101N); GEO 108N (GEOS 108N); GEO 211 (GEOS 200); GEO 226 (GEOS 226); GEO 231 (GEOS 230); GEO 315 (GEOS 330); GEO 442 OR 443 (GEOS 432 or 433); and GEO 429 (GEOS 429). Also required are a minimum of 12 credits in upper division UM Geoscience courses selected from among the following: GEO 305,310, 311, 320, 327, 420, 433, 442, 443, 460,491 (GEOS 306, 310, 311, 320, 327, 430, 432, 433, 460, 480, 495) plus GRMN 101/102.

In addition to Geoscience coursework completed at UM, students must complete one formal field course run by the Institute for Geosciences at Potsdam University to sites in Europe (arranged in consultation with advisor) plus one formal field course module run by University College Cork, selected from GL 2016 (pre-Easter Field Course-Scotland), GL3019 (Easter Field Course-Greece), GL4008 (Easter Field Course-Canary Islands). In addition, while in residence at Cork, students must complete any nine of the following courses in consultation with their UM advisor:

- GL2011 Sedimentologic Processes and Petrology

- GL2012 Igneous and Metamorphic Petrology
- GL2015 Invertebrate Paleontology and Evolution
- GL2018 Plate Tectonics and Global Geophysics
- GL3010 Igneous Petrogenesis and Geochemistry
- GL3012 Advanced Structural Geology
- GL3013 Sedimentary Environments
- GL3014 Stratigraphy and Geologic Maps
- GL3017 Environmental Geology
- GL3024 Terrestrial Ecosystems Through Time
- GL4001 Micropaleontology and Palynology
- GL4003 Petroleum Geology and Basin Analysis
- GL4003 Applied Geophysics and Computer Applications
- GL4004 Advanced Igneous Petrology
- GL4005 Hydrogeology
- Metamorphism & Geochronology

Students seeking this degree must also complete one additional formal upper-level Geosciences course at Potsdam University during their year abroad. Recommended are courses that focus on computer-based visualization of geoscience data, using GIS or other visualization platforms. Along with the formal Geoscience course work completed at UM and abroad, students earning this degree must complete a minimum of 27 credits in cognate sciences classes, including the following: PHYS 111N/113N-112N/114N or PHYS 211N/213N-212N/214N; CHMY 121N/122N (CHEM 151N/153N) and CHMY 123N/124N (CHEM 152N/154N) or CHMY 141N/143N (CHEM 161N/162N); M 162/274 OR M 171/172 (MATH 150/158 or MATH 152/153); three credits in Computer Science (modeling or programming), or GIS or Statistics. Also required is one year of college German, GRMN 101/102 (GERM 101/102) and completion of general education requirements relevant to German and Irish culture and history.

International Field Geosciences Dual Degree with Potsdam University (Germany)

This option is designed specifically for students who seek to combine a rigorous education in the Geosciences with a year long international geosciences experience and an emphasis on field-based learning. It requires attending classes and living overseas. Students demonstrating a high level of performance at the University will be eligible for partial financial support as funds are available. Although most of the course work completed during the year abroad will take place at University Potsdam in Germany, additional course work is required at the University College Cork in Ireland. For students who satisfy all degree requirements, a B.S. degree in Geosciences will be awarded by The University of Montana and a second B.S. degree in International Field Geosciences will be awarded by Potsdam University.

The following UM Geoscience courses are required to earn this degree: GEO 101N (GEOS 100N); GEO 102N (GEOS 101N); GEO 108N (GEOS 108N); GEO 211 (GEOS 200); GEO 226 (GEOS 226); GEO 231 (GEOS 230); GEO 326 (GEOS 302); and GEO 429 (GEOS 429). Also required are a minimum of 15 credits in upper division UM Geoscience courses selected from among the following: GEO 305, 310, 311, 320, 327, 315, 433, 442, 443, 437, 438, 460, 420, 491 (GEOS 306, 310, 311, 320, 327, 330, 430, 432, 433, 437, 438, 460, 480, 495).

In addition to Geoscience coursework completed at UM, the following overseas field-based Geoscience courses are required: BP15 (Field course C–France, run by Potsdam) or both BW01 (Field course-Norway, run by Potsdam) and BW02 (Field course-Alps, run by Potsdam); plus one of the following courses offered by University College Cork; GL 2016 (pre-Easter Field Course-Scotland), GL3019 (Easter Field Course-Greece), GL4008 (Easter Field Course-Canary Islands). Students seeking this degree must also complete any four of the following courses offered by Potsdam University:

- BW04 Regional Geology (6)
- BW05 Paleoclimate and Quaternary Geology (6)
- BW06 Analysis of Geologic Maps(6)
- BW07 Analytic Geochemistry (6)
- BW16 Natural Hazards (6)
- BW15 Tectonophysics and Rheology (6)
- BW11 Seismology (6)
- BW12 Seismics (6)
- BW13 Geoelectrics (6)
- BWP05 Sedimentary Systems and Stratigraphy (6)
- BWP06 Geomorphology (6)
- BWP16 Tectonics and Geodynamics (6)

Along with the formal Geoscience course work, students earning this degree must complete a minimum of 27 credits in cognate sciences classes, including the following: PHYS 111N/113N-112N/114N or PHYS 211N/213N-212N/214N; CHMY 121N/123N (CHEM 151N/152N) or CHMY 141N/143N (CHEM 161N/162N); M 162/274 (MATH 150/158) or M 171/172 (MATH 152/153); three credits in Computer Science (modeling or programming), or GIS or Statistics. While overseas, the students must complete two of the following cognate science courses at Potsdam University:

- BWP07 Basics in GIS
- BWP08 Basics in Remote Sensing
- BWP09 Numerical Methods
- BWP10 Basic Data Analysis

Also required is one year of college German GRMN 101/102 (GERM 101/102) and completion of general education requirements relevant to German and Irish culture and history.

Option in Earth Science Education

Major Teaching Field of Earth Science: A student must complete GEO 101N, 102N, 105N, 231, 226, 301, 310, 315 (GEOS 100N, 101N, 105N, 230, 226, 301, 310, 330), 3 additional credits from any geosciences course numbered 100 or above and 12 credits from any geosciences courses numbered 300 or above. Also required are GPHY 303N, ASTR 131N-132N, M 151, STAT 341 (MATH 121, 341), CS 101, CHMY 485 (CHEM 485), and C&I 426. One of BIOL 121N-122N or CHMY 121N/123N (CHEM 151N-152N) or PHYS 111N/113N or 112N/114N must be completed.

For endorsement to teach earth science, a student also must gain admission to Teacher Education and Student Teaching and meet the requirements for certification as a secondary teacher (see the School of Education section of this catalog). The demand in most Montana high school for teaching in this field may be limited, and students must complete the requirements for the required second teaching endorsement (major or minor).

Suggested Course of Study

For questions concerning your special interests or preparation, see a geology advisor.

Interdisciplinary Geosciences B.S.

First Year	A	S
CHMY 121N/122N (CHEM 151N/153N) or CHMY 141N (CHEM 161N)	4(5)	–
CHMY 123N/124N or CHMY 143	–	5
WRIT 101 (ENEX 101) College Writing I	3	–
GEO 101N/102N (GEOS 100N) Intro to Physical Geology	4	–
GEO 108N (GEOS 108N) Climate Change	–	3
CS 172 Intro to Computer Modeling	–	3
General Education	5(4)	4
	16	15
Second Year	A	S
M 151 (MATH 121) Precalculus	4	–
M 171 (MATH 152) Calculus	–	4
FOR 210N Introductory Soils	4	–
GEO 211 (GEOS 200) Earth History and Evolution	4	–
GEO 226 (GEOS 226) Earth Materials	–	4
GEO 231 (GEOS 230) Geosciences Field Methods	–	4
Electives and General Education	3	3
	15	15
Third Year	A	S
PHYS 111N/113N-211N/213N	5	–
Additional cognate science*	–	5
GEO any 300 and above	6	6
Electives and General Education	4	4
	15	15
Fourth Year	A	S
GEO any 300 and above	6	6
Additional cognate science*	3	3
Electives and General Education	6	6
	15	15

*Suggested, a total of 30 additional science credits are required. See special degree requirements.

Geosciences B.S.

First Year	A	S
CHMY 121N/122N (CHEM 151N/153N) or CHMY 141N (CHEM 161N)	4(5)	–
CHMY 123N/124N (CHEM 152N/154N) or CHMY 143N (CHEM 162N)	–	5
WRIT 101 (ENEX 101) College Writing I	3	–

GEO 101N (GEOS 100N) 102N Intro to Physical Geology	4	–
GEO 108N (GEOS 108N) Climate Change	–	3
CS 172 Intro to Computer Modeling	–	3
M 151 (MATH 121) Precalculus (if needed)	–	4(0)
General Education	2(1)	3(7)
	13	18

Second Year

	A	S
M 171 (MATH 152) Calculus	4	–
M 172 (MATH 153) Calculus II	–	4
GEO 211 (GEOS 200) Earth History and Evolution	4	–
GEO 226 (GEOS 226) Rocks, Minerals, and Resources	4	–
GEO 231 (GEOS 230) Geosciences Field Methods	–	4
Electives and General Education	3	7
	15	15

Third Year

	A	S
PHYS 111N/113N (211N/213N)	5	–
PHYS 112N/114N-212N/214N	–	5
GEO at 300 level or above	6	6
Electives and General Education	4	4
	15	15

Fourth Year

	A	S
GEO at 300 level or above	6	6
Additional cognate science*	3	3
Electives and General Education	6	6
	15	15

*Suggested, a total of 30 additional science credits are required. See special degree requirements.

International Field Geosciences Joint B.S. Degree with University College Cork (Ireland)

	First Year	A	S
CHMY 121N/122N (CHEM 151N/153) (or CHMY 141N)		4	–
CHMY 123N/124N (CHEM 152N/154N) (or CHMY 143N)		–	5
WRIT 101 (ENEX 101) College Writing I		3	–
GEO 101N (GEOS 100N)–102N Intro to Physical Geology and Lab		4	–
GEO 108N (GEOS 108N) Climate Change		–	3
GEO 211 (GEOS 200) Earth History and Evolution		–	3
M 151 (MATH 121) Precalculus (if needed)		–	4(0)
General Education		5	0(4)
		16	15
	Second Year	A	S
M 171 (MATH 152) Calculus (or M 162)		4	–
M 172 (MATH 153) Calculus II (or M 274)		–	4
GEO 226 (GEOS 226) Rocks, Minerals and Resources		4	–
GEO 231 (GEOS 230) Geosciences Field Methods		4	–
GEO 315 (GEOS 330) Structural Geology		–	3
GEO 442 (GEOS 432) Architecture of Sedimentary Deposits or GEO 443 (GEOS 433) Sedimentary Petrology		–	4
GRMN 101 (GERM 101) Elementary German I		5	–
GRMN 102 (GERM 102) Elementary German II		–	5
		17	16
	Summer (in Potsdam)		
Field Course (Potsdam)		3	
Visualization Course (Potsdam)		3	
GEO 429 Field Course (UM)		6	
	Third Year (in Cork)	A	S
Formal GL field courses		–	5
Formal GL classroom courses		10.5	2.5

General Education		2.5	2.5
		13	10
	Summer		
GEO 429 (GEOS 429) Field Geology		6	
	Fourth Year	A	S
PHYS 111N/113N (211N/213N)		5	–
PHYS 112N/114N (212N/214N)		–	5
GEO at 300 level or above		6	6
Electives and General Education		4	4
		15	15

International Field Geosciences Dual Degree with Potsdam University (Germany)

	First Year	A	S
CHMY 121N/122N (CHEM 151N/153N)		4	–
CHMY 123N/124N (CHEM 152N/154N)		–	5
WRIT 101 (ENEX 101) College Writing I		3	–
GEO 101N (GEOS 100N)–102N Intro to Physical Geology and Lab		4	–
GEO 108N (GEOS 108N) Climate Change		–	3
GEO 211 (GEOS 200) Earth History and Evolution		–	3
M 151 (MATH 121) Precalculus (if needed)		–	4(0)
General Education		5	0(4)
		16	15
	Second Year	A	S
M 171 (MATH 152) Calculus (or M 162) (or MATH 150)		4	–
M 172 (MATH 153) Calculus II (or M 274) (or MATH 158)		–	4
GEO 226 (GEOS 226) /Rocks, Minerals and Resources		4	–
GEO 231 (GEOS 230) Geosciences Field Methods		4	–
GEO 326 (GEOS 302) Sedimentary Geology Field Trip		–	2
GRMN 101 (GERM 101) Elementary German I		5	–
GRMN 102 (GERM 102) Elementary German II		–	5
Electives and General Education		–	4
		17	15
	Summer (in Potsdam)		
BP15 (or BW01 and BW02)		6	
	Third Year (in Potsdam)	A	S
Formal BP or BWP class work		6	6
BWP cognate science classes		3	3
Electives and General Education		3	3
		12	12
	Winter (in Cork)		
Formal GL field courses		–	2.5
	Fourth Year		
PHYS 111N/113N (211N/213N) (221N)		5	–
PHYS 112N/114N (212N/214N) (222N)		–	5
GEO at 300 level or above		6	6
Electives and General Education		4	4
		15	15

Earth Science Education Option

	First Year	A	S
CS 172 Introduction to Computer Modeling or equivalent		–	3
WRIT 101 (ENEX 101) College Writing I		3	–
GEO 101N (GEOS 100N)–102N Intro to Physical Geology and Laboratory		4	–

GEO 105 (GEOS 105) Oceanography	–	2
GEO 231 (GEOS 230) Geosciences Field Methods	–	3
M 151 (MATH 121) Precalculus	4	–
PSYX 100S (PSYC 100S) Introduction to Psychology	4	–
*Electives and General Education	3	6
	18	14

Second Year

	A	S
ASTR 131N–132N Elementary Astronomy I, II	3	3
CHMY 121N (CHEM 151N) General and Inorganic Chemistry	3	–
GEO 226 (GEOS 226) Rocks, Minerals and Resources	–	4
GEO 301 (GEOS 301) Environmental Geology	3	–
GEO any 100	–	3
*Electives and General Education	6	6
	15	16

Need to formally gain admission to the Teacher Education Program. See requirement in the School of Education, Department of Curriculum and Instruction. Deadlines: March 1 and October 1.

Third Year

	A	S
CHMY 485 (CHEM 485) Laboratory Safety	–	1
C&I 200 Exploring Teaching Through Field Experience	2	–
C&I 303 Educational Psychology & Measurements	–	4
C&I Other	3	6
ERTH 303N (GEOG 322N) Meteorology	3	–
GEO 310 (GEOS 310) Invertebrate Paleontology	3	–
GEO 315 (GEOS 330) Structural Geology	3	–
GEO any 300 or above	3	6
	17	17

Fourth Year

	A	S
C&I 426 Teaching Science in Middle and Secondary Schools	3	–
C&I Other	–	6
GEO any 300 or above	3	–
*Electives and General Education	9	12
	15	18

*C&I recommends a minor teaching field. A fifth year may be required to obtain a minor field endorsement.

Requirements for a Minor

To earn a minor in Geosciences the student must complete GEO 101N (GEOS 100N), 102N, 226, 231 plus at least 12 credits in other geoscience courses numbered 300 or above. All courses must be taken for a traditional letter grade.

Courses

U = for undergraduate credit only, UG = for undergraduate or graduate credit, G = for graduate credit. R after the credit indicates the course may be repeated for credit to the maximum indicated after the R. Credits beyond this maximum do not count toward a degree.

Geosciences (GEO)

U 101N (GEOS 100N) Intro to Physical Geology 3 cr. Offered autumn and spring. General geology including the work of wind, flowing water, glacial ice, gravity, earthquakes, volcanoes and plate tectonics in shaping the earth.

U 102N (GEOS 101N) Intro to Physical Geology Laboratory 1 cr. Offered autumn and spring. Prereq. or coreq., any geoscience courses below GEO 130. A series of laboratory and field experiences designed around basic geologic processes and materials. Familiarization with common minerals, rocks, land forms, and structures. Intended to provide laboratory experience with any geoscience course below GEO 130.

U 105N Oceanography 3 cr. Offered alternate spring semesters. Origin of sea–water and ocean basins; currents, tides, and coastal processes; use and misuse of the oceans by humans.

U 106N History of Life 3 cr. Offered autumn. The evolution of plants, invertebrates and vertebrate animals, highlighting major events in the evolution of life on Earth. Includes laboratory experience with fossils.

U 107N (GEOS 103N) Natural Hazards 3 cr. Offered spring. Examination of volcanism, earthquakes, landslides, floods, coastal erosion, hurricanes, and asteroid impacts. Emphasis on processes, recognition and consequences of catastrophic events, and how to minimize their societal impacts.

U 108N Climate Change 3 cr. Offered autumn. The geoscience perspective on the earth's climate system. Climate processes and feedbacks, climate history from early earth to the ice ages, present and future changes due to natural processes and human activities.

U 191 (GEOS 195) Special Topics Variable cr. (R–6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one–time offerings of current topics.

U 207 Geological Hazards and Disasters 2 cr. Offered spring. Prereq., minimum grade of C in any 100-level geoscience course except 106. Study of major geological catastrophes, their causes and effects. Probability, frequency and recurrence intervals, magnitudes, the role of overlapping/ unrelated events. Examples of floods, hurricanes, landslides, submarine landslides, tsunamis, earthquakes, volcanic eruptions, asteroid impacts.

U 211 (GEOS 200) Earth History and Evolution 3 cr. Offered spring. Prereq., any 100–level GEO course. Traces the history of the earth since its inception 4.5 billion years ago. Presents scientific theories for the origin of the earth and the nature of important earth shaping events of the past, including the development of the oceans, atmosphere and climate..

U 226 Rocks, Minerals and Resources 4 cr. Offered autumn and spring. Prereq., any geoscience 100–level lecture course, GEO 102N (GEOS 101N), CHMY 121N or 141N (CHEM151N or CHEM 161N). Study of minerals and rocks utilizing an Earth Systems approach; mineral identification and paragenesis; survey of the distribution of minerals from the interior to the surfaces of planets and the processes that led to their formation.

U 231 (GEOS 230) Geosciences Field Methods 3 cr. Offered autumn and spring. Prereq., GEO 101N-102N (GEOS 100N–101N). Field methods and interpretations. This course introduces students to a variety of field methodologies routinely used in the collection and interpretation of geoscientific field data.

U 260 River Systems 3 cr. Offered spring alternate years. Hydrologic and geomorphic basis of environmental management problems concerning river systems. Analysis of the processes of flooding, sedimentation, and morphological change in channels, flood plains, deltas, and alluvial fans. Effects of climate, land use and engineering.

U 291 (GEOS 295) Special Topics Variable cr. (R–6) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one–time offerings of current topics.

U 301 Environmental Geology 3 cr. Offered autumn. Prereq., GEO 101N-102N, (GEOS 100N–101N, 130); M 115 or 151 (MATH 117 or 121); CS 172 or equiv. experience with spread sheets and word processors. Human effects on geologic processes and the effect of geologic processes on humans. Group and independent research projects on local and regional environmental geology problems are used to teach scientific problem solving. Topics include population growth, management of surface and groundwater quantity and quality, resource use, global environmental change.

UG 326 (GEOS 302) Sedimentary Geology Field Trip 2 cr. Offered spring. Prereq., GEO 101N (GEOS 100N). Examination of modern and ancient sedimentary depositional systems in the field through a 9–day spring break field trip. Possible areas of focus include the Permian Reef Complex of West Texas, the California convergent margin, Oregon coastal processes, geology of the Basin and Range, Death Valley Region, Colorado Plateau, and Oklahoma Aulacogen.

U 304E Science and Society 3 cr. Offered autumn. Role of scientific knowledge in human societies from the pre–Classical to the present. Discussion of tools for integrating science into ethical, political, and social decisions, including analyses of modern case studies from physical sciences.

U 305 (GEOS 306) Igneous and Metamorphic Petrology 4 cr. Offered spring. Prereq., GEO 226 (GEOS 226), CHMY 143N (CHEM 162N). Igneous rock associations, igneous processes and origins; metamorphic minerals and phase relationships, metamorphic zones, facies, and conditions; metamorphic environments, metallic minerals and mineral deposits.

UG 310 Invertebrate Paleontology 3 cr. Offered autumn. Prereq., GEO 101N (GEOS 100N) or equiv. Principles of paleontology including morphology, classification and evolution of major groups of fossils and their application to paleoecology and biostratigraphy.

UG 311 Paleobiology 3 cr. Offered spring. Prereq., GEO 310 (GEOS 310) or equiv. Application of geologic and biologic principles to problems in paleontology.

UG 313 Curation Techniques 2 cr. Offered spring. Prereq., basic course in natural sciences. Instruction in basic techniques of managing natural history collections. Focus on practical applications.

U 315 (GEOS 330) Structural Geology 3 cr. Offered autumn. Prereq., GEO 226 (GEOS 226). Structures of deformed rocks; mechanical principles; graphical interpretation of structural problems, tectonic principles.

UG 317 (GEOS 309) Planetary Science 3 cr. Offered autumn even-numbered years. Prereq., PHYS 111N/113N or 211N/213N and M 162, 171 (MATH 150 or 152). Same as ASTR 351. Physical and geological characteristics of planets, satellites, asteroids, comets, and

meteoroids with an emphasis on comparative planetology.

U 320 Global Water 4 cr. Offered spring. Prereq., one semester of college chemistry, WRIT 101 (ENEX 101) or equiv. Study of the chemistry of water as it moves through the hydrological cycles; discussion of how water chemistry evolves through atmospheric water, precipitation, ground water, and surface water.

U 327 Geochemistry 4 cr. Offered autumn even-numbered years. Prereq., one year of college chemistry and one semester of geology. One semester of mineralogy recommended. Chemical principles applied to geologic processes. Origin and chemical composition of atmosphere and hydrosphere. Methods of radiometric dating and isotope applications.

UG 382 Global Change 3 cr. Offered intermittently. Prereq., consent of instr. Lectures, readings, and discussions on geological and geochemical processes that affect global change using recent literature; carbon dioxide buildup, greenhouse effect, ozone depletion, desertification, ice ages, and other global events.

U 391 (GEOS 395) Special Topics Variable cr. (R–9) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

U 392 (GEOS 396) Independent Study Variable cr. (R–6) Offered every term. Specific topics of particular interest to individual students.

U 398 Internship Variable cr. Offered every term. Prereq., 12 credits in geosciences. Extended classroom experience which provides practical application of classroom learning during placements off campus. Prior approval must be obtained from the faculty supervisor and the Internship Services office. No more than 3 credits of GEO 398 (GEOS 398) may be applied to the geosciences minor. A maximum of 6 credits of Internship (198, 298, 398, 498) may count toward graduation.

UG 407 Global Biogeochemical Cycles 3 cr. Offered spring odd numbered years. Same as FOR 408, BIOL/CCS 407. Exploration of how variations in the availability or utilization of critical Earth elements influences the atmosphere, the oceans, and the terrestrial biosphere including the natural and agricultural ecosystems on which we depend.

UG 420 (GEOS 480) Hydrogeology 4 cr. Offered autumn. Prereq., GEO 101N (GEOS 100N)-102N; PHYS 111N/113N or 211N/213N; M 162 OR 171 (MATH 150 or 152) strongly recommended. Occurrence, movement, quality, and methods of quantification of groundwater. Geological framework and physics of groundwater flow. Supply, contamination, and management problems.

U 425 Geology of the Pacific Northwest 3 cr. Offered intermittently. Prereq., GEO 101N (GEOS 100N). Narrative discussion of the evolutions of the Pacific Northwest from Archean time to present.

UG 426 (GEOS 402) Sedimentary Geology Field Trip 2 cr. Examination of sedimentary depositional systems through a nine-day spring break field trip off campus.

U 429 Field Geology 6 cr. Offered summer. Prereq., GEO 315 (GEOS 330) and consent of instr. Geologic mapping on aerial photos and topographic base maps. Field interpretation in a variety of rock types and structures. Taught every summer near Dillon, Montana. Extra fees. Pre-registration in early spring.

UG 433 (GEOS 430) Global Tectonics 3 cr. Offered spring. Prereq., GEO 315 (GEOS 330), M 162 (MATH 150), and 2.25 or better overall GPA in geosciences courses. Examination of large scale structural features of earth's surface and their relation to tectonic processes as well as active tectonic phenomena including seismicity, volcanism, and crustal deformation.

UG 436 Subsurface Imaging in Archaeology 3 cr. Offered Spring. Prereq., successful completion of UM general education requirements for math and natural science. Applied and theoretical aspects of radar, magnetics, gravity, and electrical methods related to the detection of buried archaeological features. The focus is on the development of experimental design, data acquisition, processing, and interpretation. Course content is also applicable to shallow environmental sources and problems.

UG 437 Seismology and Magnetics 4 cr. Offered autumn. Prereq. or coreq., M 172 (MATH 153), GEO 101N-102N (GEOS 100N-101N), PHYS 111N/113N. Theory and global aspects of seismology and magnetics as well as their practical application to environmental problems.

UG 438 Gravity and Magnetics 4 cr. Offered Spring. Prereq. or coreq., M 172 (MATH 153), GEO 101N (GEOS 100N)-102N, PHYS 111N/113N. GPS, gravity, and electromagnetic methods with acquisition, processing, and interpretation of locally-collected data. Applications include environmental and crustal scale imaging, tectonic processes, and whole-earth models.

UG 442 (GEOS 432) Architecture of Sedimentary Deposits 4 cr. Offered spring. Study of the architectural elements and composition of sedimentary deposits in the context of their tectonic environments and their influence on petroleum and hydrogeologic systems.

UG 443 (GEOS 433) Sedimentary Petrology 4 cr. Offered spring. Prereq., graduate standing or GEO 442 (GEOS 432). Field, hand specimen and thin section petrology of siliciclastic and carbonate rocks, emphasis on tectonic and diagenetic interpretation of siliciclastic rock and environments of deposition and diagenesis of carbonate rocks.

UG 460 Process Geomorphology 4 cr. Offered autumn, alternate years. Coreq., one year college calculus and physics. Quantitative examination of landforms, runoff generation, weathering, mechanics of soil erosion by water and wind, mass wasting, glacial and periglacial

processes and hillslope evolution.

UG 469 (GEOS 465) Computer Modeling in the Physical Sciences with Matlab 3 cr. Offered spring alternate years. Coreq., one year college calculus and physics. Introduction to Matlab and writing and using computer models to address typical problems faced by physical scientists. Topics include heat diffusion, carbon storage, and landscape evolution. No previous computer experience required.

UG 488 Snow, Ice and Climate 3 cr. Offered spring. Prereq., M 121 (MATH 100). Study of basic physical processes occurring in snow and ice, and how these processes govern the interaction between frozen water and the climate system. The first half of the course focuses in snow, with special attention to snow formation in the atmosphere, snow metamorphism, water flow through snow, and basic avalanche mechanics. The second half of the course focuses on ice and includes glacier and ice sheet flow dynamics, glacier hydrology, and ice age theory. Graduate students will be required to complete additional problem sets requiring higher level math; perform additional reading assignments; perform at a higher level on assignments and exams where students are asked to outline and describe various physical processes; submit a well researched and reference research proposal that is able to synthesize previous research and provide a sophisticated research plan.

UG 491 (GEOS 495) Special Topics 1-8 cr. (R-8) Offered intermittently. Experimental offerings of visiting professors, experimental offerings of new courses or one-time offerings of current topics.

UG 492 (GEOS 496) Independent Study Variable cr. (R-6) Offered every term. Specific topics of particular interest to individual students.

U 493 Omnibus Variable cr. (R-10) Offered intermittently. Independent work under the University omnibus option. See index.

UG 494 Senior Geology Seminar 1-10 cr.(R-10) Offered intermittently. Prereq., upper-division standing in geosciences or consent of instr. Independent study of various topics under the direction of a faculty member.

U 499 Senior Thesis/Capstone 3-10 cr.(R-10) Offered every term. Prereq., 18 credits in geosciences. Independent research project in any geosciences topic supervised by faculty member, and leading to completion of baccalaureate degree.

G 502 Thesis/Dissertation Proposal 1 cr. Offered spring. Work with advisors to choose a research project and write a proposal.

G 508 Fundamentals of Academic Research 3 cr. Offered fall. Prereq., graduate standing. An introduction to research methods and tools in the academic setting intended for first semester graduate students in geosciences. Topics include proposal writing, presenting research results in oral and written formats, using computer tools for research in the geosciences, and ongoing research of department faculty.

G 522 Metamorphic Terrain Analysis 3 cr. Offered autumn. Introduction to techniques used to analyze burial and uplift histories of metamorphic terrains. Topics include: geochronology, including closure temperature theory and the use of geochronologic systems as thermochronometers; geothermometry and geobarometry; quantitative thermodynamic modeling of P-T paths; heat flow and the thermal structure of orogenic belts.

G 528 Sedimentary Basin Analysis 4 cr. Offered autumn. Influence of allocyclic processes (tectonism, climate, eustacy, etc.) in shaping the evolution of sedimentary basins. Emphasis on integration and synthesis of tools of sedimentary basins analysis, including the study of depositional systems, provenance, paleocurrents, subsidence, sequence stratigraphy, and well logs.

G 531 Environmental Geochemistry of Metal Contamination 4 cr. Offered autumn. Prereq., GEO 570, 579 (GEOS 570, 579); CHMY 442 (CHEM 442); FOR 511 or consent of instr. Integration of major processes and cycles transporting, fixing, and transforming inorganic contaminants in aquatic systems, soils, sediments and subsurface environments. Concentration on research to solve complex environmental problems.

G 548 Topics in the Cryosphere 3 cr.(R-6 M.S., R-12 Ph.D.) Offered spring. Prereq., graduate standing or consent of instructor. Readings, discussions, lectures, and field experiments on various topics related to snow, ice, and climate processes. Recent topics: meltwater infiltration in snow, glacier hydrology, climate cycles, ice, and sea level rise.

G 560 Fluvial Geomorphology 4 cr. Offered intermittently. Prereq., one year college calculus and physics. Application of fluid mechanics to sediment transport and development of river morphology. Form and process in river meanders, the pool-riffle sequence, aggradation, grade, and baselevel.

G 570 Advanced Geochemistry 4 cr. Offered autumn even-numbered years. Prereq., one year college chemistry. Chemistry of aqueous systems including aqueous kinetics, aqueous thermodynamics, acid/base chemistry, carbonate systematics, oxidation/reduction reactions, mineral solubility, and complexation. Includes an introduction to the use of geochemical models. Concepts applied to natural systems.

G 572 Advanced Hydrogeology 3 cr. Offered spring. Prereq., GEO 420 (GEOS 480) or consent of instr. Advanced concepts used in groundwater investigations, including flow systems analysis, hydrogeologic monitoring and sampling, resource evaluation, exploration, development and monitoring, and contaminant transport. Special problem areas in groundwater exploration and management.

G 573 Applied Groundwater Modeling 3 cr. Offered autumn. Prereq., GEO 420 (GEOS 480) and consent of instr. Development of numerical modeling techniques, finite difference and finite element modeling of groundwater flow systems. Application of standard 2D and

3D models to field problems.

G 575 Clays and Clay Petrology 3 cr. Offered spring. Prereq., consent of instr. Clay mineralogy including fundamental particle theory; x-ray identification methods. Origins of clays; petrology of shales through low-grade metamorphism.

G 579 Geochemistry of Hot Springs 3 cr. Offered autumn, even-numbered years. Prereq., one year of college of chemistry or consent of instr. Chemistry and geology of hydrothermal systems including solute/gas geothermometry, acid/base reactions, oxidation/reduction reactions, mineral equilibrium, and microbial ecology as applied to terrestrial and submarine hydrothermal systems. Includes an introduction to the use of geochemical models.

G 580 Topics in Mineralogy and Petrology Variable cr. (R-6 for M.S., R-12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: tectonics and petrology; alkaline igneous rocks.

G 582 Topics in Structure and Geophysics Variable cr. (R-6 for M.S., R-12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: structural analysis, Precambrian crustal evolution, field trips on Rocky Mountain structure.

G 583 Topics in Stratigraphy, Sedimentation and Paleontology Variable cr. (R-6 for M.S., R-12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: evolution of life; Proterozoic stratigraphy; reefs through time.

G 585 Topics in Hydrogeology and Low-Temperature Geochemistry Variable cr. (R-6 for M.S., R-12 for Ph.D.) Prereq., consent of instr. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: field methods, well design, contaminant transport, geochemical modeling.

G 587 Topics in Geomorphology Seminar Variable cr. (R-6 for M.S., R-12 for Ph.D.) Offered spring. Prereq., consent of instr. Reading and discussion of relevant papers. Offerings on request of graduate students by arrangement with appropriate faculty. Recent topics: landscape evolution; weathering processes; tectonic geomorphology.

G 590 Supervised Internship 1-12 cr. Offered intermittently.

G 595 Special Topics Variable cr.(R-8) Offered intermittently. Prereq., consent of instr. Experimental offerings of visiting professors, experimental offerings of new courses, or one-time offerings of current topics.

G 597 Advanced Problems Variable cr.(R-10) Offered intermittently. Prereq., consent of instr. Investigations of geological problems exclusive of thesis or dissertation research.

G 599 Thesis Research Variable cr.(R-6) Offered every term. Prereq., thesis proposal approval. Directed research to serve as thesis for the master degree. Credit assigned upon submittal of final copy of approved and bound thesis.

G 699 Dissertation Research Variable cr.(R-12) Offered every term. Prereq., dissertation proposal approval. Directed research to serve as dissertation for the Ph.D. degree. Credit assigned upon submittal of final copy of approved and bound dissertation.

Faculty

Professors

- Marc S. Hendrix, Ph.D., Stanford University, 1992
- Nancy W. Hinman, Ph.D., University of California (San Diego), 1987
- Johnnie N. Moore, Ph.D., University of California (Los Angeles), 1976
- James W. Sears, Pd.D., Queen's University, 1979
- Steven D. Sheriff, Ph.D., University of Wyoming, 1981 (Chair)
- George D. Stanley, Ph.D., University of Kansas, 1977
- William W. Woessner, Ph.D., University of Wisconsin (Madison), 1978

Associate Professor

- Joel T. Harper, Ph.D., University of Wyoming, 1997

Assistant Professors

- Julia A. Baldwin, Ph.D., Massachusetts Institute of Technology, 2003
- Rebecca O. Bendick, Ph.D., University of Colorado, Boulder, 2000
- Marco P. Maneta, Ph.D., University of Extremadura (Spain), 2006
- Andrew C. Wilcox, Ph.D., Colorado State University, 2005

Emeritus Professors

- David Alt, Ph.D., University of Texas, 1961
- Donald W. Hyndman, Ph.D., University of California (Berkeley), 1964
- Ian M. Lange, Ph.D., University of Washington, 1968
- Raymond C. Murray, Ph.D., University of Wisconsin, 1955
- Graham R. Thompson, Ph.D., Case Western Reserve, 1971
- John P. Wehrenberg, Ph.D., University of Illinois, 1956
- Robert M. Weidman, Ph.D., University of California (Berkeley), 1959
- Donald Winston, Ph.D., University of Texas, 1963

Department of History

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Richard Drake, Chair

For the student in search of a broad education rather than in training for a particular occupation, the History Department offers an exciting program of instruction. It is designed to provide a knowledge and understanding of the background and ramifications of present local, national, and world affairs. The program emphasizes understanding rather than the memorization of names and dates. Students are taught how to read critically, analyze thoughtfully, conduct research carefully, and write intelligently.

Toward this end, the department offers a wide variety of courses ranging in time, location, and subject. For those students interested in local history there are courses on Montana, the West and unique aspects of the frontier. Other classes stress the nature of early American society, the American Revolution, family and gender in America, the Civil War, and diplomacy in the Cold War. Still others emphasize European social, cultural, and intellectual history, European exploration, the French Revolution, Islamic civilization, Asian history, Russian history, and African history. Topical courses concentrate upon the European peasantry, documentary analysis, diplomacy, war and peace, terrorism, and environmental history.

The History Department helps to prepare men and women for many different kinds of occupations. Graduates are employed in federal, state or local government positions ranging from domestic to foreign service, from senators to research analysts. Many teach history in Montana or in other states while others pursue their educations at advanced graduate schools earning master or doctoral degrees. Several have been awarded Rhodes or Marshall Scholarships.

Lawyers, journalists and businessmen also are trained by the department; many combine history with political science, journalism, or business. History provides not only a basis for the pursuit of their chosen profession but also furnishes knowledge and perspective for intelligent leadership of citizens in community affairs.

The department offers the Bachelor of Arts, Master of Arts, and the Doctor of Philosophy degrees.

Special Degree Requirements

Refer to graduation requirements listed previously in the catalog. See index.

Requirements for a History Major

Students selecting a major in history must complete the following requirements:

I. Courses and credits

A. A minimum of 40 credits in history, maximum of 60. Of the 40-credit total, 9 credits must be in European history, 9 in American history, and 9 in world history (Asian, Islamic, African, or Latin American). History majors must complete at least 21 upper-division credits.

B. All history majors must take at least 2 or the following 8 courses: HSTR 101H, 102H, 103H, 104H, (HIST 104, 105, 107, 108), HSTA 101H, 102H, 103H, 104H (HIST 151-154).

C. History majors must complete HSTR 300 (HIST 300), The Historian's Craft or a 400-level approved history writing course.

II. Languages

The Department requires competency in English and a proficiency in one foreign language. These requirements include:

A. WRIT 101 (ENEX 101) or its equivalent.

B. Foreign language requirements may be satisfied by completing anyone of the following options: