Geosciences (GEOS)

Jason Tullis
Department Chair
216 GEAR
479-575-3355
Email: jatullis@uark.edu

John Shaw
Department Vice-Chair and Graduate Director
216 GEAR
479-575-3355
Email: shaw84@uark.edu

Edward C. Holland
Geography M.S. Coordinator
119 GEAR
479-575-6635
Email: echollan@uark.edu

Andrew P. Lamb
Geology M.S. Coordinator
226 GEAR
479-575-4866
Email: aplamb@uark.edu (echollan@uark.edu)

Linyin Cheng
Geosciences Ph.D. Coordinator
230 GEAR
479-575-5569
Email: lc032@uark.edu

Department of Geosciences Website (http://fulbright.uark.edu/departments/geosciences/)

Degrees Conferred:
M.S. in Geography (GEOG)
M.S. in Geology (GEOL)
Ph.D. in Geosciences (GEOS)

Graduate Certificates Offered (non-degree):
Geospatial Technologies (GIST)

Geography (GEOG) (M.S.)

Areas of Study: Human geography, physical geography, GIS, cartography, space and planetary sciences.

Program Description: The Department of Geosciences offers a Master of Science (M.S.) degree in geography. This program draws on a variety of faculty expertise in physical, environmental, human, and regional studies in geography as well as in cartography, remote sensing, photogrammetry, and computational aspects of geographic information science (GIS) or geoinformatics.

Geology (GEOL) (M.S.)

Areas of Study: General geology, space and planetary sciences

Program Description: Instruction in geology at the graduate level focuses on preparation of students to become practicing professional geologists in industry or to pursue, without deficiencies, doctorates at established programs. Students intending to enter the industrial workforce are encouraged to maintain a broad perspective with an emphasis in an area of geology that has a demonstrated record of past employment, such as petroleum geology or environmental geology. The greatest strength of the program in geology at the University of Arkansas is instruction in practical geologic interpretation, with emphasis on field relationships. This instructional strength includes all levels of teaching and supports an active research program that serves to strengthen the research and communication skills of the students through writing assignments, oral presentations, and participation in professional societies.

Geosciences (GEOS) (Ph.D.)

Primary Areas of Faculty Research:

1. Basin evolution and analysis (including multiple aspects of petroleum geology that incorporate sedimentation, structural geology, stratigraphy and geophysics),
2. Crustal and mantle composition and tectonic evolution,
3. Neotectonics and dynamic geomorphology,
4. Geoinformatics (including GIS, remote sensing, GPS geodesy, and geospatial analysis),
5. Groundwater dynamics, karst hydrology and limnology, and
6. Paleoclimatology.

The Department of Geosciences focuses on research and education dealing with the nature, genesis, and history of the Earth and the global environment, the evolution of landscapes and biota at the Earth's surface, and the advance of geospatial technologies. The Doctor of Philosophy degree is designed for students who are committed to scholarship in the geosciences and who wish to prepare for professional employment within the academic community, industry, or government. Geosciences research requires rigorous observation, quantitative analysis, and modeling in order to yield scientific results that are acceptable for publication in first-rate, internationally-ranked journals. Given the interdisciplinary nature of Geosciences, the Department of Geosciences encourages research including elements of space and planetary sciences, biological sciences, environmental sciences, physics and chemistry to address relevant problems at the boundaries of geoscience and other disciplines.

Applicants for the doctoral program must have completed the baccalaureate degree with a major in geosciences or an allied discipline. Students with academic preparation at the undergraduate or masters level in other disciplines of physical science, engineering, and mathematics are also encouraged to apply. All applicants must submit their scores on the Graduate Record Examination directly to the University of Arkansas Graduate School, provide three letters of recommendation from individuals qualified to assess the applicant's academic potential, a personal curriculum vita, and a statement of academic and research interests.

Qualified students with a bachelor's degree or a master's degree may be accepted into the Ph.D. program. Academic requirements for admission to the program are listed in the table below. In addition, prospective applicants are encouraged to contact Department of Geosciences faculty with similar research interests to initiate dialogue regarding availability for mentoring, potential research topics, and research funding opportunities.

M.S. in Geography

Admissions to Degree Program: Applicants must be admitted to the Graduate School and meet the following requirements: 1) satisfactory undergraduate preparation in geography, 2) three letters from persons competent to judge the applicant's potential for graduate studies, 3) satisfactory GRE scores, and 4) adequate mathematical preparation at the undergraduate level, including statistics, algebra, and/or calculus. Students who do not meet these requirements may be admitted

conditionally. Students with course deficiencies may enroll concurrently in graduate courses. Students speaking English as a foreign language are encouraged to take the TOEFL with results reported to the department.

Degree Requirements: Requires a total of 30 semester hours. A minimum of 24 semester hours of course work (including a 6-hour core and 6 hours of quantitative or computational electives), 6 semester hours of thesis credit, and a comprehensive examination (defense of thesis) conducted by the candidate's thesis committee are required for all students who obtain an M.S. degree in Geography. Quantitative or computational electives not listed in the Department's Graduate Student Handbook must be pre-approved by the master's advisory committee.

Core		
GEOS 50903	History and Philosophy of Geography	3
GEOS 56102	Research Methods in Geosciences	2
GEOS 50101	Colloquium	1
Quantitative or Computational Electives		
Quantitative or computational courses approved by Department or master's advisory committee		6
Other Electives		
Courses in consultation with master's advisory committee		12
Thesis		
GEOS 6000V	Master's Thesis	6
Total Hours		**30**

Students should also be aware of Graduate School requirements with regard to master's degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#mastersdegreestext).

M.S. in Geology

Admission to Degree Program: Students admitted to graduate study should have completed an undergraduate geology program similar to that required for the B.S. degree at the University of Arkansas. Applicants lacking an appropriate background may satisfy deficiencies while enrolled in Graduate School. Prospective students should submit application forms, three letters of recommendation, and a statement of their graduate and professional goals before January 15 for the fall semester and October 15 for the spring semester to assure their consideration. These dates are also deadlines for receipt of application for financial assistance.

Requirements for the Master of Science Degree: The program in Geology requires 30 graduate course credit hours, six of which will be derived from a thesis reporting the results of an original research problem. All course work, a thesis topic, and the final thesis must be approved by the student's thesis committee. This committee is selected by the student and the student's thesis director and will consist of a minimum of three members. At least two of the committee members will be chosen from geology faculty whose areas of expertise coincide with the research interests of the student.

Thesis		6
GEOS 56102	Research Methods in Geosciences	2
GEOS 50101	Colloquium	1
Electives at 50000 level		12
Taught by Geology faculty and not to include unnamed special topics and independent study.		
Additional Electives		9
To be determined in consultation with the thesis adviser and advisory committee.		
Total Hours		**30**

A listing of geology Faculty can be found in the Geosciences Graduate Student Handbook.

Courses transferred or previously taken as an undergraduate may not be used for graduate credit toward the 24 credit hour requirement. Students should be aware that courses taken to fulfill deficiencies as graduate students will incur graduate tuition.

To complete the requirements for the degree, the candidate must complete all course work with a grade-point average of 3.00, submit an acceptable thesis, and pass a comprehensive examination based primarily on a defense of the student's thesis.

Students should also be aware of Graduate School requirements with regard to master's degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#mastersdegreestext).

Ph.D. in Geosciences

Geosciences-specific requirements are intended to be in harmony with those of the Graduate Catalog admissions (http://catalog.uark.edu/graduatecatalog/admissions/) and requirements for Ph.D. degrees (http://catalog.uark.edu/graduatecatalog/degreerequirements/#phdandedddegreestext) as well as all other university-level requirements. Supplemental information can be found in Department of Geosciences Graduate Handbook. In case of conflict, university-level requirements prevail, followed by Geosciences program requirements found below. Exceptions to program requirements, in consultation with the adviser, must be approved by the Geosciences Ph.D. coordinator and the department chair.

Admission Requirements:

- Undergraduate and graduate GPA as well as GRE (Verbal, Quantitative, and Writing) will be reviewed on a competitive basis by the Geosciences Ph.D. admissions committee
- Recommendations: Three (3) letters of recommendation from individuals qualified to assess the applicant's academic potential
- Acceptance by an adviser
- Current curriculum vitae
- Statement of academic and research interests
- Submit application by Jan. 15 for the fall semester to assure consideration

Degree Requirements:

University-level requirements stipulate 42 credit hours beyond the M.S. Geography, M.S. Geology, or an equivalent master's degree (or for those starting the program without a master's, 72 credit hours beyond a related bachelor's degree). These credit hours must include the following:

- GEOS 56102 Research Methods in Geosciences
- GEOS 50101 Colloquium (may be repeated up to four times)
- At least 12 hours of regularly offered GEOS courses; special problems, individual study classes, GEOS 56102, and GEOS 50101 are excluded from fulfilling this 12-hour requirement
- At least 6 hours (two courses) of regularly offered (excluding special problems or individual study classes) courses outside of the department that supplement the student's research interests and

dissertation topic as approved by the adviser; these may be 30000- and/or 40000-level undergraduate courses if approved by the advisory committee and the Graduate School and International Education
- At least 18 hours and up to 30 hours of doctoral dissertation (GEOS 7000V); no more than 6 hours of doctoral dissertation may be taken before being admitted to candidacy
- The Ph.D. degree is primarily a research degree, but communication of that research is critical for extension and application of research results as well as professional development; in order to advance communication skills, each student is required to teach labs and/or a course for at least one semester and/or to present scientific results at one or more national or international professional meetings

Examination for Candidacy:

Two candidacy exams should be taken within the first two years of graduate study and after completion of 12 hours of graduate study, including Research Methods in Geosciences and Colloquium (see above). The candidacy exams are administered by the advisory committee (consisting of the adviser plus 3-5 additional faculty members) during full-semester classes. The first exam is a review paper written using the format and length of a specified refereed journal. The committee will assign the paper topic and journal style, and the paper will be due 30 days later. The advisory committee will determine whether the quality of the review paper demonstrates sufficient preparation for independent dissertation research. The second candidacy exam is an oral defense of a written dissertation proposal. The format of the written dissertation proposal will be specified by the advisory committee. The defense must demonstrate to the advisory committee that the student is prepared to move to the independent dissertation-research stage. Upon successful admission to candidacy, the advisory committee is dissolved, and a dissertation committee (adviser plus 2-4 additional faculty members) may then be formed.

Graduate Certificate in Geospatial Technologies

The Department of Geosciences offers an online Geospatial Technologies Graduate Certificate through University of Arkansas Global Campus (http://globalcampus.uark.edu/). This certificate is designed for working professionals who wish to develop technical skills in the emerging field of geospatial technologies. The certificate provides the technical instruction needed to be employed in the geosciences and collateral disciplines as one of the American Society of Photogrammetry and Remote Sensing's "Mapping Scientist" and as a "Certified Geographic Information Systems Professional" (GISP).

Requirements for a Geospatial Technologies Graduate Certificate

Requirements for admission: Graduate status; there are no disciplinary requirements.

Students must complete the following 18 credit hours, but it is possible to waive GEOS 50403 and GEOS 50703 (up to 6 credit hours) through successful completion of proficiency exams.

GEOS 55403	Geospatial Applications and Information Science	3
or GEOS 57303	Geospatial Data Science in Public Health	
GEOS 50403	Foundations of Geospatial Data Analysis	3
GEOS 50703	Geospatial Technologies Computational Toolkit	3
GEOS 55503	Spatial Analysis Using ArcGIS	3
GEOS 50803	Geospatial Data Mining	3
GEOS 55903	Introduction to Geodatabases	3
Total Hours		**18**

Graduate Faculty

Aly, Mohamed H., Ph.D. (Texas A&M), M.S., B.S. (Zagazig University), Associate Professor, 2013, 2020.

Befus, Kevin, Ph.D. (University of Texas at Austin), M.S. (University of Colorado Boulder), B.S. (Wheaton College), Assistant Professor, 2020.

Boss, Steve K., Ph.D. (University of North Carolina at Chapel Hill), M.S. (Utah State University), B.S. (Bemidji State University), University Professor, 1996, 2023.

Cheng, Linyin, Ph.D. (University of California, Irvine), M.S. (Clarkson University), B.S. (Sichuan University), Assistant Professor, 2018.

Cothren, Jackson David, Ph.D., M.S. (The Ohio State University), B.S. (United States Air Force Academy), Professor, Leica Geosystems Chair in Geospatial Imaging, 2004, 2017.

Covington, Matthew D., Ph.D. (University of California-Santa Cruz), B.A. (University of Arkansas), Associate Professor, 2012, 2018.

Davidson, Fiona M., Ph.D., M.A. (University of Nebraska-Lincoln), B.A. (Newcastle Upon Tyne Polytechnic), Associate Professor, 1992, 1998.

Dumond, Gregory, Ph.D. (University of Massachusetts), M.S. (Texas Tech University), B.S. (University of Texas El Paso), Associate Professor, 2010, 2017.

Feng, Song, Ph.D., M.S. (Chinese Academy of Sciences), B.S. (Yunnan University), Associate Professor, 2013, 2018.

Fung, Cadi Y., Ph.D. (Michigan State University), M.S. (Northern Arizona University), B.S., B.S. (University of California, Santa Barbara), Instructor, 2022.

Holland, Edward C., Ph.D., M.A. (University of Colorado, Boulder), B.A. (Princeton University), Associate Professor, 2016, 2022.

Lamb, Andrew P., Ph.D. (Boise State University), M.S. (Florida Institute of Technology), B.S. (University of Dublin, Trinity), Assistant Professor, 2017.

Liner, Christopher L., Ph.D. (Colorado School of Mines), M.S. (University of Tulsa), B.S. (University of Arkansas), Professor, 2012.

Paradise, Thomas R., Ph.D. (Arizona State University), M.Sc. (Georgia State University), F.G.A. (Goldsmith Hall Gem-A, London), G.G. (Gemological Institute of America), B.S. (University of Nevada), University Professor, 2000, 2016.

Peter, Brad G., Ph.D. (Michigan State University), B.A. (University of Texas at Austin), Assistant Professor, 2022.

Potra, Adriana, Ph.D. (Florida International University), M.S., B.S. (University of Babes-Bolyai, Romania), Associate Professor, 2012, 2019.

Sharman, Glenn R., Ph.D. (Stanford University), B.S. (Wheaton College), Associate Professor, 2017, 2022.

Shaulis, Barry J., Ph.D., M.S., B.S. (University of Houston), B.B.A. (University of Georgia), Research Associate, 2016.

Shaw, John B., Ph.D. (University of Texas at Austin), B.A. (Oberlin College), Associate Professor, 2014, 2019.

Stahle, David William, Ph.D. (Arizona State University), M.A. (University of Arkansas), B.A. (University of Arizona), Distinguished Professor, 1982, 2005.

Suarez, Celina A., Ph.D. (University of Kansas), M.S. (Temple University), B.S. (Trinity University), Associate Professor, 2012, 2018.

Theiss, Hank, Ph.D. (Purdue University), M.S. (Purdue University), B.S. (Virginia Tech), Research Associate Professor, 2020.

Tullis, Jason A., Ph.D., M.S. (University of South Carolina), B.S. (Brigham Young University), Professor, 2004, 2017.

Warn, Seth A., Ph.D. (University of Arkansas), B.S. (Columbia College), Research Assistant Professor, 2019.

Courses

GEOS 50101. Colloquium. 1 Hour.
Weekly meetings of faculty, graduates, advanced students and guests to discuss research and trends in the field of geography. (Typically offered: Spring) May be repeated for up to 2 hours of degree credit.

GEOS 50403. Foundations of Geospatial Data Analysis. 3 Hours.
Basic mathematical tools applied in geospatial technology, including trigonometry in mapping, linear algebra in remote sensing, optimization in spatial decision support, and graph theory in routing. Course develops the framework for spatial data analysis and decision support. Pre- or Corequisite: GEOS 55403. (Typically offered: Fall and Spring)

GEOS 50503. Quaternary Environments. 3 Hours.
An interdisciplinary study of the Quaternary Period, including dating methods, deposits, soils, climates, tectonics, and human adaptation. Lecture 2 hours, laboratory 2 hours per week. Prerequisite: Graduate standing. (Typically offered: Fall)
This course is cross-listed with ANTH 50503, ENDY 50503.

GEOS 50703. Geospatial Technologies Computational Toolkit. 3 Hours.
Basic computational tools and processes applied in geospatial software, related computer hardware components, systems and applications software, and spatial database fundamentals. Python, including SciPy and NumPy, geospatial implementations will be emphasized. No programming experience is required. Pre- or Corequisite: GEOS 55403. (Typically offered: Fall and Spring)

GEOS 50803. Geospatial Data Mining. 3 Hours.
Basic tools for analyzing, summarizing and visualizing geospatial data. Exploratory data and spatial data analysis, probability distributions and application, single and multivariate analysis and hypothesis testing, and spatial smoothing and interpolation. Emphasis will be on problem solving in geospatial settings using the R statistical language. Prerequisite: GEOS 50403 and GEOS 50703 or equivalent. (Typically offered: Fall and Spring)

GEOS 50903. History and Philosophy of Geography. 3 Hours.
This course familiarizes students with the history of geography, the contributions of geographers to scientific thought and theory, and research techniques that are used in geography. Emphasis is given to the integration of statistical and spatial analysis, and their applications in field research. The course includes short field-based projects in and around Northwest Arkansas. (Typically offered: Spring Even Years)

GEOS 5100V. Special Problems in Physical Geosciences. 1-6 Hour.
Special problems in Geosciences. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

GEOS 51103. Global Change. 3 Hours.
Examines central issues of global change including natural and human induced climate change, air pollution, deforestation, desertification, wetland loss urbanization, and the biodiversity crisis. The U.S. Global Change Research Program is also examined. (Typically offered: Fall)
This course is cross-listed with ENDY 51103.

GEOS 51303. Radar Remote Sensing. 3 Hours.
Introduction to radar remote sensing and its applications in geology, geography, archeology, engineering, and agriculture. Focuses on Synthetic Aperture Radar (SAR) and advanced techniques including radar stereo, polarimetry, and interferometry. Covers Interferometric SAR (InSAR) for mapping topography and modeling Earth's surface motions due to earthquakes, volcanic eruptions, landslides, and subsidence. (Typically offered: Spring)

GEOS 51403. 3D Seismic Exploration. 3 Hours.
Interpretation of 3D seismic data for geological structure, stratigraphy, and pore fluid variations with emphasis on hydrocarbon exploration. Prerequisite: GEOS 44303 or GEOS 54303. (Typically offered: Spring)

GEOS 51603. Hydrogeologic Modeling. 3 Hours.
Topics include numerical simulation of ground water flow, solute transport, aqueous geochemistry, theoretical development of equations, hypothesis testing of conceptual models, limitations of specific methods, and error analysis. Emphasis on practical applications and problem solving. Prerequisite: GEOS 40303 or GEOS 52603 (formerly GEOS 40303) and computer literacy. (Typically offered: Irregular)

GEOS 51703. Urban Geography. 3 Hours.
Areal patterns of modern urban regions and the focus shaping these patterns. Emphasis is placed on American urban areas and their evolution and functional areas. Field work. Graduate degree credit will not be given for both GEOS 40703 and GEOS 51703. (Typically offered: Irregular)

GEOS 51803. Geography of the Middle East. 3 Hours.
Physical and cultural landscapes, natural and cultural resources, art and architecture, land use, political history, OPEC, and current problems of North Africa and the Middle East region west of Afghanistan are discussed. Class participation, discussions, slides and films, and student presentations will round out the class. Graduate degree credit will not be given for both GEOS 40403 and GEOS 51803. (Typically offered: Fall)

GEOS 5200V. Special Problems in Human Geography. 1-6 Hour.
Special problems in human geography. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

GEOS 52103. Principles of Remote Sensing. 3 Hours.
Fundamental concepts of remote sensing of the environment. Optical, infrared, microwave, LIDAR, and in situ sensor systems are introduced. Remote sensing of vegetation, water, urban landscapes, soils, minerals, and geomorphology is discussed. The course includes laboratory exercises in GIS software and field spectroscopy. (Typically offered: Fall)

GEOS 52203. Sedimentary Petrology. 3 Hours.
Sediments and sedimentary rocks. Lecture 2 hours, laboratory 2 hours per week. Corequisite: Lab component. Prerequisite: GEOS 42203 or GEOS 53203 (formerly GEOS 42203). (Typically offered: Fall)

GEOS 52403. Political Geography. 3 Hours.
Contemporary world political problems in their geographic context. Development of the principles of political geography with emphasis upon the problems of Eastern Europe, Africa, and Southeast Asia. Graduate degree credit will not be given for both GEOS 42403 and GEOS 52403. (Typically offered: Fall Odd Years)

GEOS 52503. Geomorphology. 3 Hours.
Mechanics of landform development. Lecture 2 hours, laboratory 3 hours per week. Several local field trips are required during the semester. Graduate degree credit will not be given for both GEOS 40503 and GEOS 52503. (Typically offered: Spring)

GEOS 52603. Hydrogeology. 3 Hours.
Occurrence, movement, and interaction of water with geologic and cultural features. Lecture 3 hours per week. Graduate degree credit will not be given for both GEOS 40303 and GEOS 52603. Corequisite: Lab component. Prerequisite: MATH 22003 or MATH 24004. (Typically offered: Spring)

GEOS 52703. Principles of Geochemistry. 3 Hours.
Introduction to fundamental principles of geochemistry from historic development to modern concepts. Graduate degree credit will not be given for both GEOS 40603 and GEOS 52703. Prerequisite: CHEM 14201, CHEM 14203 and GEOS 23103. (Typically offered: Fall)

GEOS 52803. Economic Geology. 3 Hours.
Introduction to mineral deposits used as economic resources. Covers basic geology and geochemistry of mineral deposit formations and the formation of major classes of deposits. Examines the relationship between the distribution of ores, oil, gas, coal, and Plate Tectonics. Explores environmental issues associated with the extraction of earth resources. Graduate degree credit will not be given for both GEOS 40803 and GEOS 52803. Prerequisite: GEOS 23103. (Typically offered: Irregular)

GEOS 52903. Introduction to Global Positioning Systems and Global Navigation Satellite Systems. 3 Hours.
Fundamentals of navigation, mapping, and high-precision positioning using the Navstar Global Positioning System. Topics include datum definition and transformation, map projections, autonomous and differential positioning using both code and carrier processing, and analysis of errors. Graduate degree credit will not be given for both GEOS 45903 and GEOS 52903. (Typically offered: Fall)

GEOS 53203. Stratigraphy and Sedimentation. 3 Hours.
Introductory investigation of stratigraphic and sedimentologic factors important to the study of sedimentary rocks. Lecture 2 hours, laboratory 3 hours per week. A required weekend, two-day field trip will be conducted during the semester. Graduate degree credit will not be given for both GEOS 42203 and GEOS 53203. Corequisite: Lab component. Prerequisite: GEOS 34103. (Typically offered: Fall)

GEOS 53303. Igneous and Metamorphic Petrology. 3 Hours.
Elementary to advanced study of the origin and evolution of igneous and metamorphic rocks in a variety of plate tectonics settings. Lecture 2 hours, Laboratory 2 hours per week. Corequisite: Lab component. (Typically offered: Spring)

GEOS 53503. Meteorology. 3 Hours.
Examination of the atmospheric processes that result in multifarious weather systems. Offered as physical science. Graduate degree credit will not be given for both GEOS 43503 and GEOS 53503. (Typically offered: Fall)

GEOS 53603. Climatology. 3 Hours.
Fundamentals of topical climatology followed by a study of regional climatology. Offered as physical science. Graduate degree credit will not be given for both GEOS 43603 and GEOS 53603. (Typically offered: Spring)

GEOS 5370V. Geology Field Trip. 1-2 Hour.
Camping field trip to areas of geologic interest, usually conducted during Spring Break. Graduate degree credit will not be given for both GEOS 4370V and GEOS 5370V. (Typically offered: Spring) May be repeated for up to 4 hours of degree credit.

GEOS 53803. Hazard & Disaster Assessment, Mitigation, Risk & Policy. 3 Hours.
Comprehensive introduction to interdisciplinary approaches to natural and environmental hazards and risk. Hazards and disaster assessment, mitigation, and policy are the focus of the class. Graduate degree credit will not be given for both GEOS 43803 and GEOS 53803. (Typically offered: Spring) May be repeated for up to 6 hours of degree credit.

GEOS 53903. Mathematical Modeling of Geological Processes. 3 Hours.
This course explores a variety of topics in applied mathematics and computational methods within the context of studying geological processes and from the perspective of a modeling practitioner. Programming is conducted in Python. Knowledge of Calculus II is necessary. (Typically offered: Irregular)

GEOS 54003. American Public Lands and Policy. 3 Hours.
The course examines the role of American federal public lands in 19th-21st century geography, history, policy, and art. It investigates the growth of conservation, preservation, and management movements in the US by looking at America's national parks, forests, dams, wildlife refuges, wilderness areas, managed and agricultural lands. Prerequisite: Graduate standing. (Typically offered: Irregular)

GEOS 54303. Geophysics. 3 Hours.
Derivation from physical principles, of the geophysical methods for mapping the Earth. Computational methods of converting gravity, magnetic, radiometric, electrical, and seismic data into geologic information. Lecture 3 hours, laboratory 2 hours per week. Graduate degree credit will not be given for both GEOS 44303 and GEOS 54303. Corequisite: Lab component. Prerequisite: MATH 25004 and PHYS 20203 and PHYS 20201 and GEOS 35104. (Typically offered: Irregular)

GEOS 54503. Introduction to Raster GIS. 3 Hours.
Theory, data structure, algorithms, and techniques behind raster-based geographical information systems. Through laboratory exercises and lectures multidisciplinary applications are examined in database creation, remotely sensed data handling, elevation models, and resource models using boolean, map algebra, and other methods. Graduate degree credit will not be given for both GEOS 45503 and GEOS 54503. (Typically offered: Fall)
This course is cross-listed with ANTH 55503.

GEOS 54603. Microtectonics. 3 Hours.
Focuses on the microstructural evolution of tectonite rocks and the constraints that can be gleaned from optical microscopic evaluation of rocks in petrographic thin-sections and hand samples. Results are evaluated in the context of plate tectonic theory and geodynamics. Knowledge of mineralogy and petrology equivalent to GEOS 23103 is required. Pre- or Corequisite: GEOS 55603. Corequisite: Lab component. (Typically offered: Fall)

GEOS 54703. Applied Climatology. 3 Hours.
Applied climatology involves the use of climatic data to solve a variety of social, economic and environmental problems, such as for clients in agriculture, water and energy management. The basic purpose of applied climatology is to help society, at all scales and levels, to achieve a better adjustment to the climatic environment. (Typically offered: Fall)

GEOS 5500V. Internship in GIS & Cartography. 3-6 Hour.
Supervised experience in GIS and/or cartographic applications with municipal, county, state, or private enterprises. (Typically offered: Spring and Summer) May be repeated for up to 6 hours of degree credit.

GEOS 55203. Cartographic Design & Production. 3 Hours.
This course addresses advanced cartographic concepts (i.e. visual hierarchy, aesthetics, image cognition) and production techniques as they relate to computer-assisted mapping. Students produce a variety of maps using Adobe Illustrator (CS 4-6) software to build a map portfolio. Field trips may be required. Graduate degree credit will not be given for both GEOS 45203 and GEOS 55203. (Typically offered: Spring)

GEOS 55303. Introduction to Petroleum Geophysics. 3 Hours.
Introduction to seismic wave propagation and petroleum seismology with particular emphasis on seismic events, elastic waves, and seismic survey design. Credit will not be given for both GEOS 45303 and GEOS 55303. Prerequisite: MATH 25004, PHYS 20203, and GEOS 35104 or consent of instructor. (Typically offered: Fall)

GEOS 55403. Geospatial Applications and Information Science. 3 Hours.
An introduction to the methods and theory underlying the full range of geographic information science and collateral areas - including GNSS, remote sensing, cadastral, spatial demographics and others. (Typically offered: Fall and Spring)

GEOS 55503. Spatial Analysis Using ArcGIS. 3 Hours.
Applications of analysis of spatial data using ArcGIS tools in map design, on-line mapping, creating geodatabases, accessing geospatial data, geo-processing, digitizing, geocoding, spatial analysis including basic spatial statistics, analysis of spatial distributions and patterning and 3D application using ArcGIS 3D Analyst. (Typically offered: Fall and Spring)

GEOS 55603. Tectonics. 3 Hours.
Development of ramifications of the plate tectonics theory. Analysis of the evolution of mountain belts. Lecture 3 hours per week. Prerequisite: GEOS 35104. (Typically offered: Fall)

GEOS 55803. Enterprise and Multiuser GIS. 3 Hours.
GIS practice that is typical of collaborative team-based geospatial organizations. Solve real-world problems through end-to-end GIS design and implementation using ArcGIS Enterprise, extensive federal, state, and local repositories, and high quality software documentation. Includes relevant training in geospatial provenance and metadata, and in enterprise and multiuser GIS administration. Introductory-level familiarity with GIS is recommended. (Typically offered: Spring)

GEOS 55903. Introduction to Geodatabases. 3 Hours.
Fundamental concepts and applications of geospatial databases. Schema development and spatial data models for geodata. Spatial and attribute query and optimization, properties and structures of relational and object-oriented geodatabases. Spatial extensions of SQL, spatial indexing, measurement, and geometry. Course will use PostGIS, ESRI File Geodatabases, and MS-SQL. Prerequisite: GEOS 35403 and GEOS 31003 or equivalent. (Typically offered: Fall and Spring)

GEOS 5600V. Graduate Special Problems. 2-6 Hour.
Library, laboratory, or field research in different phases of geology. (Typically offered: Fall, Spring and Summer) May be repeated for up to 4 hours of degree credit.

GEOS 56102. Research Methods in Geosciences. 2 Hours.
Survey of research methodologies used in both geology and geography, with an emphasis on quantitative analysis. Preparation of research proposals and presentations in the field of geosciences. Prerequisite: Graduate standing. (Typically offered: Spring)

GEOS 56503. GIS Analysis and Modeling. 3 Hours.
Unlike conventional GIS courses that focus on studying "where", this course will teach students to address beyond "where" using various GIS analysis and modeling techniques to explore "why" and "how". The course will provide theoretical and methodological reviews of the principles of cartographic modeling and multi-criteria decision-making. Graduate degree credit will not be given for both GEOS 46503 and GEOS 56503. (Typically offered: Spring)
This course is cross-listed with ENDY 56503.

GEOS 56603. Low-Temperature Geochemistry of Natural Waters. 3 Hours.
Covers the low-temperature geochemistry of waters and their associated minerals at Earth's surface. Examines the controls on the chemical composition of natural waters and the minerals precipitated from them. Topics covered will include water-rock interactions, pH, redox, the carbonate-water system, clay minerals and exchange, heavy metals, and a brief introduction to stable isotopes and geomicrobiology. Credit will not be given for both GEOS 46603 and GEOS 56603. Prerequisite: CHEM 14201, CHEM 14203, GEOL 11103, and GEOL 11101. (Typically offered: Fall)

GEOS 56903. Environmental Justice. 3 Hours.
This course deals with the ethical, environmental, legal, economic, and social implications of society's treatment of the poor, the disenfranchised, and minorities who live in the less desirable, deteriorating neighborhoods, communities, and niches of our country. The class integrates science with philosophy, politics, economics, policy, and law, drawing on award-winning films, current news, and case studies. Credit will not be given for both GEOS 46903 and GEOS 56903. (Typically offered: Spring)

GEOS 57303. Geospatial Data Science in Public Health. 3 Hours.
Introduction to geospatial data science, including geographic information systems (GIS) and related technologies, with an emphasis on their practical applications in the fields of public health, global health, healthcare analytics, healthcare administration, and other health-related fields. (Typically offered: Fall)

GEOS 57403. Petroleum Geology. 3 Hours.
Distribution and origin of petroleum. Lecture 2 hours, laboratory 2 hours per week. Graduate degree credit will not be given for both GEOS 42503 and GEOS 57403. Corequisite: Lab component. Prerequisite: Admission to the Geology graduate program. (Typically offered: Fall)

GEOS 57503. Karst Hydrogeology. 3 Hours.
Assessment of ground water resources in carbonate rock terrains and how they vary with rock properties and climate. Studying the processes that develop karst conduits (caves) and understanding their impact on water quantity and quality. Prerequisite: GEOL 11103 and (MATH 22003 or MATH 24004). (Typically offered: Irregular)

GEOS 57803. Geography of Europe. 3 Hours.
Geographic regions of the area with emphasis on their present development. Graduate degree credit will not be given for both GEOS 47803 and GEOS 57803. (Typically offered: Irregular)

GEOS 57903. Geospatial Unmanned Aircraft Systems. 3 Hours.
Geospatial unmanned aircraft systems (UAS) are becoming key technologies in a number of disciplines. This course will introduce safe and legal operation of UAS in aerial photography, multispectral, thermal and LIDAR applications, geodetic control, photogrammetric and computer vision processing, and the creation of accurate 2D and 3D digital information products. Pre- or Corequisite: (GEOS 32103 or GEOS 52103) and (GEOS 45903 or GEOS 52903) or equivalent. (Typically offered: Fall)

GEOS 58503. Environmental Isotope Geochemistry. 3 Hours.
Introduction to principles of isotope fractionation and distribution in geologic environments, isotopic analytical methods, and extraction of isotope samples; application of isotopes in characterization of geologic processes and interaction with hydrologic, surficial, and biologic attenuation, paleothermometry soil, and biogeochemical processes. (Typically offered: Spring) May be repeated for up to 3 hours of degree credit.
This course is cross-listed with ENDY 58503.

GEOS 58703. Quantitative Methods in Earth Science. 3 Hours.
Foundations of quantitative thinking, data analysis and visualization, mathematical modeling, and scientific programming, with applications in the Earth Sciences. Interpretation of scientific data and communication of results. Corequisite: Lab component. Pre- or Corequisite: MATH 22003 and MATH 24004. (Typically offered: Fall)

GEOS 59303. Ancient Forest Science and Sustainability. 3 Hours.
Ancient forests preserve beautiful habitat with high ecological integrity. This course will examine the development, spatial distribution, and ongoing destruction of ancient forests worldwide, and how science can contribute to the understanding and sustainable management of these valuable resources. (Typically offered: Spring)

GEOS 59703. Seminar in GIScience. 3 Hours.
Geographic information science and technology research topics of particular interest to the graduate student class. (Typically offered: Spring) May be repeated for up to 9 hours of degree credit.

GEOS 59903. Dynamics of Sediment Transport. 3 Hours.
The course will give aspiring geologists and civil engineers tools for solving sedimentological problems in their fields. Starting from a grounding in fluid mechanics, we will learn how sediment is transported and stratigraphy accumulated. This will be applied to problems in sedimentology at all scales. (Typically offered: Fall Odd Years)

GEOS 6000V. Master's Thesis. 1-6 Hour.
Master's thesis. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

GEOS 7000V. Doctoral Dissertation. 1-9 Hour.
Dissertation research. Prerequisite: Graduate standing and Ph.D. candidacy (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.