Geography

Degrees Offered

• Master of Arts
• Doctor of Philosophy

Nature of the Program

The graduate program in geography at West Virginia University provides students with the opportunity to study for a master of arts or a doctor of philosophy degree with an area of emphasis in one or more of the following fields:

• Geographic information science
• Environmental geography
• Human geography

The M.A. is designed so that full-time students should satisfy all program requirements within two years. Students are expected to be well-grounded in one or more of the program’s three areas of specialization (environmental geography, geographic information science, and space, place, and development). The M.A. degree program in geography was designated a program of excellence by the West Virginia University Board of Governors in 1998, 2003, and 2008. This award is given to superlative degree programs in recognition of their contribution to higher education in West Virginia and national recognition.

Research

Students who are interested in pursuing research in an area other than these may do so provided the research area matches the interest of a faculty member in the department who agrees to supervise the student’s program. Students who wish to focus their research on a particular region are encouraged to do so. The Graduate Program in Geography at WVU has strong links with the University’s Regional Research Institute, the State GIS Technical Center, the Geology Program, the Water Research Institute, the International Studies Program, the West Virginia Geological and Economic Survey, the Center for Women’s Studies, and the Center for Black Culture and Research.

Computing Facilities

The geography program has extensive computing facilities housed in a new 98,000 square foot building dedicated exclusively to geography and geology. The new building has five computer laboratories dedicated to teaching and research. The department has ESRI ArcGIS, ERDAS Imagine, and ENVI site licenses. In addition, the department supports SAS, SAS-Graph, JMP, Surface III, Oracle, and extensive database and statistical packages. The department’s geovisualization research group operates an immersive four-wall 3-D display environment or CAVE. The remote sensing program operates an ASD full-range portable spectroradiometer.

FACULTY

CHAIR
• Tim Carr - Ph.D. (University of Wisconsin-Madison)

ASSOCIATE CHAIR FOR GEOGRAPHY
• Karen Culcasi - Ph.D. (Syracuse University)

PROFESSORS
• Trevor Harris - Ph.D. (University of Hull) Geographic Information Science
• Amy Hessl - Ph.D. (University of Arizona) Biogeography, Forest Ecosystems
• Randall Jackson - Ph.D. (University of Illinois) Director Regional Research Institute, Economic Geography
• Brent McCusker - Ph.D. (Michigan State University) Land Use Change, Africa
• Timothy Warner - Ph.D. (Purdue University) Remote Sensing
PROFESSOR EMERITUS
• Greg Elmes - Ph.D. (Penn State University)
  Geographic Information Science
• Ken Martis - Ph.D. (University of Michigan)
  Political, Electoral and Historical Geography

ASSOCIATE PROFESSORS
• Jamison Conley - Ph.D. (Penn State University)
  Spatial Analysis, Geocomputation
• Karen Culcasi - Ph.D. (Syracuse University)
  Political Cartography, Middle East
• J. Steven Kite - Ph.D. (University of Wisconsin-Madison)
  Geomorphology, Quaternary Studies, Geoarchaeology
• Brenden McNeil - Ph.D. (Syracuse University)
  GIScience, Environmental Modeling
• Bradley Wilson - Ph.D. (Rutgers University)
  Food Justice, Solidarity Economies, Political Ecology

ASSOCIATE PROFESSOR EMERITUS
• Robert Hanham - Ph.D. (Ohio State University)
  Regional Development

ASSISTANT PROFESSORS
• Martina Caretta - Ph.D (Stockholm University)
  Feminist Geography, Human Dimensions of Water
• Jonathan Hall - Ph.D. (Ohio State University)
  Desert Ecology, Biogeography
• Insu Hong - Ph.D. (Arizona State University)
  GIScience, Virtual Reality and Spatial Optimization
• Rick Landenberger - Ph.D. (West Virginia University)
  Remote Sensing, Geosciences Education
• Eungul Lee - Ph.D. (University of Colorado)
  Climatology, Land-Atmosphere Interactions
• Aaron Maxwell - Ph.D. (West Virginia University)
  Remote Sensing, GISc, Physical Geography
• Maria Alejandra Perez - Ph.D. (University of Michigan)
  Human Geography, Science & Society, Speleology, Latin America
• Jamie Shinn - Ph.D. (Penn State University)
  Environmental Governance, Political Ecology, Adaptation to Climate Change

Admission/Application Requirements
M.A. applicants must submit GRE scores, a personal two-page statement defining the applicant’s interest in geography and career intentions, and two letters of recommendation from people who are familiar with the student’s undergraduate training.

Ph.D. applicants should send three letters of recommendation, GRE scores, and a two-page research statement. Applicants are strongly encouraged to contact potential doctoral advisors among the faculty prior to application.

To receive full consideration, including consideration for funding opportunities, all applications for Fall admission must be submitted by January 1. To be considered for Fall admission without financial assistance, application material must be received by April 1.

Prospective M.A. students must have an overall cumulative undergraduate GPA of 3.0.

Prospective Ph.D. students must hold a M.A./M.S. degree and a cumulative GPA of at least 3.3 in their previous graduate work. Students with degrees in other non-geography disciplines are encouraged to apply although they may be asked to make up deficiencies in geography during the first year in the program.

International students are encouraged to submit their materials at least three months in advance of all deadlines.
Teaching Assistantships
A small number of graduate teaching assistantships are competitively awarded by the Geography program on an annual basis. Teaching assistants are employed to work in support of undergraduate courses. Applicants who wish to be considered for a teaching assistant position should make that request known in their application.

Research Assistantships
Research assistantships must be applied for through the faculty member whose research is providing the funding. The geography faculty are engaged in numerous funded research projects, many of which provide graduate students with opportunities for obtaining research skills and experience as well as employment and tuition aid. Furthermore, the professional contacts made in the course of faculty research frequently provide graduate students with opportunities for career development.

Master of Arts
The Master's Program in Geography at West Virginia University provides students with cutting edge training in the history and theory of geography, experience with advanced geographic research methodologies and specialized mentoring from faculty experts across three sub-disciplinary fields (Human Geography; Environmental Geography; Geographic Information Science).

DEGREE REQUIREMENTS
To earn an M.A. in Geography at WVU students must complete 31 credit hours of graduate courses (based upon the curriculum described below), form a committee of graduate faculty to supervise your thesis or project, and then complete and publicly defend your thesis or project.

ADVISING
Throughout the admissions process the Graduate Committee coordinates with faculty to assist new students to identify a potential advisor. In the Fall semester M.A. students are required to select an advisor who can aid the student to develop a Plan of Study. The student should choose an advisor no later than two weeks before the end of their first semester in the program. Until an advisor is selected doctoral students will be supported by the Graduate Committee.

MAJOR REQUIREMENTS

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<thead>
<tr>
<th>Course Code</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>GEOG 601</td>
<td>Geographic Traditions</td>
<td>3</td>
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<tr>
<td>Methods Course:</td>
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<td>3</td>
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<tr>
<td>GEOG 594</td>
<td>Seminar</td>
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<tr>
<td>GEOG 603</td>
<td>Qualitative Research in Geography</td>
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<tr>
<td>GEOG 701</td>
<td>Advanced Research Methods</td>
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<tr>
<td>Colloquium:</td>
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<td>4</td>
</tr>
<tr>
<td>GEOG 600</td>
<td>Geography Research Colloquium (repeated)</td>
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<tr>
<td>Geography Courses</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Professional Master's or Thesis Option:</td>
<td></td>
<td>3-6</td>
</tr>
<tr>
<td>GEOG 780</td>
<td>Non-Thesis Project (plus an additional 3 hours of electives)</td>
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<tr>
<td>GEOG 797</td>
<td>Research (thesis students)</td>
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<tr>
<td>Thesis Proposal</td>
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<td>Thesis Defense</td>
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<tr>
<td>Electives</td>
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<td>8</td>
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<tr>
<td>Total Hours</td>
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<td>30-33</td>
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ACADEMIC PROGRESS
Students must maintain a GPA of 3.0 and complete all course, examination and dissertation requirements in a timely fashion. The academic progress of every doctoral student is reviewed each year. Students must submit a self-evaluation signed by their advisor by January 15. The Graduate Committee will conduct its annual review of students in February and communicate with students in March. Waivers to the PhD deadlines, timing requirements, and other rules may be requested from the Graduate Coordinator. Waivers are only given under extraordinary circumstances.

The M.A. Thesis Option
The M.A. thesis is an independent research project undertaken by the student. The thesis research should adhere to the following:
• Demonstrate knowledge of the literature in the student’s chosen field
• Use data and methods appropriate to the research
• Draw conclusions from the research endeavor

M.A. thesis option students develop a thesis proposal toward the end of the first year and during the first summer. The first step is to develop a written thesis proposal. This must be completed to the satisfaction of the student’s advisor and thesis committee no later than October 1 of the student’s second year. This is followed by an oral presentation to all students and faculty in the geography program no later than October 31 (unless there are scheduling conflicts). Presentations must be advertised within the department. Students should aim to complete the thesis proposal process well before the October deadline in order to ensure progress towards graduation the following semester. Students not able to meet this schedule should seek a meeting with their advisor to resolve the issue prior to the deadline dates.

The defense of the thesis takes place when the advisor and the committee agree that a defendable copy of the thesis is complete. The defense date must be advertised at least two weeks in advance. Only in exceptional circumstances will the thesis committee waive the two-week requirement for advertising thesis proposals and defenses. The thesis examination is graded on a pass/provisional pass/fail basis. To pass the examination, there can be no more than one unsatisfactory grade from the committee members. A student who fails may submit another thesis or a revised version upon the approval of the student’s committee. No student may be re-examined more than once. A student who is given a provisional pass will generally be required to make minor revisions or corrections to the thesis.

Thesis proposals and defenses are not normally scheduled between June 15 and August 15.

The Professional Master’s Option

Overview

The professional master’s option consists of an additional graduate course and a three-credit-hour project (GEOG 780). The professional master’s option is designed for students interested in a more focused project than the traditional research thesis option. It is not recommended for students considering entering a Ph.D. program. The thesis project has strict deadlines and must be completed in one semester and after the completion of GEOG 601 and either GEOG 603 or GEOG 701.

Deadlines and Timetable

Students planning on selecting the professional masters’ option must make a written request to the Geography Graduate Committee no later than two weeks before the start of the semester in which the project is undertaken. The request should be endorsed by the student’s advisor. Only after the written request has been received will the geography graduate director issue a permit for the course. It is strongly recommended that the project topic be selected prior to the beginning of the semester.

A written project plan is to be submitted to the advisor and committee no later than three weeks after the start of the semester. The project plan includes an objective, methods, and timetable. No public presentation of the proposal is required.

The student is required to have meetings with the advisor and the committee in weeks seven and eleven to present progress reports.

The project must be completed and successfully defended by the end of the semester in which the project was undertaken. If the student completes the project, passes the defense, and submits the project to the library by the end of the semester, the student will be given a grade of S (satisfactory) for the project (GEOG 780).

If the student completes and defends the project, but is unable to submit the project to the library by the university deadline, the student will be assigned an (I) incomplete for the project. The student then has up to two weeks after the last day of exam week to submit the project to the library; otherwise, the I is converted to a U (unsatisfactory).

If the student completes the project and fails the defense or if the project is not completed and defended by the end of the semester, the student will be given a grade of U for the GEOG 780 course.

Students who receive a grade of U may reapply to do a different project the following semester. Students cannot reapply more than once.

The Graduate Committee may grant an extension to the one semester deadline under exceptional circumstances.

Project Topic and Defense

The choice of a project topic is to be determined by close interaction and agreement between the student, advisor, and committee. The project may comprise a wide range of activities, but is usually either (a) an applied problem-solving exercise with minimal literature review, (b) an empirical test of an idea from the literature with minimal literature review, or (c) a literature review or development of a conceptual idea using the literature.

The project is defended in a public presentation at the end of the project semester, but no later than the university deadline for a thesis defense. The defense time and location must be published in the department no less than two weeks in advance. The standard for passing will be that the majority of the advisory committee (two or more of the three members) evaluate the work as substantially meeting the goals identified in the written research plan.
Most projects are expected to be in written form (fifteen to twenty pages). Other forms of presentation may be acceptable such as maps, software, video, land-use plan, image classification, field-trip guide, work of art, etc.; however, a written document explaining the project is still required.

**Doctor of Philosophy**

A limited number of the required courses may be waived if the student has already completed an equivalent course and can demonstrate proficiency with the material.

**MAJOR REQUIREMENTS**

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<td><strong>Geography Courses:</strong></td>
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<tr>
<td>GEOG 407</td>
<td>Environmental Field Geography</td>
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<td>GEOG 452</td>
<td>Geographic Information Science: Applications</td>
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<td>GEOG 453</td>
<td>Geographic Information Science: Design and Implementation</td>
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<td>GEOG 485</td>
<td>Methods of Geographic Research</td>
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<tr>
<td>GEOG 550</td>
<td>Geographic Information Science</td>
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<td>Seminar: Land Use and Cover Change</td>
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<td>Geographic Information Science: Technical Issues</td>
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<td>GEOG 753</td>
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<tr>
<td><strong>Seminar Course:</strong></td>
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<tr>
<td>GEOG 607</td>
<td>Geography of Fire</td>
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<td>GEOG 612</td>
<td>Gender, Society and Space</td>
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<td>GEOG 615</td>
<td>Development Geography</td>
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<td>GEOG 621</td>
<td>Advanced Fluvial Geomorphology</td>
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<td>GEOG 694: Seminar</td>
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<td><strong>Electives:</strong></td>
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<td><strong>Comprehensive Examinations</strong></td>
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<td><strong>Dissertation Proposal</strong></td>
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<td><strong>Dissertation</strong></td>
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<td><strong>Total Hours</strong></td>
<td>36</td>
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**EXAMINATIONS AND DISSERTATION**

The student is required to pass an oral and three written comprehensive examinations no later than the fourth semester. The student will be examined on two areas of specialization and the student's dissertation research topic. Upon successful completion of the comprehensive examination and no later than the end of the fifth semester, the student will be expected to defend a dissertation research proposal. The award of the Ph.D. is granted upon the successful defense of the dissertation itself.

**Graduate Certificate in GIS and Spatial Analysis**

**CERTIFICATE CODE - CG37**

Complete 4 of the following courses: 12

<table>
<thead>
<tr>
<th>Course Code</th>
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<tr>
<td>ARE 729</td>
<td>Spatial Econometrics</td>
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<tr>
<td>or ECON 729</td>
<td>Spatial Econometrics</td>
</tr>
<tr>
<td>RESM 540</td>
<td>Geospatial Modeling</td>
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**Major Learning Goals**

**GEOGRAPHY**

The Graduate Program in Geography at West Virginia University trains students at the highest level to assume leadership roles in research, teaching, and applied work in Human Geography, Environmental Geography, and Geographic Information Science.

**M.A. Program**

- Master the existing scholarship in the study of Geography with the goal of using this scholarship in the pursuit of their own professional and/or research field.
- Conduct research in their area of specialization or engage in an applied geography project oriented to their professional goals.
- Prepare to be professionals in careers that require training at a high level in Geography.

**Ph.D. Program**

- Master the existing scholarship in the study of Geography with the goal of using this scholarship in the pursuit of their own research.
- Engage in and conduct original research in their area of specialization.
- Prepare to be professionals in careers that require training at the highest level in Geography.

The Geography Graduate Committee regularly reviews the structure and content of the M.A. and Ph.D. programs to provide the best possible education to students in order to meet the needs for highly trained individuals in Human Geography, Environment Geography, and Geographic Information Science.

**GEOGRAPHY COURSES**

**GEOG 517. Climatological Analysis. 3 Hours.**
PR: GEOG 207 or Consent. Statistical analysis and interpretation of climatological data and application to physical and human problems across the globe using user-friendly and programmable tools. (Also listed as GEOG 317.)

**GEOG 525. Problems in Geomorphology. 0-4 Hours.**
(Also listed as GEOL 525.)

**GEOG 550. Geographic Information Science. 4 Hours.**
PR: Instructor's permission. Principles and practice of geographical information science. Geospatial data handling for research, planning and decision-making. Spatial analysis, information production, and display.

**GEOG 553. Environmental Impact Assessment. 3 Hours.**
Study of the process and methods, including GIS, by which the environmental consequences of development actions are assessed and evaluated in advance of their occurrence.

**GEOG 591. Advanced Topics. 1-6 Hours.**
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

**GEOG 593A. Special Topics. 1-6 Hours.**
A study of contemporary topics selected from recent developments in the field.

**GEOG 594A-Z. Seminar. 1-6 Hours.**
Seminars arranged for advanced graduate students.
GEOG 600. Geography Research Colloquium. 1 Hour.
PR: Consent. Lectures and presentation on recent and current research by resident and visiting scholars.

GEOG 601. Geographic Traditions. 3 Hours.
PR: Consent. Review of the major approaches in geographic scholarship.

GEOG 602. Geographic Research-Design. 3 Hours.
PR: GEOG 300 and GEOG 601. Choosing, preparing, and developing research problems of geographic interest. Emphasizes proposal writing and research design alternatives.

GEOG 603. Qualitative Research in Geography. 3 Hours.
PR: GEOG 602 or consent. Analysis of qualitative research in geography and related fields. Examine methodological approaches and techniques that explore and interpret issues in the development of geographical research projects.

GEOG 607. Geography of Fire. 3 Hours.
PR: Graduate standing. Course explores spatial science and human environment relations through a review of fire ecology literature. This is a seminar-style course with weekly readings, discussion, and a term project required by each student.

GEOG 612. Gender, Society and Space. 3 Hours.
PR: GEOG 601 or Consent. Examines how gender and feminist perspectives are an integral part of how space is used, distributed, and perceived in society. Overviews of major developments in the field including diversity and difference, representation, identity, and nature.

GEOG 615. Development Geography. 3 Hours.
PR: Consent. An analysis of the concept and practice of development. Alternative people-centered approaches to social change are investigated.

GEOG 621. Advanced Fluvial Geomorphology. 4 Hours.
PR: GEOL 321 or GEOG 321 or Consent. Analysis of stream processes, landforms, deposits, including paleohydrology and Appalachian surficial geology. Required weekend field trips at student's expense. (Also listed as GEOL 621.).

GEOG 622. Surficial and Glacial Geology. 4 Hours.
PR: GEOL 321 or GEOG 321 or Consent. Analysis of late Cenozoic landscapes, especially those caused by glaciers or otherwise influenced by global climate change. Required weekend field trips at student's expense. (Also listed as GEOL 622.).

GEOG 630. Seminar: Land Use and Cover Change. 3 Hours.
Review, discussion, and critique of major scientific approaches to the study of land use and cover change. All world regions and biomes covered. Includes theoretical and technical discussions of change, human dimensions, and policy issues.

GEOG 640. Geopolitical Perspectives. 3 Hours.
This course uses geopolitical perspectives to critically examine the linkages between power and places. Seminal literatures in the sub-field of geopolitics are read and critiqued, including critical geopolitics, feminist geopolitics and post-colonial theory.

GEOG 651. Geographic Information Science: Technical Issues. 3 Hours.
PR: GEOG 350. Current issues in GIS research. Technical aspects of GIS operations, algorithms, theory of geographical data structures, and error handling. Labs focus on tools, data structures, database languages and macros. (2 hr. lec., 1 hr. lab.).

GEOG 654. Environmental Geographic Information Systems Modeling. 3 Hours.
Provides background and hands-on experience needed to answer scientific questions about the environment within a raster-based GIS framework. Students should have introductory level GIS background.

GEOG 655. Remote Sensing Principles. 3 Hours.
Mapping of earth features using aerial and satellite-borne sensors, image enhancement, geo-referencing, and classification. (Also listed as GEOL 655.).

GEOG 689. Geography Graduate Student Internship. 1-6 Hours.
PR: Consent. Internship in the private or public sector designed for practical application of geographic training.

GEOG 691A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

GEOG 692A-Z. Directed Study. 1-6 Hours.
Directed study, reading, and or research.

GEOG 693A-G. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

GEOG 694A-Z. Seminar. 1-6 Hours.
Seminars arranged for advanced graduate students.

GEOG 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

GEOG 696. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his/her program.
GEOG 697. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.)

GEOG 698. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

GEOG 699. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use of the University’s facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department’s 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is P/F; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

GEOG 701. Advanced Research Methods. 3 Hours.
PR: GEOG 601. Review of quantitative and qualitative methods used in geographic research.

GEOG 711. Regional Development. 3 Hours.
PR: Consent. Review of contemporary geographic theories of uneven spatial development of capitalism.

GEOG 752. Advanced Geographic and Information Science. 3 Hours.
PR: GEOG 452 or GEOG 651 or Consent. Functional strengths and weaknesses of GIS. Related geographical information, science technologies, GPS, remote sensing, multimedia, spatial statistics, and expert systems. Multi- dimensionality (4-D GIS), temporality, social implications of GIS.

GEOG 753. Exploratory Spatial Data Analysis. 3 Hours.
Develop expertise in spatial analytical techniques for use in geographical data analysis and GIS.

GEOG 755. Advanced Remote Sensing. 0-3 Hours.
PR: GEOG 655 or GEOL 655 or consent. Collection, processing, and classification of remotely sensed data, including optical, thermal, radar, and topographic information. (2 hour lecture, 1 hour laboratory.) (Also listed as GEOL 755.).

GEOG 780. Non-Thesis Project. 3 Hours.
Research activities leading to a non-thesis project report.

GEOG 791A. Advanced Topics. 1-6 Hours.
PR: Consent Investigation of topics not covered in regularly scheduled courses.

GEOG 792A-B. Directed Study. 1-6 Hours.
Directed study, reading, and research.

GEOG 793A-B. Special Topics. 1-6 Hours.

GEOG 794A-Z. Seminar. 1-6 Hours.
Seminars arranged for advanced graduate students.

GEOG 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.

GEOG 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

GEOG 797. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.)

GEOG 930. Professional Development. 1-6 Hours.
Professional Development courses provide skill renewal or enhancement in a professional field or content area (e.g., education, community health, geology). These tuition waived, continuing education courses are graded on a pass/fail grading scale and do not apply as graduate credit toward a degree program.

GEOLOGY COURSES

GEOL 510. Computer Aided Subsurface Interpretations. 3 Hours.
PR: GEOL 311 and GEOL 341. Develop subsurface interpretations from integrated geological, geophysical and engineering databases in a computer workstation environment. Construct maps and 3D visualizations of subsurface structure, seismic horizons, layer properties, etc., for prospect location and subsurface assessment.

GEOL 511A. Sedimentary Geology in Ireland - Travel. 1 Hour.
Travel portion of GEOL 511. See GEOL 511 for description.
GEOL 522. Surficial and Glacial Geology. 3 Hours.
PR: GEOL 321 or GEOG 321 or consent. Analysis of late Cenozoic landscapes, especially those caused by glaciers or otherwise influenced by global climate change. Required weekend field trips at student's expense. (Also listed as GEOG 522.)

GEOL 525. Problems in Geomorphology. 0-4 Hours.

GEOL 543. Tectonics. 3 Hours.
PR: GEOL 341 and GEOL 311; undergraduates need Consent. Investigation of patterns and processes of large-scale deformation mechanisms that shape the earth. Focuses on the structural evolution and modeling process of various plate boundaries.

GEOL 554. Environmental and Exploration of Geophysics 2. 3 Hours.
PR: PHYS 102 and (MATH 156 or GEOL 351) or Consent. Basic and applied studies of reflection and refraction seismology and ground penetrating radar methods will be covered with an emphasis on the use of computers in the modeling and interpretation of seismic data.

GEOL 556. 3-D Seismic Visualization. 3 Hours.
This course focuses on the application of 3-D seismic data visualization and interpretation technologies to the characterization of subsurface structure, facies, and reservoirs, with particular reference to hydrocarbon exploration and CO2 sequestration.

GEOL 558. Seismic Attribute. 3 Hours.
PR: GEOL 341 and GEOL 311 and MATH 155. The effective seismic attribute technologies and attribute interpretation workflows, their application to the characterization of subsurface structures, facies, and reservoir properties, with particular reference to hydrocarbon exploration and C)2 sequestration.

GEOL 562. Quantitative Hydrogeology. 3 Hours.
PR: MATH 156 or GEOL 351 and GEOL 463 or Consent. Mathematical and computer analysis of groundwater flow, aquifer systems, radial-flow solutions; well/aquifer test methods; superposition, boundaries; dispersive/advective transport.

GEOL 564. Environmental Hydrogeology. 4 Hours.
PR: GEOL 101 and GEOL 102 and GEOL 463 and (PR or CONC: GEOL 562). Seminar reviewing groundwater occurrence, flow, quality, and exploration in various geologic terrains; groundwater pollution and dewatering; and groundwater technology. Includes topical literature review.

GEOL 575. Imperial Barrel Competition. 3 Hours.
The students will participate in the Imperial Barrel Award competition sponsored by the American Association of Petroleum Geologists (AAPG). They will evaluate a real-world petroleum basin using industry seismic and well data and will make a presentation to a panel of professional judges recommending an exploration strategy. Travel to the regional and national AAPG meeting may be required.

GEOL 579. Applied Petroleum Geoscience. 3 Hours.
Students work in teams to conduct integrated characterization of a petroleum reservoir, develop numerical simulation, consider technical options, perform economic analyses and make a final report to the company/organization.

GEOL 580. Organic Contaminant Geochemistry. 3 Hours.
This course focuses on fundamental chemical properties and structures of organic contaminants that control their functionality, fate, and transport in the environment. Natural organic matter and inorganic phases are discussed relative to contaminant mobility.

GEOL 585. Optical Mineralogy and Petrology. 3 Hours.
PR: GEOL 285. Introduction to the optical properties of minerals and the use of the petrographic microscope. Interpretation of sedimentary, igneous, and metamorphic rocks based on microscopic examination of thin sections. (Offered alternate years.).

GEOL 586. Advanced Isotope Geochemistry. 3 Hours.
PR: GEOL 486. Advance the understanding of isotopic systems by comprehensive discussion of selected research publications. Laboratory exercises will provide hands-on training in stable isotope measurement techniques. Study topics will focus on use of isotopes to address research questions in variety of fields, including geology, biology, forensics, environmental sciences and energy.

GEOL 588. Aqueous Geochemistry. 3 Hours.
PR: GEOL 101 and CHEM 112 or CHEM 116, or Consent. Review of basic chemical principles as they apply to aqueous geochemical environments. Properties of water and the types, sources, and controls of the common and environmentally significant chemical species dissolved in water.

GEOL 591A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

GEOL 593A-C. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

GEOL 594. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

GEOL 610. Advanced Stratigraphy. 3 Hours.

GEOL 611. Carbonate Sedimentology. 4 Hours.
GEOL 615. Stratigraphy of Porous Media. 3 Hours.
PR: GEOL 311. Advanced discussion of the deposition of clastic sediments, chemistry of carbonates, sequence stratigraphy, porosity development in sandstones and limestones, flow of oil through rock.

GEOL 616. Advanced Sedimentation. 4 Hours.
PR: GEOL 311 or Consent. (Required field trips at student's expense.) Origin of sedimentary rocks; principles involved in interpretation of ancient geography, climates, animals, and plants. Emphasis on detrital sediments and rocks.

GEOL 621. Advanced Fluvial Geomorphology. 4 Hours.
PR: GEOL 321 or GEOG 321 or Consent. Analysis of stream processes, landforms, deposits, including paleohydrology and Appalachian surficial geology. (Required weekend field trips at student's expense; also listed as GEOG 521.)

GEOL 632. Paleocology. 3 Hours.
PR: GEOL 331 and GEOL 311 or Consent. Methods of paleoecologic analysis in sedimentary geology. Topics include trace fossil analysis, shell biogeochemistry, community paleoecology, biofacies analysis of basins, and Precambrian paleoecology.

GEOL 642. Advanced Structural Geology. 3 Hours.
PR: GEOL 341. Theoretical and observational aspects of the development of geological structures. Problems ranging from the microstructural to the orogenic scale will be addressed.

GEOL 645. Basin Analysis. 3 Hours.
PR: GEOL 341 and GEOL 311 or equivalent. The origin, development, and distribution of basins and the structure found within basins throughout the world are studied. The techniques used for investigating basin evolution are emphasized. The effects of basin processes on the occurrence of energy resources are addressed.

GEOL 655. Remote Sensing Principles. 3 Hours.
Mapping of earth features using aerial and satellite-borne sensors, image enhancement, geo-referencing, and classification. (Also listed as GEOG 655.)

GEOL 659. Quantitative Methods in Geoscience. 3 Hours.
PR: STAT 312 or STAT 511 or Consent. Brief review and introduction to multivariate quantitative techniques as applied to geology and geography.

GEOL 665. Groundwater Modeling. 4 Hours.
PR: GEOL 562 or Consent. Theory and application of groundwater flow modeling, focusing on MODFLOW; numerical methods; discretization and boundaries; parameterization and calibration; problems and case histories.

GEOL 666. Karst Geology. 3 Hours.
PR: Consent. Review of karst terrain hydrogeology and geomorphology, emphasizing origins and nature of caves, sinkholes and other karst landforms, environmental problems of karst, and its water and mineral/ petroleum resources.

GEOL 680. Masters Project Research. 1-5 Hours.
Planning and presentation of a professional project, including proposal, work plan execution, and project report. Status reports and timeline planning. Must be taken in two consecutive semesters, totaling to 6 credits.

GEOL 687. Physical Geochemistry. 3 Hours.

GEOL 690. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of geology. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It also provides a mechanism for students not on assistantships to gain teaching experience. (Grading will be P/F.)

GEOL 691A-B.. 1-6 Hours.
GEOL 692A-L. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

GEOL 693A-B. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

GEOL 694A-C. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

GEOL 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

GEOL 697. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.)

GEOL 698. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.
GEOL 699. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking course work credit, but who wish to meet residence requirements, use the University facilities and participate in its academic and cultural programs. NOTE: Graduate students not actively involved in course work or research or enrolled, through enrollment in his/her departments Graduate Colloquium, to consult with graduate faculty, participate in both formal and informal academic activities sponsored by his/her program and retain all of the rights and privileges of duly enrolled students. Grading is P/F; colloquium credit may not be counted against credit requirements for master's programs.

GEOL 755. Advanced Remote Sensing. 3 Hours.
PR: GEOG 655 or GEOL 655 or consent. Collection, processing and classification of remotely sensed data, including optical, thermal, radar, and topographic information. (2 hour lecture, 1 hour laboratory.) (Also listed as GEOG 755.).

GEOL 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of geology. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading will be P/F.).

GEOL 791. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

GEOL 794. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

GEOL 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.

GEOL 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

GEOL 798. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

GEOL 799. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use of the University's facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department's 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is P/F; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

GEOL 930. Professional Development. 1-6 Hours.
Professional development courses provide skill renewal or enhancement in a professional field or content area (e.g., education, community health, geology). These tuition-waived continuing education courses are graded on a pass/fail grading scale and do not apply as graduate credit toward a degree program.