EARTH AND ENVIRONMENTAL SCIENCES (Ph.D.)

Executive Officer: Professor Cindi Katz
The Graduate Center
365 Fifth Avenue
New York, NY 10016
Email: Ees@gc.cuny.edu
http://www.gc.cuny.edu/EES/

FACULTY

Terence D. Agbeyegbe ■ Sean C. Ahearn ■ Samir A. Ahmed ■ Stephen Ukpabi Aja ■ Jochen Albrecht ■ Thomas Angotti ■ Teresa J. Bandosz ■ Homar Barcena ■ Stefan Becker ■ Sunil Bhaskaran ■ Somdev Bhattacharji ■ James Biles ■ Jeffrey A. Bird ■ William Blanford ■ Christopher Blaszczak-Boxe ■ Karin A. Block ■ Rebecca Boger ■ James F. Booth ■ Brett F. Branco ■ Hannes E. Brueckner ■ Frank S. Buonaiuto Jr. ■ Jean Carmalt ■ Anthony Carpi ■ John A. Chamberlain Jr. ■ Zhongqi (Joshua) Cheng ■ Nicholas K. Coch ■ Saul B. Cohen ■ Harold C. Connolly Jr. ■ Constantin Cranganu ■ Eric Delson ■ Ratan Dhar ■ Timothy T. Eaton ■ Denton S. Ebel ■ Shayesteh Esmaeila-Mahani ■ Carson Farmer ■ John J. Flynn ■ Allan Frei ■ William J. Fritz ■ Stanley D. Gedzelman ■ Vinay Gidwani ■ Ruth Wilson Gilmore ■ Hongmian Gong ■ Yuri Gorokhovich ■ Kenneth Alan Gould ■ Jean Grassman ■ Daniel Habib ■ George E. Harlow ■ William H. Harris ■ Roger Hart ■ David Harvey ■ N. Gary Hemming ■ George R. Hendrey ■ Mohamed Babiker Ibrahim ■ Urs Jans ■ Peter Kabachnik ■ Cindi Katz ■ Patricia M. Kenyon ■ Carsten Kessler ■ Reza Khanbilvardi ■ Nazrul Khandaker ■ Yehuda L. Klein ■ Athanasios Koutavas ■ Nir Y. Krakauer ■ Neil H. Landman ■ Arthur M. Langer ■ Irene S. Leung ■ Tammy L. Lewis ■ Marc-Antoine Longpre ■ Setha M. Low ■ Allan Ludman ■ Z. Johnny Luo ■ Juliana A. Maantay ■ Elia Machado ■ Peter J. Marcotullio ■ Steven Markowitz ■ Andrew R. Maroko ■ John Marra ■ Jeffrey Marsh ■ Edmond A. Mathez ■ Peter H. Mattson ■ Kyle C. McDonald ■ Cecilia M. McHugh ■ Andrew McIntyre ■ Jin Meng ■ Michael K. Menser ■ Jacob L. Mey ■ Ines M. Miyares ■ Alfredo Morabia ■ Fred Moshary ■ Cherukupalli E. Nehru ■ Wenge Ni-Meister ■ Robert P. Nolan ■ Hamidreza Norouzi ■ Gregory D. O'Mullan ■ Rupal Oza ■ Hari K. Pant ■ Marianna E. Pavlovskaya ■ Stephen F. Pekar ■ Jonathan R. Peters ■ Micahel Piasecki ■ Deborah Popper ■ Wayne G. Powell ■ Laxmi Ramasubramanian ■ Joaquin Rodriguez ■ Alfred L. Rosenberger ■ Ashaki A. Rouff ■ Leonid Roytman ■ Randye L. Rutberg ■ Haydee Salmun ■ Surendra K. Saxena ■ B. Charlotte Schreiber ■ Martin P. Schreibman ■ David Elihu Seidemann ■ John E. Seley ■ Frederick C. Shaw ■ Heather Sloan ■ William D. Solecki ■ Jeffrey C. Steiner ■ Gillian Meg Stewart ■ Karl-Heinz Szekielda ■ Marco Tedesco ■ David L. Thurber ■ Monica W. Varsanyi ■ Charles Vorosmarty ■ John R. Waldman ■ William G. Wallace ■ Michael K. Weisberg ■ Chuixiang Yi ■ Pengfei Zhang ■ Yan Zheng ■ Sharon Zukin

THE PROGRAM

The Ph.D. Program in Earth and Environmental Sciences offers a wide array of research options with faculty specializations in Geography and Geological Sciences, with focuses on atmospheric sciences, geographic information sciences, geology, geochemistry, geophysics, human geography, hydrology, and physical geography. Many of these areas include environmental science applications in ongoing projects. Besides faculty from Geology and Geography, the EES program includes faculty from Anthropology, Biology, Chemistry, Economics, and Engineering.

The Ph.D. Program in Earth and Environmental Sciences cooperates with the Civil Engineering Department at City College, the Center for the Analysis and Research of Spatial Information at Hunter College, and the American Museum of Natural History.

The Earth and Environmental Sciences program's two specializations are centered at one or more CUNY campus. The Geography specialization—including human geography, physical

geography, geographic information science, and geographic education—is at Hunter College and at Lehman College. With regard to the Environmental and Geological Sciences specialization, geological sciences, including atmospheric sciences, is at The City College; geology is at Brooklyn College; and environmental geology is at Queens College. When applying for admission, applicants must specify the specialization (Geography or Environmental and Geological Sciences) for which they would prefer to be considered. All applications must be submitted to the Admissions Office at the Graduate Center.

All courses are offered through the Graduate Center. Most required courses and some special topics courses are conducted at the Graduate Center. Laboratory courses and research work are offered at the various campuses of the University.

En-route M.A.
Upon completing 45 credits with an average grade of B, passing the First Examination, and satisfactorily completing a major research paper, the student may apply for an M.A. degree. The degree is awarded formally by one of the participating colleges.

SPECIAL REQUIREMENTS FOR ADMISSION
In addition to the requirements for admission stipulated by the University, applicants to the Earth and Environmental Sciences program are expected to have a minimum average of B in their undergraduate major. The program's Admissions and Awards Committee will consider exceptions to the above for candidates with other strengths. A high score on the Graduate Record Examination is necessary. The applicant is strongly recommended to have completed mathematics through calculus.

SPECIAL REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY
The following requirements are in addition to the University requirements stated earlier in this bulletin.

Course of Study The curriculum for all doctoral students in the Earth and Environmental Sciences program consists of a minimum of 60 graduate credits beyond the Baccalaureate degree, in addition to courses that may be deemed necessary to be taken to remedy undergraduate training deficiencies. Graduate transfer credits will be accepted subject to the rules pertaining to doctoral students as described in this bulletin.

THE SPECIALIZATION IN ENVIRONMENTAL AND GEOLOGICAL SCIENCES
The Environmental and Geological Sciences specialization within the Ph.D. Program in Earth and Environmental Sciences offers research opportunities in a broad spectrum of Earth-focused science reflecting the research interests of the faculty – including topics of classical Geology; studies of Earth's fluid envelopes; and applying combinations of geology, biology, chemistry, and physics to studying Earth's diverse environments and their ecosystems. These are grouped into four mutually-supportive areas within which faculty expertise and state-of-the-art instrumentation support exciting scientific investigations:

Atmospheric and Hydrological Sciences
Terrestrial, Estuarine, and Marine Studies
Earth Materials and Earth Processes
Urban Environments and Public Health

Modern research in Environmental and Geological Sciences commonly crosses the boundaries between these areas, e.g. isotope geochemists and biostratigraphers work with sedimentologists and climatologists to analyze paleoclimates over tens of millions of years; bedrock geologists work with geochemists and hydrogeologists to understand arsenic concentration in groundwater drinking supplies. Our program is designed to emphasize such linkages. A full range of research facilities is available within CUNY, and in addition, students may work at organizations and institutions, such as Brookhaven National Laboratory, the American Museum of Natural History, Lamont-Doherty Earth Observatory, with which our faculty are affiliated.

Core Areas in the Environmental and Geological Sciences Specialization

Atmospheric and Hydrological Sciences
Students with a primary interest in the two fluid envelopes that support life on Earth will find research opportunities in the Atmospheric and Hydrological Sciences area of concentration. CUNY faculty members are leaders in studies of weather, climate and hydrology. Current research addresses topics such as storms, droughts, hurricanes, flooding, groundwater depletion and contamination, and their impacts on society. Recently identified trends in the atmosphere, cryosphere and hydrosphere indicate that anthropogenic climate changes now under way will profoundly alter terrestrial and marine hydrological systems with uncertain consequences for humanity. Our studies in paleoclimatology not only help with understanding the Earth's climate history, but also can provide clues to what the future holds in store. Current research projects include: development of the history of hurricanes, isotope distributions within hurricanes, remote sensing of atmospheric pollutants, surface enhanced zeolites in groundwater treatment facilities, and paleoclimates recorded in the sediments below Antarctic ice shelves.

Terrestrial, Estuarine and Marine Studies
The Terrestrial, Estuarine and Marine Studies (TEMS) specialization is designed for students interested in a wide range of environmental sciences encompassing both basic and applied research. TEMS research emphasizes physical, biological, geochemical and ecological interactions. TEMS offers opportunities for research in one of the world's most densely populated areas, including impacts of urbanization, climate change and invasive species on a variety of areas such as Long Island Sound and of the Hudson River Estuary. World-wide, studies include: impacts of changing atmospheric chemistry on forests of the Upper Mid-west; global change and the intensification of Gulf hurricanes; the role of post-glacial climate change and rising sea level in the flooding of Eurasian inland seas; arsenic contamination of South Asian water supplies; and many other topics.

Earth Materials and Earth Processes
Society has become increasingly aware of the importance of geologic constraints on a sustainable economy within a stable and healthy environment. Topics in this core area have traditionally resided in classically oriented Geology programs but are increasingly incorporated in modern, broad-spectrum studies of urban and rural environments. Such studies offer insights into the foundations of Earth's varied environments and evidence from the past as to the nature and rate of environmental change. Doctoral studies can be done in mineralogy and petrology; sedimentology and stratigraphy; paleontology and paleoecology; tectonics; geomorphology; geochemistry; geochronology; seismology and other areas of geophysics; and resource exploration and development. Such work not only advances the frontiers of these disciplines but also improves our understanding of the factors controlling environment and environmental change. Ongoing research includes studies on: tectonic evolution of the Appalachian and Caledonide orogens; deformation mechanisms in ductile and brittle fault systems; geothermometry and geobarometry; fluvial, eolian, glacial, and coast erosion and deposition; and evolutionary paleobiology of sharks.

Urban Environments and Public Health
Epidemics, tsunamis, earthquakes, volcanism, storms, and their prediction and effects on urban societies have become a subject of intense concern. The Urban Environment and Public Health core area focuses on these and other environmental, geological, and geomedical aspects of urban life. The Graduate Center's unique location in the heart of one of the world's largest urban areas insures that students interested in contributing to improvement in urban life, in the health of urban populations and the preservation of natural ecosystems in urban settings will find unexcelled opportunities at CUNY. Current research in this core area includes studies of: the effect of New York City power station effluents on fish populations; monitoring of heavy metal and organic compounds in benthos/bottom sediment/water in New York City estuaries; repopulation of native species in New York coastal waters; the epidemiology and risk assessment of asbestos, arsenic, silica, talc, polychlorinated biphenyls, and cigarette smoke in human populations.

Curriculum Requirements for the Environmental and Geological Sciences Specialization
Within their first semester, incoming students are expected to consult with their prospective adviser(s) and devise a personal program of study to acquire command over the skills and methods needed to work in their proposed area of research.

Course work in the Specialization includes the following required courses:

1. EES 71600; Earth Systems I: Origin and Evolution of Earth and Life (3 credits, first semester).

2. EES 71700; Earth Systems II: Earth's Energy Networks (3 credits, second semester).

3. EES 70400; The Nature of Scientific Research (3 credits, first semester)

4. EES 80200 Dissertation Proposal Workshop (3 credits). Prerequisites for EES 80200 are: 1, satisfactory completion of all first-year core courses; 2, satisfactory completion of the First Examination; 3, submission of a one-page dissertation proposal abstract; 4, approval of the student's dissertation adviser; and 5, permission of the Executive Officer.

Requirements for the Environmental and Geological Sciences Specialization
From the first stages of matriculation, the student directs his/her program toward the desired research specialization. The major steps occur in the following order: First Examination, Second Examination, Oral Defense of the Dissertation Proposal, Oral Defense of the Dissertation.

First Examination The examination is a written and oral examination administered by the Environmental and Geological Sciences Curriculum Committee following the student's successful completion of at least 15 course credits including the following requirements:

A. The three first-year core courses (EES 702, EES 716, EES 717), each with a grade of B or better.

B. At least two other graduate-level courses in at least one of the four Environmental and Geological Sciences Subdivisions: Atmospheric and Hydrologic Sciences; Earth Materials and Earth Processes; Terrestrial, Estuarine, and Marine Studies; and Urban Environments and Public Health.

C. An overall average of 3.0 or better in all courses.

The written part of the first exam will consist of a closed-book, sit-down exam. The questions will be prepared by members of the Environmental and Geological Sciences First Exam Committee and will be based on the content and selective sets of readings for each core course and area of specialization selected by the student. Students will be expected to provide substantive responses in essay form to the questions asked and to demonstrate familiarity with the salient literature. The number of questions in each part of the exam will be consonant with the time allocated for completing the exam. No reference material will be permitted during the exam. Students will not have seen the questions until they take the test, and must answer all questions asked. The committee, following a short period to review the written examination, will meet with the student's and have the opportunity to ask follow-up questions, based on their written responses. The grade (pass/fail) will be based on the student's performance on both the written and oral examinations. A student who fails all or part of the written or oral examinations will be given one opportunity to retake those parts of the examination, no more than 12 months after the original examination.

Upon satisfactory completion of the First Examination, the student selects his/her dissertation committee. This committee sits with the student and selects those additional courses that are relevant to the area of dissertation research. The committee recommends whether or not the student must pass a specific foreign language examination. In consultation with the student, the committee selects an area to test the student's computer proficiency.

Second Examination The Second Examination involves the submission and defense of a proposal describing the dissertation research planned by the student. A dissertation committee, comprising a minimum of three members of the doctoral faculty, is appointed to assist the student in preparing for the Second Examination.

Oral Defense of the Dissertation Proposal The dissertation proposal must be written in an acceptable research-journal format, and presented to the student's Dissertation Committee for a critical review of content. Dissertation Committee must receive the Proposal at least two weeks prior to the scheduled Second Examination. The Second Examination is an oral examination conducted by the Dissertation Committee during which the student describes and defends

all aspects of his/her proposal. The student must be able to explain his/her research in the context of the historical development of the research discipline; relate his/her project to ongoing research in his/her field, and must demonstrate a thorough command of the literature relevant to the research. Normally, the Second Examination takes place upon completion of 60 credits, and requires approximately 2 hours.

The Dissertation Committee will require that the student rectify any errors in the research plan or address specific inadequacies in the literature review through a retake of all or a portion of the exam as specified by the Dissertation Committee no more than 12 months from the date of the first attempt.

Oral Defense of the Dissertation

THE GEOGRAPHY SPECIALIZATION

The Geography specialization within the Ph.D. Program in Earth and Environmental Sciences at the City University of New York provides an opportunity for doing geographical doctoral studies in one of the world's largest and most dynamic metropolitan locations. The doctoral program aims to provide students with modern training in the discipline of Geography. Given the strengths and interests of the faculty, a focus on the environment, in the broadest sense of that term, animates much of the programmatic work and provides a bridge among specialized concentrations. The specialization has six core areas: Cities and Urban Processes, Physical Geography, Globalization and Uneven Development, Productions of Nature, Geographic Information Science and Spatial Methods, and Health Geographies. These areas are not construed as mutually exclusive but as overlapping and interactive. Many faculty members participate in more than one core area, and students are encouraged to do likewise. Students are permitted to combine courses from the Geography specialization with the Geosciences specialization. They are also encouraged to take courses in related disciplines — particularly those such as Anthropology, Environmental Psychology, and Women's Studies — that house faculty with connections to geography to round out their educational experience. Through the Interuniversity Doctoral Consortium, it is possible to take courses at other institutions such as Columbia, New York, New School, and Rutgers universities.

Faculty members associated with the Geography specialization, based primarily at Hunter and Lehman colleges and at the Graduate Center, pursue interests in their own areas utilizing a variety of methods. A primary objective of the Geography specialization as a whole, however, is to utilize the urban laboratory of the New York metropolitan region as a catalytic framework to bring diverse threads of geographic research together in a collective and interactive effort. An attempt has been made to remove some of the artificial barriers that have traditionally developed between areas within the discipline of Geography. While a focus on the relations between urbanization and environmental issues seems particularly appropriate, many other combinations of research are possible. For example a student is able to combine geographic information science with urban theory, coastal geomorphology with urban hazards, social theory with a critical approach to geographic knowledge, theories of uneven geographic development with urban studies, migration studies with regional development, or geographic education with a focus on children's geographies.

Helping to facilitate these cross-specializations are a number of research centers housed within the program including the Center for the Analysis and Research of Spatial Information, the Center for Urban Coastal Processes, and the Center for Geographic Education. The Center for Place, Culture, and Politics, the Center for Human Environments, and the Bildner Center for Western Hemisphere Studies at the Graduate Center also engage with themes of interest to students within the Geography specialization.

While there is an emphasis on using the New York metropolitan area as a laboratory for training and research, faculty with considerable expertise are actively engaged in a wide range of regional and global issues (Africa, Asia, Latin America, Europe as well as North America). This permits local issues to be placed in a global perspective and facilitates cross-cultural and comparative work. Given the wide range of techniques and methods deployed by faculty, there is also an emphasis on maintaining the diversity of approaches and of methodologies that gives so much strength to the program. Our aim is to promote diversity and to ensure open conversation, communication, and collaboration across different traditions.

Course requirements are kept to a minimum. Each student, in consultation with key faculty, can look forward to designing a tailor-made educational program to satisfy his or her own needs. We are committed to fostering a strong sense of Geography as a community of interests working over a wide range of topics armed with an equally wide range of methodologies.

Core Areas in the Geography Specialization

Cities and Urban Processes
Located in the heart of Manhattan, the program aims to combine a general understanding of the role of cities in regional, national and international developments with deep analysis of the elements that make the city what it is: the built environment, transportation systems, migration flows, ethnic and religious differentiation, and the cultural, economic, and social uses of space. Within the varying frameworks of location theory, political economy, and political ecology, faculty research encompasses transportation system modeling, retail and consumption patterns, business location (including financial services), urban governance and administration, the role of philanthropic institutions and NGOs, social differentiation, transnational migration, gentrification, economic practices of the household, the environmental impacts of urbanization and sustainable urban development, climate change, urban health, social movements, public space and privatization of urban space, urban daily life, the ongoing urban transformation, and the dynamics of interregional and inter-urban relations in their global context. Social theorists examine the production of space and questions of race, gender, class and ethnic differentiations in the urban and regional context.

Physical Geography
Studies of the physical environment, at all spatial and temporal scales, have always been important. In the context of environmental problems facing humanity in the twenty-first century, an appreciation of the earth system, including all its components and their interactions, is even more critical. To understand, mitigate, and/or adapt to any significant environmental problem, from urban pollution to global climate change, an interdisciplinary approach including aspects of physical science working in conjunction with other disciplines is usually essential. Faculty members are conducting research in a diverse array of fields, including climatology, geology, atmospheric sciences, oceanographic sciences, and remote sensing of the earth's environment. Research projects focus on subdisciplines such as geochemistry, paleoclimate, land-surface interactions, hydrology, climate change, and cryospheric studies. Students are encouraged to avail themselves of opportunities to work on research projects with CUNY faculty, as well as with experts from other institutions. Many students are currently working in one of our active laboratories, including a geochemistry laboratory, a computer-based environmental geosciences laboratory, and a climate laboratory. Our students have participated in the NOAA-CREST (National Oceanic and Atmospheric Administration's Cooperative Remote Sensing Science and Technology Center) program, of which CUNY is one of the lead institutions. NOAA-CREST is a partnership between government, academe, and industry to conduct research consistent with NOAA's missions of environmental assessment, prediction, and stewardship using a variety of modern techniques.

Globalization & Uneven Development
A critical investigation of globalization and uneven development is an important focus of the program. Globalization is viewed as a multifaceted process that consists of economic, cultural, and political developments. Its outcomes and challenges to it are studied in many contexts including global North and South as well as a post-socialist world.

Productions of Nature
Nature does not stand outside of history; indeed it is continuously made and re-made within the complex of socio-spatial relationships that constitute human collectivities. While people have long modified nature for human ends, with capitalism this material transformation of nature now extends from the molecular to the planetary. Agricultural landscapes, managed forests, fish farms, genetically modified organisms, and built environments are all hallmarks of this 'second

nature'. So thoroughgoing is this production of nature that even the 'natural' existence of our own bodies is no longer self-evident. But production of nature is not to be confused with control over nature. The re-arranging of matter that is involved in producing nature can lead to novelty-by-combination and unexpected ecological outcomes – such as acid rain, avian flu, or global warming – that can thwart human design. More positively, the production of nature foregrounds the political and resolutely geographic character of justice: to the extent that human wellbeing is premised on nature being 'available' in particular ways, some deeply iniquitous and some more equal, the question becomes how we produce nature and who controls this production of nature.

Geographic Information Science and Spatial Methods

Geographic information science deals with the development and applications of the concepts, principles, models, methods, and technologies for gathering, processing, and analyzing geographically referenced data and effectively communicating the derived information to scientists, engineers, legislators, managers, and the general public for judicious and timely spatial decision-making. Program faculty have active research programs in spatial analysis, GIS programming, participatory GIS, critical GIS, global positioning systems, and remote sensing. The program covers the theoretical aspects, and technical issues using a wide range of applications. Particular emphasis is placed on the representation, visualization, and communication of spatial information; models, algorithms, and methodologies for efficient extraction of spatial information from remotely sensed data; spatial statistics and analysis; collaborative spatial decision-making; and innovative applications of geographic information technologies in environmental and resource management, urban and regional planning, international development, public safety, human health, and policy analysis.

Health Geographies

The Health Geographies specialization track focuses upon the spatiality of disease and other public health issues, particularly health in the urban environment. It explores the intersection of population geography, ecological studies, community health research, epidemiology, environmental analysis, and hazard and risk assessment. The influence of environmental and socio-economic factors upon health are examined in a geographical context, including patterns of health disparities and inequities; environmental health justice; environmental burdens and impacts; differential access to health care and healthy lifeways; the impact of the built environment upon health outcomes; linking health outcomes with social and physical environments; the relationship between social capital and health; patterns of disproportionate vulnerability, exposure, and risk; local-scale and global health inequalities; migration and health; the provision and utilization of health services, the geographies of disease, illness, disability, and specific gender and age health issues. Health is studied from a geographical perspective through the relevant theory, methodologies and research, using both qualitative and quantitative methods, including GISc, spatial analysis, and geostatistics. The theoretical framework can include the positivist, social interactionist, structuralist, and post-structuralist approaches to the geographies of health.

Curriculum Requirements for the Geography Specialization

Incoming students are expected to consult with their prospective adviser(s) and devise a personal program of study to acquire command over the skills and methods they need to work in their proposed area of research within their first semester. If courses for specific skills and methods are not available within the program, students will be encouraged to seek the necessary instruction elsewhere. The core course work includes the following requirements.

1. EES 71100 Introductory Workshop in Academic Resources (no credit) All students will take a noncredit intensive introductory workshop in the first weeks of the first semester introducing them to academic resources (libraries), IT facilities, and how to use the opportunities for research in the metropolitan area efficiently and well.

2. EES 70900 Geographical Thought and Theory (3 credits, first semester) This course explores the foundations of geographical knowledge. The course situates the history of geographical thought in its broad philosophical and historical context. Topics may include themes such as

the concept of nature (incorporating scientific, anthropological, historical, and humanistic perspectives), questions of technology and society (with particular emphasis on technologies of geographical enquiry and representation —for example, cartography to geographic information science, remote sensing, statistics); how to think about basic geographical concepts such as space, place, region, and environment in historical perspective; and examination of the relations between geographical knowledge and political power.

3. EES 71200 Geographical Knowledge in Action (3 credits, second semester) This integrated course takes the form of an investigative workshop in which students and faculty collaborate in the examination of a specific geographic problem using the New York metropolitan region as a focus for study. Students with different research interests will here be encouraged to integrate their skills (along with those of participating faculty) in studying a general problem in an integrative way. Research seminars will bring in outside experts to look at different facets of a common problem.

4. EES 70400 The Nature of Scientific Research (3 credits, first year) This course is designed to introduce first-semester students in the Ph.D. Program in Earth and Environmental Sciences to the principles of scientific inquiry. Following a broad overview of the epistemological foundations of the sciences, we compare and contrast the nature of explanation in the historical sciences (biology and geology), experimental sciences (physics and chemistry) and social sciences. We will discuss in detail the mix of quantitative and qualitative methods that are appropriate to each of these fields of inquiry. Finally, we explore ethics in scientific research. We will go beyond the issues of fabrication, falsification and plagiarism to look at the broader responsibilities of the researcher to her (his) research subjects, co-authors, mentor / mentee, scientific community, and society at large.

5. EES 80200 Dissertation Proposal Workshop (3 credits). This seminar is designed to teach students how to write a dissertation proposal, prepare grant proposals, and present ideas in a seminar setting. The student is required to formulate a dissertation proposal under the supervision of the student's mentor and the instructor. Permission of the dissertation adviser and instructor is required.

Requirements for the Geography Specialization

From the first stages of matriculation, the students direct their program toward their desired research specialization. The major steps occur in the following order: First Examination, Second Examination, Oral Defense of the Dissertation Proposal, Oral Defense of the Dissertation.

First Examination A written and oral examination is administered by the Geography First Examination Committee, comprising members of the doctoral faculty in Geography, following the student's successful completion of between 18 and 24 course credits including the following requirements:

A. The three first-year core courses (EES 704, EES 709, EES 712), each with a grade of B or better;

B. A methods course directed to the student's specific needs;

C. At least one graduate-level course in two of the following areas: Cities and Urban Processes, Physical Geography, Globalization and Uneven Development, Productions of Nature, Geographic Information Science and Spatial Methods, and Health Geographies.

D. An overall average of 3.0 or better in all courses.

Note: A student who has taken any of the required courses in section A or B in a master's program or equivalent may test out of the course by taking the course final examination. The written component of the first exam will be an open-book, take-home exam. The questions will be prepared by members of the Geography First Examination Committee, based on selective sets of readings for each core course and area of specialization. Students will be expected to provide substantive responses to several essay questions, with citations and references to all the salient literature. The committee, following a 1-2 week period to review the written examination, will meet with the student and have the opportunity to provide feedback and ask follow up questions, based on the written responses. The grade (pass/fail) will be based on the student's performance on both the written and oral examinations. A student who fails all or part of the written or oral examinations will be given one opportunity to retake those parts of the examination, no more than 12 months after the original examination.

Second Examination The Second Examination involves the submission and defense of a proposal describing the dissertation research planned by the student. A dissertation committee, comprising a minimum of three members of the doctoral faculty, is appointed to assist the student in preparing for the Second Examination.

Oral Defense of the Dissertation Proposal The dissertation proposal must be written in an acceptable research-journal format, and presented to the student's Dissertation Committee for a critical review of content. The Dissertation Committee must receive the Proposal at least two weeks prior to the scheduled Second Examination. The Second Examination is an oral examination conducted by the Dissertation Committee during which the student describes and defends all aspects of his/her proposal. The student must be able to explain his/her research in the context of the historical development of the research discipline; relate his/her project to ongoing research in his/her field, and must demonstrate a thorough command of the literature relevant to the research. Normally, the Second Examination takes place upon completion of 60 credits, and requires approximately 2 hours.

The Dissertation Committee will require that the student rectify any errors in the research plan or address specific inadequacies in the literature review through a retake of all or a portion of the exam as specified by the Dissertation Committee no more than 12 months from the date of the first attempt.

Oral Defense of the Dissertation

Courses

Students will be permitted to register for courses appearing in either specialization providing they meet the necessary prerequisites of the course or receive permission from the faculty member teaching the course. These course names and numbers are subject to change based on recent revisions in the program; see the program's website above.

EES 70100* Advanced Principles of Physical Geology
3 hours lecture, 3 hours laboratory, field trips, 4 credits
EES 70200* Advanced Principles of Historical Geology
3 hours lecture, 3 hours laboratory, field trips, 4 credits
EES 70300 Introduction to Mapping Science
1 hour lecture, 3 hours laboratory, 3 credits
EES 70400 The Nature of Scientific Research
2 hours, 2 credits
EES 70500 Earth's Internal Processes
2 hours lecture, 2 hours laboratory, 3 credits
EES 70600 Earth's Surface Processes
2 hours lecture, 2 hours laboratory, 3 credits
EES 70700 Human Geography
3 hours lecture, 3 credits
EES 70800 Time, Life and Global Change
2 hours lecture, 2 hours laboratory, 3 credits
EES 70900 Geographic Thought and Theory
30 hours lecture, 3 credits
EES 71000* Structural Geology
75 hours, 4 credits
EES 71100 Introductory Workshop in Academic Resources
5 hours, 0 credits
EES 71200 Geographical Knowledge in Action
45 hours, 3 credits
EES 71400 Introduction to Geophysics
30 hours lecture and 45 hours laboratory or 15 hours recitation, 3 credits
EES 71500 Research Opportunities in Environmental and Geological Sciences
30 hours, 1 credit

EES 71600 Earth Systems I: Origin and Evolution of Earth and Life
45 hours, 3 credits
EES 71700 Earth Systems II: Earth's Energy Networks
45 hours, 3 credits
Prerequisite: EES 71600
EES 72000 Mineralogy
30 hours lecture and either 15 hours recitation or 30 hours laboratory, 3 credits
Prerequisites: One year of college physics and calculus through differential equations or permission of instructor
EES 72300* The History and Philosophy of Geology
45 hours lecture, 3 credits
Prerequisites: Matriculation to the EES Ph.D. Program or EES 70100 and 70200
EES 72400* Igneous Petrology
30 hours lecture, 45 hours laboratory, 3 credits
EES 72600* Metamorphic Petrology
30 hours lecture, 45 hours laboratory, 3 credits
EES 73000 Paleontology of the Invertebrates
75 hours, 4 credits
EES 73600* Stratigraphic Palynology
60 hours (2 hours lecture, 2 hours laboratory), 3 credits
EES 74000 Sedimentology
75 hours (30 hours lecture, 45 hours laboratory), 3 credits
EES 74200 Stratigraphy
60 hours (2 hours laboratory, 2 hours lecture), 3 credits
EES 74300* Sedimentary Petrology
30 hours lecture, 45 hours laboratory, 3 credits
EES 74400* Environmental Geology
75 hours, 3 credits
EES 74500 Hydrology
30 hours lecture, 30 hours problem sessions and recitation, 3 credits
EES 74600 Groundwater Hydrology
30 hours lecture, 30 hours problem sessions and recitation, 3 credits
EES 74700* Coastal and Estuarine Geology
30 hours lecture, 30 hours laboratory, field trips, 3 credits
Prerequisites: EES 70100 or permission of instructor
EES 74800 Environmental Geology of the Coastal Zone
30 hours lecture, 30 hours laboratory, field trips, 3 credits
Prerequisites: EES 74700 or permission of instructor
EES 74900 Quantitative Methods in Earth and Environmental Sciences
45 hours lecture, 45 hours laboratory, 3 credits
EES 75000 Computer Applications in Earth and Environmental Sciences
2 hours lecture, 4 hours laboratory, 4 credits
Prerequisites: An introductory college level course in computer programming (Basic, Fortran, Pascal, or C) or equivalent programming skill
EES 75100 Introduction to Geographic Information Systems
45 hours, 3 credits
EES 75200 Principles of Remote Sensing
45 hours, 5 credits
EES 75300* Topographic Field Mapping
2-3 weeks, full time, 3 credits, offered during summer
EES 75400 Environmental Conservation
45 hours, 3 credits
EES 75500 Digital Image Processing
30 hours lecture, 60 hours laboratory, 4 credits

EES 75600 Coastal Dynamics
36 hours lecture, 8 hours laboratory, 3 credits, field trips
Prerequisites: EES 70100 or permission of instructor
EES 75700 Environmental Problems of Urban and Metropolitan Coasts
45 hours lecture, 3 credits, field trips
Prerequisites: EES 75600 or permission of instructor
EES 75800 Introduction to Environmental Modeling
30 hours, 3 credits
EES 75900: Multivariate Statistical Analysis in Geography
30 hours, 3 credits
EES 76000 Advanced Cartography
15 hours lecture, 90 hours laboratory, 4 credits
EES 76100 Automated Cartography
15 hours lecture, 90 hours laboratory, 4 credits
EES 76200* Photogrammetry and Air Photo Interpretation
30 hours lecture, 60 hours laboratory, 4 credits
EES 76300* Geological Applications of Remote Sensing
60 hours, 3 credits
EES 76400 Advanced Quantitative Methods in Earth and Environmental Sciences
45 hours, 4 credits
EES76500 Urban Application of GIS
30 hours, 3 credits
EES 77000 Principles of Geochemistry
45 hours, 3 credits
EES 77100 Geobiochemistry of Soils
30 hours lecture, 3 credits
Prerequisites: EES 70100 or permission of instructor
EES 77300* Low Temperature Geochemistry
3 hours (lecture), 3 credits
Prerequisite: EES 77000 or permission of instructor
EES 77350 Cosmochemistry
3 credits
Prerequisite: EES 71600
EES 77400* Physical Geochemistry
45 hours, 3 credits
EES 77500* Industrial Mineralogy
30 hours lecture, 3 credits
Prerequisites: EES 70100 or permission of instructor
EES. 77600 Climate and Climate Change
3 hours lecture plus 2 hours laboratory, 4 credits
Prerequisites: EES. 70100 or permission of instructor
EES 78000 Economic Geography
30 hours, 3 credits
EES 78100 Urban Geographic Theory
30 hours, 3 credits
EES 78200 Population Geography
30 hours, 3 credits
EES 78600 Latin Americanist Geography
30 hours, 3 credits
EES 79900 Special Topics in Earth and Environmental Sciences
15-60 hours, 1-4 credits
EES 80000 Geology Seminar
15 hours, 1 credit
EES 80100* Environmental Science Seminar
15 hours, 1 credit

EES 80200 Dissertation Proposal Workshop
45 hours, 3 credits
EES 80500 Independent Study
Credits variable, 1 or more credits per semester
EES 81000 Research for the Doctoral Dissertation
Credits variable, 1 or more credits per semester
EES 82000* Special Topics in Stratigraphy
45 hours, 3 credits
EES 82010* Stratigraphic Dating and Correlation
45 hours, 3 credits
EES 82020 Facies Analysis
45 hours, 3 credits
EES 82100* Special Topics in Paleoclimatology and Paleoceanography
45 hours, 3 credits
EES 82200* The Cenozoic Oceanographic Record as a Predictive Base
30 hours lecture and 15 hours recitation or 45 hours laboratory, 3 credits
Prerequisites: Graduate courses in marine geology and stratigraphy or permission of instructor
EES 82500* Special Topics in Paleontology
45 hours, 3 credits
EES 82501* Special Topics in Paleontology: Paleobiomechanics
45 hours, 3 credits
EES 83000 Special Topics in Geochemistry
45 hours, 3 credits
EES 83100 Special Topics in Environmental Geology
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor
EES 83200* Seminar on Urban Coastal Management
3 hours, field trips, 3 credits
Prerequisites: EES 74800 or permission of instructor
EES 84000* Special Topics in Mineral Resources
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor
EES 84500 Special Topics in Hydrology
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor
EES 84900* Special Topics in Quantitative Geology
45 hours, 3 credits
EES 85100 Carbonates and Evaporites: Sedimentology
3 hours laboratory, 3 hours lecture, field trips, 4 credits
Prerequisites: A course in sedimentology or stratigraphy or sedimentary petrology or permission of the instructor
EES 85200* Carbonates and Evaporites: Petrology
3 hours laboratory, 3 hours lecture, field trips, 4 credits
Prerequisites: EES 85100 and knowledge of the petrographic microscope
EES 86000* Special Topics in Igneous and Metamorphic Petrology
45 hours, 3 credits
EES 86001* Applications of Igneous and Metamorphic Petrology to Regional Tectonic Problems
45 hours, 3 credits
EES 86100* Special Topics in Mineralogy
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor
EES 86500* Special Topics in Sedimentology
30 or 45 hours, 2 or 3 credits
EES 87000* Special Topics in Structural Geology
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor

EES 87100* Special Topics in Tectonics
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor
EES 88500* Special Topics in Remote Sensing
30 or 45 hours, 2 or 3 credits
Prerequisite: Permission of instructor
EES 88600* Seminar in Cartographic Research
45 hours plus conferences, 3 credits
Prerequisites: Permission of instructor
EES 88700 Seminar in Remote Sensing
45 hours, 5 credits
EES 88800 Seminar in Geographic Information Systems
45 hours, 3 credits
EES 90000 Dissertation Supervision
1 credit

*offered infrequently