

GEOGRAPHY AND GEOINFORMATION SCIENCE (GGS)

100 Level Courses

GGG 101: *Major World Regions*. 3 credits.

Patterns, problems, and prospects of the world's principal human-geographic regions. Emphasizes areal differentiation and role of geographic differences in interpreting current world scene. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Mason Core: Global Understanding

Specialized Designation: Non-Western Culture

Schedule Type: Lecture

GGG 102: *Physical Geography*. 3 credits.

Interrelated processes affecting global distribution and character of climate, soils, vegetation, hydrology, and landforms. Includes elements of mapping. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Mason Core: Natural Science Overview, Encore:Sustainability

Specialized Designation: Green Leaf Course

Schedule Type: Lecture

GGG 103: *Human Geography*. 3 credits.

Overview of major ideas and approaches to studying spatial aspects of human social and behavioral systems. Surveys distribution and movement of human populations, characteristics and distribution of cultural mosaics, patterns of economic interdependence, and study of forces of cooperation and conflict among people from global perspective. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Mason Core: Social/Behavioral Sciences, Encore:Sustainability

Specialized Designation: Green Leaf Course

Schedule Type: Lecture

GGG 110: *Introduction to Geoinformation Technologies*. 3 credits.

This course introduces students to basic geoinformation technology concepts and applications. Students learn about and apply spatial data collection analytic tools and methods, including geographic information systems, and web-based map developments. Lectures examine social trends, ethical issues including privacy state of the art technological research and developments of geoinformation technologies in industry, government, education, and everyday life. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Discovery of Scholarship

Schedule Type: Lecture

GGG 121: *Dynamic Atmosphere and Hydrosphere*. 4 credits.

Systematic study of weather, climate, energy, and hydrologic systems viewed from a geospatial and global perspective. Studies the spatial distribution and relationships of the Earth's climate and hydrologic systems to other Earth systems, as well as the processes driving and changing them, including energy, climate, weather, and water resources. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Mason Core: Natural Science with Lab, Encore:Sustainability

Specialized Designation: Green Leaf Course

Schedule Type: Laboratory, Lecture

GGG 122: *Dynamic Geosphere and Ecosphere*. 4 credits.

Systematic study of biogeography and soils, viewed from a geographic, or spatial, perspective. We will study the spatial distribution and relationships of Earth's biomes and soils systems to other Earth systems, and the processes driving them, including energy, climate, nutrients, chemistry, and moisture. Cannot be combined for credit with EVPP 110 or EVPP 111. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Green Leaf Course

Schedule Type: Laboratory, Lecture

300 Level Courses

GGG 300: *Quantitative Methods for Geographical Analysis*. 3 credits.

Comprehensive introduction to quantitative methods in spatial analysis, with emphasis on solving geographical research problems. Topics include nature of spatial data; collection of spatial data; preparation of spatial data for mapping, geographic information systems, and statistical analysis; descriptive spatial statistics; areal sampling theory and methods; probability theory and distributions; hypothesis testing; correlation and regression; and areal and point pattern spatial statistics. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Scholarly Inquiry

Recommended Prerequisite: 30 credits, including GGS 102 and 103 or permission of instructor.

Schedule Type: Lecture

GGG 301: *Political Geography*. 3 credits.

Distribution and effects of power on landscape, particularly on national and global scales. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 30 credits

Schedule Type: Lecture

GGG 302: *Global Environmental Hazards*. 3 credits.

Introduces applications of observational and modeling techniques to natural hazards and the threat they pose to the world, as well as a general introduction to global climate change and its effect on regional and local scales. Examples include topics of interest to different countries and regions of the world, such as earthquakes, sand and dust storms, slope failures, volcanoes, land slides, droughts and desertification, floods, hurricanes and typhoons, severe weather, wild fires (U.S., Indonesia, Africa, S. America), sea-level rise, and tsunamis. Covers Earth system science topics related to the above hazards and their coupling with anthropogenic hazards as well as how societies respond to natural disasters and mitigation. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: 30 hours and undergraduate status

Schedule Type: Lecture

GGS 303: *Geography of Resource Conservation*. 3 credits.

Provides analysis of world resources distribution, conservation, and preservation; and problems resulting from their natural occurrence and utilization. Uses knowledge from physical and social sciences to develop complex and sophisticated understanding of issues surrounding natural resource exploitation and management, conservation, and preservation. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Mason Core: Encore:Sustainability, Synthesis

Specialized Designation: Green Leaf Course

Recommended Prerequisite: 30 credits, and completion or concurrent enrollment in all other required Mason Core courses.

Schedule Type: Lecture

GGS 304: *Population Geography*. 3 credits.

Spatial distribution of population, its causes and effects, and changing patterns resulting from population mobility. Emphasizes spatial characteristics of variables such as age, sex, race, education, and income. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Mason Core: Encore:Sustainability, Synthesis

Specialized Designation: Green Leaf Course

Recommended Prerequisite: 30 credits and completion of or concurrent enrollment in all Mason Core requirements.

Schedule Type: Lecture

GGS 305: *Economic Geography*. 3 credits.

Analyzes pattern of distribution of world economic activity, spatial economics behind this pattern, and influence of distribution on other spatial systems. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 30 credits

Schedule Type: Lecture

GGS 306: *Urban Geography*. 3 credits.

Structure and internal differentiation of cities. Variety of perspectives on nature of cities, and opportunities for intensive use of space. Urban problems and alternatives in their spatial context. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Schedule Type: Lecture

GGS 307: *Sustainable Development*. 3 credits.

Explores the concepts, applications, and tools for analysis and decision making in support of environmentally sustainable development. Case studies and problem-solving exercises will be used to stimulate learning and provide practical experience in addressing sustainable development issues. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: 60 hours; GGS 122 and GGS 302, or permission of instructor.

Schedule Type: Lecture

GGS 308: *Field Mapping Techniques*. 3 credits.

Basic techniques for collecting and recording spatial field data, including topographic maps, compass, transit, alidade, and geographic positioning systems. Includes field work. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: MATH 105, GGS 102 or GEOL 101, and 30 credits.

Schedule Type: Laboratory

GGS 309: *Meteorology and Climate*. 3 credits.

Elements of meteorology; analysis of world distribution of meteorological controls as bases of regional climatic variations. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 102, 121, or equivalent, or permission of instructor.

Schedule Type: Lecture

GGS 310: *Introduction to Digital Cartography*. 4 credits.

Origins, principles, and methods of thematic map design and production. Principles of graphic design, data compilation, analysis, and display. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Schedule Type: Laboratory, Lecture

GGS 311: *Introduction to Geographic Information Systems*. 3 credits.

Fundamental concepts and theories for appropriate use of geographic information systems (GIS). Discusses basic GIS functionality and applications in various fields. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Scholarly Inquiry

Schedule Type: Lecture

GGS 312: *Physical Climatology*. 3 credits.

Quantitative description of nature and theory of the climate system, dynamics of atmosphere-ocean-land surface, internal interactions and response to external forcing, description of the climate record and simple climate models. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to CLIM 312.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: 30 hours; and GGS 121, MATH 113, PHYS 243-244, or permission of instructor.

Schedule Type: Lecture

GGS 314: *Severe and Extreme Weather*. 3 credits.

Behavior of weather events ranging from small scale (e.g., thunderstorms and tornadoes) to mesoscale (e.g., fronts and hurricanes). Introduces the dynamical and physical processes, atmospheric boundary layer processes, and coupling between different spatial scales that create and shape severe and localized weather events. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to CLIM 314.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: MATH 113 or equivalent; CLIM/PHYS 111/112 or EOS 121 or GGS 121.

Schedule Type: Lecture

GGS 315: *Geography of the United States*. 3 credits. Diversity of US physical and cultural landscapes. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 6 credits of geography or American Studies, or permission of instructor.

Schedule Type: Lecture

GGS 316: *Geography of Latin America*. 3 credits. Regional survey of physical resources, populations, cultural characteristics, and economic activities in Latin America. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Non-Western Culture

Recommended Prerequisite: 6 credits of Geography or Latin American Studies, or permission of instructor.

Schedule Type: Lecture

GGS 319: *Air Pollution*. 3 credits. Description of major types of air pollution and introduction to how their characteristics are influenced by interaction with the atmosphere. Topics include sources and distribution of pollution from local to global scales, effects of radiation and wind on pollution, modeling of plume dispersion and pollution effects on climate. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: CLIM 111 or GGS 121.

Schedule Type: Lecture

GGS 320: *Geography of Europe*. 3 credits. Environmental, economic, social, and political factors influencing regional structure of Europe. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 6 credits of Geography or European Studies, or permission of instructor.

Schedule Type: Lecture

GGS 321: *Biogeography*. 3 credits. A survey of the relationship between distribution of plants and animals on the earth surface and the physical geography and environmental characteristics. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to BIOL 374.

Recommended Prerequisite: GGS 122 or permission of instructor.

Schedule Type: Lecture

GGS 322: *Issues in Global Change*. 3 credits. Provides the basis for evaluating existing and emerging issues in the environmental sciences at the regional and global scale, using interdisciplinary scientific principles. Combines activities designed to provide an understanding of the following: first principles underlying

regional/global issues in the environmental sciences, with attention to links among the disciplines of atmospheric sciences, biology, ecology, hydrology, oceanography, geology, human health, toxicology, and mathematical modeling; concepts of systems control, feedbacks, modeling, and hierarchical scales (spatial and temporal); role of retrospective analyses in developing a scientifically sound basis for evaluation and analysis; and studies of specific issues of interest on a regional to global scale. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 6 credits.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: GGS 121, GGS 122, or permission of instructor.

Schedule Type: Lecture

GGS 325: *Geography of North Africa and the Middle East*. 3 credits. Environmental, economic, and social factors of differentiation of regional structure and distribution of resources in North African and Middle Eastern countries. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Non-Western Culture

Recommended Prerequisite: 6 credits of Geography or courses related to Middle East, or permission of instructor.

Schedule Type: Lecture

GGS 330: *Geography of the Soviet Succession States*. 3 credits. Analyzes geographic factors involved in history, economic development, and geopolitical situation of the former Soviet Union. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Non-Western Culture

Recommended Prerequisite: 6 credits of geography or Russian studies, or permission of instructor.

Schedule Type: Lecture

GGS 333: *Issues in Regional Geography*. 3 credits. Geographical study of particular region or relevant regional issue. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 30 credits.

Schedule Type: Lecture

GGS 340: *Health Geography*. 3 credits. Spatial approaches to the study of health and disease. Topics include disease ecology and diffusion, and geographic perspectives on improving health care delivery. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Course in statistics.

Schedule Type: Lecture

GGS 354: *Data Analysis and Global Change Detection Techniques*. 3 credits. Introduces basic time series methods, especially those used in detecting trends and randomness in time series data. Various data related to global changes on different temporal and spatial scales will be identified, and the relevant analysis methods will be used to those data so that students can detect or confirm changing trends or lack of them in data. Other topics such as data formats, data visualization, and data mining may also

be included based on the background of the student body. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: IT 103, STAT 250, or permission of instructor

Schedule Type: Lecture

GGS 357: *Structures in Urban Governance and Planning*. 3 credits. Reviews spatial, policy, and administration principles that guide planning activity in United States. Outlines differences between theory and practice; and provides tools, methods, and perspectives commonly incorporated into practice of urban and regional policy analysis. Provides orientation to public-sector economy in general; and urban administration, planning, and policy in particular. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 30 credits

Schedule Type: Lecture

GGS 380: *Geography of Virginia*. 3 credits. Natural and cultural forces of Virginia. Studies regional makeup and analysis of human and environmental characteristics. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 30 credits

Schedule Type: Lecture

GGS 384: *Special Topics in Geospatial Intelligence*. 3 credits. Selected topics concerning human activity on earth derived from the exploitation and analysis of imagery and geospatial information that describes, assesses, and visually depicts physical features and geographically referenced activities on the Earth. Offered by Geography/Geoinformation Sci. May be repeated within the term.

Schedule Type: Lecture

GGS 398: *Selected Topics in Global Change*. 3 credits. Covers selected topics in global change not covered in fixed-content global change courses. Notes: Content varies and is determined by instructor. Offered by Geography/Geoinformation Sci. May be repeated within the term.

Recommended Prerequisite: 30 credits or permission of instructor.

Schedule Type: Lecture

GGS 399: *Select Topics in GGS*. 3 credits. Content varies; determined by instructor. Offered by Geography/Geoinformation Sci. May be repeated within the term for a maximum 12 credits.

Specialized Designation: Non-Western Culture

Recommended Prerequisite: 30 credits.

Schedule Type: Lecture

400 Level Courses

GGS 410: *Introduction to Hyperspectral Imaging*. 3 credits. Introduction to quantitative measurements by remote-sensing methods covering quantitative spectroscopy, spectral and thermal signatures, atmospheric physics, and the electromagnetic spectrum. Emphasis on the scientific principles involved and the transition of the technology to real-world applications. The requisite materials to begin to understand

hyperspectral imaging (HSI) technology and its many civil and military applications are presented. Covers necessary mathematics used in the analysis of n-dimensional data. Topics include hyperspectral concepts, data collection systems, data processing techniques, case studies, and U.S. national policy issues. Data processing techniques include N-dimensional space, scatterplots, spectral angle mapping, spectral mixture analysis, spectral matching, and other techniques. Applications and case studies include environmental, medical, agricultural, and military. Includes ground, airborne, and spaceborne hyperspectral systems. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: PHYS 243-244, 245-246, MATH 113 and 114, GGS 353, GGS 416 or permission of instructor.

Schedule Type: Lecture

GGS 411: *Advanced Digital Cartography*. 3 credits. This advanced course in cartography focuses on thematic map design. The objective is to produce a cartographic portfolio of well-designed, professional grade maps. Theoretical concepts and principles will be introduced using practical examples and written assignments. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 311.

Registration Restrictions:

Required Prerequisite: GGS 310^C.
^C Requires minimum grade of C.

Schedule Type: Lecture

GGS 412: *Air Photography Interpretation*. 3 credits. Methods and techniques of interpreting and using information contained in aerial photography, including applications to various aspects of physical and cultural landscape. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 60 credits and GGS 102 or 103, or permission of instructor.

Schedule Type: Lecture

GGS 415: *Seminar in Geography*. 3 credits. Students produce, present original research papers. Notes: Capstone seminar for geography majors integrating previous course work into disciplinary framework. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Writing Intensive in the Major

Recommended Prerequisite: GGS 300 and 310

Schedule Type: Lecture

GGS 416: *Satellite Image Analysis*. 3 credits. Examines methods and techniques of interpreting and using information obtained by non-photographic remote sensing systems, with particular emphasis on space-borne platforms. Includes analysis of imagery for both physical and cultural environments. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 60 credits and GGS 412, or permission of instructor.

Schedule Type: Lecture

GGS 455: *Environmental Impact Assessment*. 3 credits.

Evaluates current methods and practices for conducting and planning environmental assessments to include techniques and requirements for assessing impacts on air, water, natural resources, transportation, water facilities, and industrial and community development. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: GGS 122, GGG 302, or EVPP 377 or 6 hours of courses in ecology and environmental sciences, or permission of instructor.

Schedule Type: Lecture

GGS 456: *Introduction to Atmospheric Radiation*. 3 credits.

Helps students learn about the fundamental aspects of atmospheric radiation. The goal is to understand their essential roles in advanced remote sensing, atmospheric sciences and global and environmental change. It will provide a foundation for and will be beneficial to students in taking advanced courses in those areas. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to CLIM 456.

Recommended Prerequisite: GGS 353/GGS 309 and a course in physics, or permission of instructor.

Schedule Type: Lecture

GGS 462: *Web Mapping*. 3 credits.

Managing geospatial data is at the core of an emerging Billion-Dollar industry. This course will provide the students with the knowledge to manage and query geospatial data using relational database management systems and how to build Javascript-based Web mapping applications on top of a database to communicate and interact with the data. Students who take GGS 462 cannot receive credit for GGS 692. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 311.

Schedule Type: Lecture

GGS 463: *Applied Geographic Information Systems*. 3 credits.

Selected applications in geographic information systems (GIS). Topics include automated data capturing and processing, spatial data models and structure including object-oriented approach, advanced spatial analytical techniques including raster modeling and network analysis, programming, and algorithm development in GIS. Major purpose of course is to extend fundamental theories and concepts in GIS so students are able to conduct research with and on GIS. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Required Prerequisites: (GGS 300^C, L300 or 300T) and (GGS 311^C, 311T or L311).

^C Requires minimum grade of C.

Schedule Type: Lecture

GGS 470: *Special Topics in Geographic Techniques*. 3 credits.

Content varies in the subject of Geographic Techniques. Offered by Geography/Geoinformation Sci. May be repeated within the term for a maximum 12 credits.

Recommended Prerequisite: GGS 110.

Schedule Type: Lecture

GGS 480: *GGS Internship*. 1-3 credits.

Approved study programs with specific employers. Notes: Credit determined by department. Contact department one semester before enrollment. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Open only to authorized GGS majors with 90 credits and GPA of 2.50 or higher in GGS courses.

Schedule Type: Independent Study

GGS 490: *Practicum in Geographical Applications*. 1-3 credits.

Application of geographical research tools and techniques in conjunction with faculty instruction and research. Individualized sections taught by arrangement with full-time faculty. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 3 credits.

Recommended Prerequisite: Authorized GGS majors with 90 credits.

Schedule Type: Independent Study

GGS 495: *GGS Senior Research Project*. 3 credits.

Applications of research tools and techniques on specific GGS topics, in conjunction with faculty instruction and research. Individualized sections taught by arrangement with full-time faculty. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 90 credit hours, authorized major.

Schedule Type: Research

GGS 499: *GGS Independent Study*. 1-3 credits.

Individual study of selected area of geography. Notes: Requires directed research paper. May be repeated with permission of the department. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Open only to authorized GGS majors with 90 credits and GPA of 2.50 or higher.

Schedule Type: Independent Study

500 Level Courses

GGS 501: *Geography and Geoinformation Science Distance Education Orientation*. 1 credit.

Describes study structure and basic expectations (In terms of time commitment, expectations, technical Issues and communication) for distance education courses in the Geography and Geoinformation Science department. Notes: The course is self-paced, enabling students to proceed at their own speed. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 505: *Transportation Geography*. 3 credits.

Structure, principles, location, and development of world transportation. Critical role of transportation in moving people, goods, and ideas at international, national, regional, and urban levels. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 6 credits of geography

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 507: *Sustainable Development*. 3 credits.

Sustainability lies at the intersection of the environment, society and economics. This course explores the concepts, applications, and tools for analysis and decision making in support of environmentally sustainable, socially responsible and economically prosperous development. Case studies and problem-solving exercises will stimulate learning and provide practical experience in addressing sustainable development issues. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 520: *Geography for Teachers*. 3 credits.

Emphasizes problems and techniques in teaching geography; and current developments in research, methodology, and philosophy in the discipline. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 524: *Introduction to Environmental and Resource Economics*. 3 credits. Introduces theory of external costs and benefits, public goods, natural resource management, and benefit and cost analysis for noneconomists.

Lecture-discussion format with student presentations and participation. Analytical problem set, short writing assignments, and exams. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to EVPP 524.

Recommended Prerequisite: Basic algebra skills.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 525: *Economics of Human/Environment Interactions*. 3 credits.

Advanced topics in environmental, natural resource, and ecological economics for noneconomist. Emphasizes sustainability, intergenerational equity, and economic-ecological feedbacks. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to ECON 895, EVPP 525.

Specialized Designation: Green Leaf Course

Recommended Prerequisite: EVPP 524/GGS 524 or equivalent

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 531: *Land-Use Modeling Techniques and Applications*. 3 credits.

Survey of literature on spatially explicit empirical models of land-use change. Hands-on experience developing and running simple models. Techniques covered include statistical models, mathematical programming models, cellular automata, agent-based models, and integrated models. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to EVPP 531.

Recommended Prerequisite: GGS 550, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 533: *Issues in Regional Geography*. 1-6 credits.

Geographical study of particular region or relevant regional issue. Notes: Content varies. May be repeated with permission of the department. Offered by Geography/Geoinformation Sci. May be repeated within the term for a maximum 12 credits.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 540: Health Geography.** 3 credits.

Spatial approaches to study of health and disease. Topics include disease ecology and diffusion, and geographic perspectives on improving health care delivery. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Course in statistics.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 550: Geospatial Science Fundamentals.** 3 credits.

Introduces geospatial sciences, emphasizing concepts and theories of cartography, remote sensing, air photo interpretation, Global Positioning Systems, spatial data structures, and geographic information systems. Lectures accompanied by hands-on exercises. Notes: Only available for students without previous course work in cartography. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 551: Thematic Cartography.** 3 credits.

Analyzes nature of perceptual organization and visual systems in thematic map communication portrayal, graphic handling, and data analysis. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 310 or 550

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 553: Geographic Information Systems.** 3 credits.

Sources of digital geospatial data; and methods of input, storage, display, and processing of spatial data for geographic analysis using GIS. Lectures, hands-on exercises familiarize students with current technology. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 550 or equivalent, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 554: History of Cartography.** 3 credits.

History of cartographic portrayal of Earth from ancient times through 19th century, emphasizing interrelation of human culture, technological development, and geographical knowledge as reflected in maps. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 560: Quantitative Methods.** 3 credits.

Survey of quantitative methods commonly used in geographic research. Emphasizes spatial analysis techniques. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Previous course work in statistics, or GGS 310 or 550.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture**GGG 562: Photogrammetry.** 3 credits.

Treatment of photogrammetric problems, including least squares adjustments, image coordination refinements, collinearity equation, resection, relative orientation, and analytic aerotriangulation. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 412, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 563: *Advanced Geographic Information Systems*. 3 credits.

Discusses advanced GIS concepts including spatial data structure, spatial analysis, programming data fusion, Internet components, and spatial database management. Hands-on activities demonstrate concepts and specific applications in both cultural and physical geography. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 553 or equivalent.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 579: *Remote Sensing*. 3 credits.

Examines use of various types and combinations of electromagnetic energy to obtain spatial information. Concentrates on nonphotographic and spaceborne remote sensing platforms and sensors. Examines essential operational parameters for existing and future systems and strategies for visual extraction of features. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 412, or GGS 550, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 581: *World Food and Population*. 3 credits.

Topics include maldistribution of population, regional disparities in growth rates and income distribution, food production, and world hunger. Discusses population policies, with emphasis on Third World countries. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 590: *Selected Topics in Geography*. 1-3 credits.

Analyzes topics of immediate interest. Notes: Content varies. Offered by Geography/Geoinformation Sci. May be repeated within the term for a maximum 12 credits.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

600 Level Courses

GGS 605: *Systematic Applications of GIS*. 3 credits.

Provides those working with spatially referenced data the technical skills to use GIS to conduct spatial analyses on socioeconomic phenomena related to labor, retail, and real estate markets. Introduces and emphasizes the development of technical and methodological skills to understand the potential and the pitfalls of using GIS for spatial analyses of socioeconomic phenomena. Offered by Geography/Geoinformation Sci. May be repeated within the term.

Recommended Prerequisite: GGS 553

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 631: *Spatial Agent-Based Models of Human-Environment Interactions*. 3 credits.

Discusses key challenges in spatial modeling of human-environment interactions. Reviews agent-based modeling applications in urban and rural interactions, agriculture, forestry, and other areas. Hands-on development of simple ABM models and investigation of linkages between GIS and ABM. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to EVPP 631.

Recommended Prerequisite: GGS 531 or CSS 600, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 644: *Fundamentals and Interpretation of Imaging Radar*. 3 credits. Provides understanding of components, functionality, and use of radar remote sensing for acquiring spatial information. Concentrates on operational systems. Includes hands-on assignments. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 579, or other basic course in remote sensing.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 650: *Introduction to GIS Algorithms and Programming*. 3 credits. Introduction to programming methods and their application to Geographic Information Systems, including the fundamentals of object-oriented programming and GIS-specific data structures and algorithms. Employs an object-oriented language such as Visual Basic.Net, and existing freeware and commercial GIS libraries. Topics covered include variables, arrays, control structures, objects and classes, raster and vector data structures, spatial algorithms, and spatial indexing methods. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 553 or equivalent introductory GIS course, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 653: *Geographic Information Analysis*. 3 credits. Explores existing and potential capabilities of geographic information systems in conducting spatial analysis and modeling. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 553 and 560

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 655: *Map Design*. 3 credits.

Advanced examination of principles of map design, including discussions of map design research. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 310 or 550.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 656: *The Hydrosphere*. 3 credits.

Covers components and transfer processes in hydrosphere, which consists of aqueous envelope of Earth including oceans, lakes, rivers, snow, ice, glaciers, soil moisture, ground water, and atmospheric water vapor. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to EVPP 652.

Recommended Prerequisite: Two semesters of calculus, partial differential equation recommended; or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 657: *The Lithosphere*. 3 credits.

Global-scale overview of lithosphere; the solid nonliving Earth, its materials, cycles, plate tectonic and geomorphic processes; and history, including interactions with and history of hydrosphere, atmosphere and biosphere, and methods of analysis. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to GEOL 601.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 658: *Terrain Mapping*. 3 credits.

Covers fundamental methods of digitally representing terrain data, major technologies, and programs for generating terrain data; methods for quantifying terrain error and assessing terrain data quality; and a variety of applications. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 553 or equivalent, or permission or instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 660: *Automated Cartography*. 3 credits.

Survey of algorithms and techniques to generalize information on maps and in geographic information systems. Covers simplified representation of geographic objects, surfaces, and thematic information. Includes GIS programming component. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 650 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 661: *Map Projections and Coordinate Systems*. 3 credits.

Covers development of various map projections and coordinate systems, property analysis, distortions, and applications. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 310 or 550

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 664: *Spatial Data Structures*. 3 credits.

Studies spatial data structures and their application in digital cartography, geographic information systems, and image-processing systems. Examines raster and vector data structures, and attribution schemes and topological models. Includes data transformation, information loss, data quality, and the role of metadata. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: B or better in GGS 560.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 670: *Introduction to Atmosphere and Weather*. 3 credits.

Applies climatic concepts to natural and human-modified environments, and analyzes climatic change. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 671: *Algorithms and Modeling in GIS*. 3 credits.

Examines several fundamental GIS algorithms based upon computational geometry and computer graphics. Also discusses issues in modeling features of different dimensions and surfaces in GIS. Significant programming expected. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: B or better of GGS 560.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 674: *Environmental Impact Analysis*. 3 credits.

Scientific and administrative processes involved in environmental impact analysis and environmental impact statements. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 675: *Location Science*. 3 credits.

This course presents the theory and practice of Location Science - the study of the optimal or near optimal spatial location or allocation of facilities, routes, personnel, or other assets. A variety of algorithms and heuristics for location problems is presented. Lectures and both in-class and take-home exercises reinforce students' mastery of the

techniques and understanding of advanced theoretical issues. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 680: *Earth Image Processing*. 3 credits.

Focuses on how geoinformation technologies, including GIS, RS, and GPS, and spatial analytical techniques can be integrated to address various situations in environmental risk assessment, monitoring, and planning. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 416 or GGS 579 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 681: *Social Media Analysis*. 3 credits.

The course covers theory, principles, and analytical techniques in geospatial analysis of social media, including data collection, location-based and cyberspace social network analysis, content analysis, and geovisualization of such data. Examples of applications in various domains are used to demonstrate and explore the use of social media analysis. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 550 or GGS 553 or permission of the instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 684: *Selected Topics in Geospatial Intelligence*. 3 credits.

Covers topics relevant to geospatial intelligence, especially addressing emerging trends, focused intelligence applications, and relevant technological advances, not covered by existing courses. Sample topics addressed in this course include geosensor networks, landmine detection using remote sensing techniques, the use of unmanned aerial vehicles in geospatial intelligence, and the use of virtual reality techniques

for geospatial information modeling and analyst training. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Students must be admitted to the Geospatial Intelligence Certificate program or have permission from the program's academic director.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 685: *Capstone Course in Geoinformatics*. 3 credits.

This course is intended to provide a capstone experience for graduate students by synthesizing knowledge and experience that they acquired in earlier coursework to address a complex geospatial intelligence problem. The course requires analytical, collaborative, and communication skills. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: 12 credits in the geospatial intelligence certificate program or permission of program coordinator.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 689: *Seminar in Geographic Thought and Methodology*. 3 credits.

Includes historical development of geographic thought and current philosophy of geography; rationale for various subfields; and geographic research techniques and methods of analysis. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 560

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Seminar

GGS 692: *Web-based Geographic Information Systems*. 3 credits.

Management of geospatial data by means of a database system. Communication of geospatial data over the Internet using browser-based interfaces. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 550 or equivalent, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 695: *Geography and Geoinformation Science Graduate Internship*. 1-6 credits.

Approved study programs with specific employers. Students and employer supervisors must demonstrate relevancy of study program to degree requirements. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 6 credits.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Internship

GGS 698: *Directed Readings and Research*. 1-3 credits.

Reading and research on specific topic under direction of faculty member. Notes: Written report required; oral exam and report may be required. Offered by Geography/Geoinformation Sci. May be repeated within the term for a maximum 12 credits.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Non Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

700 Level Courses

GGS 700: *Comprehensive Exam*. 1 credit.

Preparation and completion for the comprehensive exam within the GGS department. Instructor should be the chair of the examination committee. The exam committee will specify exam content. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 12 credits.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Independent Study

GGS 704: *Spatial Demography*. 3 credits.

Intermediate-level, population geography course discussing demographic concepts and spatial dimensions of population. Features various indices,

measures, and models commonly used in human geography. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Prior courses in quantitative methods and GIS recommended.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 721: *Biogeography*. 3 credits.

Provides broad understanding of how physical geography and environment influence spatial and temporal distribution of plants and animals on Earth's surface. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Courses in ecology, chemistry, and geology.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 740: *Hyperspectral Imaging Systems*. 3 credits.

Provides requisite materials to understand hyperspectral imaging technology and its many civilian and military applications. Emphasizes scientific principles involved and technology application to real-world imaging systems. Topics include hyperspectral concepts and system tradeoffs; data collection systems; calibration techniques; data processing techniques and software; classification methods; and case studies. Data processing techniques include N-dimensional space, scatterplots, spectral angle mapping, spectral mixture analysis, spectral matching, and mixture tuned matched filtering. Discusses ground, airborne, and spaceborne hyperspectral remote sensing systems. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: CSI 660 or equivalent, or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 754: *Earth Science Data and Advanced Data Analysis*. 3 credits.

Covers accessing and applying Earth observations and remote-sensing data for Earth system science research and applications. Major topics are data formats, analysis and visualization tools, advanced data analysis methods, and data applications. Also covers combining innovative information technology techniques and Earth science data to set up online data centers for accessing data through the web. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to CSI 754.

Recommended Prerequisite: GGS 579 or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 756: *Physical Principles of Remote Sensing*. 3 credits.

Emphasizes fundamental physical and mathematical principles of remote sensing. Also provides overview of the current Earth Observation System as well as the National Polar-Orbiting Operational Environmental Satellite Systems (NPOESS), and NPOESS Preparatory Project missions. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 753 or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 759: *Topics in Earth Systems Science*. 1-6 credits.

Covers selected topics in Earth systems and global changes not covered in fixed-content Earth systems and global changes courses. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 760: *Advanced Topics in Remote Sensing*. 3 credits.

Content varies in the area of remote sensing. Offered by Geography/Geoinformation Sci. May be repeated within the term for a maximum 12 credits.

Recommended Prerequisite: GGS 579 or GGS 680.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 772: *Cloud Geographic Information Systems*. 3 credits.

Examines different aspects of science and technology in the context of distributed GIS. Includes general concepts, architecture, component design and development, and system integration as well as other advanced topics, including interoperability and agent-based GIS. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Introductory course in GIS and some programming experience, or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 773: *Interoperability of Geographic Information Systems*. 3 credits.

Advanced course addressing theories, standards, and implementations of web-based interoperable geographic information systems for online data and information services. Reviews international standards, including

OGC, and associated tools for interoperability. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 754 and GGS 553, or a course in GIS.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 777: *Remote Sensing Natural Hazards*. 3 credits.

Provides an overview of major natural hazards, their governing dynamics and remote-sensing techniques used to study, forecast, and mitigate hazards. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 579 or GGS 680; or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 787: *Scientific Data Mining for Geoinformatics*. 3 credits.

Covers specialized data mining algorithms, geoscience data models, and data information systems. Emphasis on domain-specific data mining algorithms suitable for spatial data and spatio-temporal data with geoscience and geoinformatics applications. Introduces real geoscience data mining applications in detailed applications. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: Competency in programming at the level of CSI 601-607 or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGS 791: *Advanced Spatial Statistics*. 3 credits.

Advanced course focusing on analyzing georeferenced or spatial data represented as points or polygons. Addresses higher moments, point pattern analyses, and interpolations of points to surfaces. Includes spatial regression. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Recommended Prerequisite: GGS 560 or STAT 535/554, or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

GGG 792: *Seminar in Earth Systems Science*. 2 credits.
Capstone experience. Seminars presented by faculty and students.
Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to EVPP 792.

Recommended Prerequisite: 15 Graduate Credits including CSI 655, GGS 656, and GGS 657, or permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Seminar

GGG 795: *Seminar in Regional Analysis*. 3 credits.
Analyzes and synthesizes physical and cultural elements of geography in selected region. Should be taken near end of master's degree program. Provides opportunity to apply selective knowledge gained in previous systematic courses to specific region. Offered by Geography/Geoinformation Sci. May not be repeated for credit.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Seminar

GGG 798: *Research Project in Earth Systems Science*. 1-6 credits.
Reading project chosen and completed under guidance of graduate faculty member resulting in acceptable technical report. Notes: For students enrolled in Earth Systems Science master's program. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Admission to Earth Systems Science MS program, 12 graduate credits, and permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Thesis

GGG 799: *Thesis*. 1-6 credits.
Degree candidacy and departmental approval of thesis proposal. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 6 credits.

Recommended Prerequisite: Degree candidacy and departmental approval of thesis proposal.

Registration Restrictions:
Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Thesis

800 Level Courses

GGG 840: *Hyperspectral Imaging Applications*. 3 credits.
Introduces advanced hyperspectral imaging and multisensor concepts with emphasis on real-world civilian and military applications. Topics include advanced hyperspectral concepts, multisystem tradeoffs, data collection and processing systems, imaging radar systems, laser

systems, calibration techniques, data fusion, quantitative remote sensing techniques, data compression techniques, case studies, and U.S. national policy. Applications and case studies include environmental, homeland security, medical, military, disaster mitigation, agricultural, and transportation. Offered by Geography/Geoinformation Sci. May not be repeated for credit. Equivalent to CSI 854.

Recommended Prerequisite: CSI 660 or equivalent, or permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate level students.

Schedule Type: Lecture

900 Level Courses

GGG 900: *Geography and Geoinformation Science Colloquium*. 1 credit.
Presentations in specific research areas of Geography and Geoinformation sciences by faculty and staff, Mason faculty in related programs, and professional visitors. Notes: Maximum 3 credits may be applied to Earth systems and geoinformation sciences PhD. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 3 credits.

Registration Restrictions:
Enrollment is limited to Graduate level students.

Schedule Type: Seminar

GGG 998: *Dissertation Proposal*. 1-12 credits.
Covers development of research proposal that forms basis for doctoral dissertation, under guidance of dissertation director and doctoral committee. Notes: May be repeated, but no more than 12 credits of GGS 998 may satisfy doctoral degree requirements. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 12 credits.

Recommended Prerequisite: Doctoral student or permission of instructor.

Registration Restrictions:
Enrollment is limited to Graduate level students.

Schedule Type: Dissertation

GGG 999: *Dissertation*. 1-12 credits.
Doctoral dissertation research under direction of dissertation advisor. Notes: May be repeated, but no more than total 24 credits in GGS 998 and 999 may be applied to doctoral degree. Offered by Geography/Geoinformation Sci. May be repeated within the degree for a maximum 24 credits.

Registration Restrictions:
Enrollment limited to students with a class of Advanced to Candidacy.

Enrollment is limited to Graduate level students.

Schedule Type: Dissertation