# Geographic Information Systems (GIS)

**GIS 205 Spatial Thinking with GIS** (3 credit hours)
Spatial thinking and how it relates to the basic foundations of geospatial science and geographic information systems (GIS) are introduced. Students will learn to tell stories through maps using geographic information and geospatial data and analysis by applying spatial reasoning through a series of interactive assignments and discussions. Students will learn to define spatial problems and design solutions across a variety of disciplines, setting the stage for additional technical coursework in GIS and Geospatial Science.

*GEP Interdisciplinary Perspectives*
*Typically offered in Spring only*

**GIS 280 Introduction to GIS** (3 credit hours)
This course provides an overview of the operations and functions of geographic information systems [GIS]. Students develop a fundamental understanding of geographic information management and analysis methods. Emphasis is placed on the nature of geographic information, working with spatial data, and elementary geospatial analysis and modeling techniques. Students learn effective operation of GIS software and gain exposure to GIS tools that support these emphasis areas. Extensive independent learning and computer experiences include online laboratory sessions, alongside synchronous online or in-person weekly problem sessions. Students will need access to a laptop for the in-person problem sessions.

*Typically offered in Fall and Spring*

**GIS 295 Special Topics in Geospatial Information Science** (1-4 credit hours)
Special Topics in Geospatial Information Science at the 200 level for offering courses on an experimental basis.

*Typically offered in Fall, Spring, and Summer*

**GIS 411/GIS 511 Coding for Geospatial Applications** (2 credit hours)
Exploration of the intersection between coding and Geographic Information Systems. This course provides a broad overview of coding platforms commonly used in geospatial applications, with an emphasis on basic Python programming skills for geospatial tasks related to spatial data science and visualization. Prior programming experience is not required or expected. Some GIS experience is preferred. Students in the GIS and Spatial Data Science minor may opt to take this course in the same semester as GIS 450 when available.

Prerequisite: GIS 280
*Typically offered in Fall only*

**GIS 450 GIS and Spatial Data Science in Practice** (1 credit hours)
Students in this course will review best practices in GIS and Spatial Data Science from an interdisciplinary perspective through a series of real-world case studies in both natural and social sciences as well as applications of spatial data science via guest lectures from non-profit, government agency, research, and other industry representatives. Finally, students will work as a group to tackle a real-world issue using their collective knowledge of GIS and Spatial Data Science. This course is intended for students completing the GIS and Spatial Data Science minor. Students may opt to take GIS 411 and this course in the same semester when available.

Corequisite or Prerequisite: GIS 411 or permission of instructor
*Typically offered in Fall only*

**GIS 495 Special Topics in GIS** (1-6 credit hours)
Presentation of material not normally available in regular course offerings or offering of new courses on a trial basis. Credits and content determined by the faculty member in consultation with the Department.

*Typically offered in Fall, Spring, and Summer*

**GIS 499 Undergraduate Research Experience in Geospatial Analytics** (1-6 credit hours)
Mentored research experience in geospatial analytics. A minimum of 45 hours must be completed for each credit hour earned. The experience must be arranged in advance and approved by the Center for Geospatial Analytics prior to enrollment. Approval requires completion of the Center's Undergraduate Research agreement/Contract, which must be signed by the student, their research mentor, and their academic advisor. Students should refer to their curriculum requirements for possible restrictions on the total number of GIS 499 credit hours that may be applied to their degree.

*Typically offered in Fall, Spring, and Summer*

**GIS 501 Geospatial Professionalism** (1 credit hours)
Students will examine a variety of topics critical to successful navigation of the geospatial profession, with an emphasis on map communication and presentation, interpreting geospatial research, the ethical, legal, and social implications (ELSI) of using spatial data, metadata concepts, and linking results to policy actions. Students will engage in several writing, presentation, and interpretation exercises.

*Typically offered in Fall and Spring*

**GIS 510 Fundamentals of Geospatial Information Science and Technology** (3 credit hours)
This course provides an advanced overview of how geographic information systems [GIS] facilitate data analysis and communication to address common geographic problems. Students improve spatial reasoning and problem definition expertise while emphasizing geographic data models and structures, data manipulation and storage, customization through programming, and the integration of geospatial analysis and modeling into project-based problem solving applicable to a variety of disciplines. Skilled application of both desktop and cloud-based GIS software supports these areas. Extensive independent learning and computer experiences include virtual laboratory sessions, alongside optional online or in-person weekly help sessions to facilitate student learning.

Prerequisite: Graduate Standing or PBS or Permission of Instructor
*Typically offered in Fall and Spring*

**GIS 511/GIS 411 Coding for Geospatial Applications** (2 credit hours)
Exploration of the intersection between coding and Geographic Information Systems. This course provides a broad overview of coding platforms commonly used in geospatial applications, with an emphasis on basic Python programming skills for geospatial tasks related to spatial data science and visualization. Prior programming experience is not required or expected. Some GIS experience is preferred. Students in the GIS and Spatial Data Science minor may opt to take this course in the same semester as GIS 450 when available.

Prerequisite: GIS 280
*Typically offered in Fall only*

**GIS 512 Introduction to Environmental Remote Sensing** (3 credit hours)
Principles and hands-on techniques for processing and analyzing remotely sensed data for natural resource applications. Topics include review of the electromagnetic spectrum, pre-processing (georectification, enhancements and transformations), processing (visual interpretation, indices, supervised and unsupervised classification) and post-processing (masking, change analysis and accuracy assessment) of digital image data. This course will provide students with fundamental concepts and skills needed to pursue further studies in digital processing of remotely sensed data.

*Typically offered in Spring only*

**GIS 515 Cartographic Design** (2 credit hours)
Principles of cartographic design and how to apply them to produce high-quality geographic information system (GIS) based maps. Successful students will acquire an understanding of map design and experience applying it with GIS software. Students produce project maps in both print and web media.

Prerequisite: GIS 510
*Typically offered in Spring only*

**GIS 517/LAR 517 GIS Applications in Landscape Architecture and Environmental Planning** (3 credit hours)
Introduction to the methods and applications of geographic spatial modeling technology in landscape architecture and environmental planning.

*Typically offered in Fall only*

**GIS 520 Geospatial Data Science and Analysis** (3 credit hours)
This course provides exposure to and practice applying a variety of geospatial analysis methods and tools to support decision-making. Students will use both ArcGIS Pro and the R(TM) programming language and briefly explore the interoperability between these platforms. Using both platforms, we will practice data cleaning and processing, as well as descriptive and inferential spatial analysis methods. Students will learn to identify common limitations and special considerations that arise when working with geospatial data workflows and will learn how to leverage multiple tools to develop appropriate analysis methods. This course will be a combination of lectures and hands-on software training. Prior knowledge of GIS fundamentals is required.

Prerequisite: GIS 510
*Typically offered in Fall and Spring*

**GIS 521 Surface Water Hydrology with GIS** (3 credit hours)
The application of geographic information systems (GIS) to surface water modeling including stream and watershed delineations, regulatory wetlands jurisdiction determinations, and flood mapping. In addition students will develop spatial computation methods to support hydrological analysis in land use planning, landscape management, and engineering assessments.

Prerequisite: GIS 510 or PA 541 or SSC 440
*Typically offered in Fall and Spring*

**GIS 530 Spatial Data Foundations** (3 credit hours)
This course focuses on geospatial information systems from a mathematical and information science perspective. We discuss theoretical frameworks for conceptualizing geographic data, including levels of measurement, data control, and the vector data and raster data paradigms. Then we discuss the geometric underpinnings of geospatial systems: representing data with geographic elements, spatial referencing systems, and projection. Next, we explore map-related topology and computational geometry concepts. Finally, we survey the algorithms for core spatial manipulations, such as interpolation and polygon operations.

Prerequisite: GIS 510 or PA 541 or SSC 440
*Typically offered in Fall and Spring*

**GIS 535 Web and Mobile GIS Protocols** (3 credit hours)
This course examines the design, development and deployment of web and mobile geospatial applications using internet and web-based protocols. Throughout the course, students will develop and deploy web and mobile GIS maps and applications relevant to their career using on-premises hosted infrastructure. Course participants will be required to complete assignments with data relevant to their interests. Additionally, students will search for and examine scientific and popular literature to understand how the course concepts are being employed and to foster ideas and discussion.

Prerequisite: GIS 510
*Typically offered in Fall only*

**GIS 540 Geospatial Programming** (4 credit hours)
This course equips students with essential skills for geospatial programming. Topics include computer programming to call geospatial processing tools, batch process, performing file reading/writing, and generating displays. To support these tasks, students learn basic programming concepts, such as pseudocode, flow-control, code reuse, and debugging. In the final project, students streamline GIS workflows and customize GIS user interfaces. Familiarity with GIS software is required, but no prior programming experience is expected.

Prerequisite: GIS 510
*Typically offered in Fall and Spring*

**GIS 550 Geospatial Data Structures and Web Services** (3 credit hours)
This course examines the spatial database models and structures used in geospatial information science and technology as well as the design and implementation of web and related mobile computing geospatial tools and systems. Students develop, evaluate, and deploy multiple spatial data models and web services that include connections to external data sources and systems.

Prerequisite: GIS 540
*Typically offered in Fall and Spring*

**GIS 582/MEA 582 Geospatial Modeling** (3 credit hours)
The course provides foundations in methods for GIS-based surface analysis and modeling. The topics include proximity analysis with cost surfaces and least cost paths, multivariate spatial interpolation and 3D surface visualization. Special focus is on terrain modeling, geomorphometry, solar irradiation, visibility, and watershed analysis. Students are also introduced to the basic concepts of landscape process modeling with GIS and to the principles of open source GIS. Introductory level knowledge of GIS or surveying/ geomatics principles is required.

*Typically offered in Fall and Spring*

**GIS 584/MEA 584 Mapping and Analysis Using UAS** (3 credit hours)
The course provides an overview of UAS mapping technology and its rules and regulations. The principles of UAS data collection are explained along with optional hands-on practice with in flight planning and execution. The main focus is on processing imagery collected from UAS using structure from motion techniques and deriving orthophoto mosaics and ultra-high resolution digital elevation models of land surface, vegetation and structures. More advanced topics include multi-temporal 3D data analysis, fusion with lidar data and 3D visualization.

Prerequisite: GIS 510 or GIS/MEA 582 or Permission of Instructor
*Typically offered in Fall only*

**GIS 590 Geospatial Information Science Master's Project** (3 credit hours)
This is the culmination course for The Master of Geospatial Information Science and Technology degree. This course provides students with the opportunity to demonstrate their accumulated degree skills and expertise by developing and communicating the solution to a complex geospatial problem through a Master's Capstone project. The project will include interoperable spatial and non-spatial data, web services, customized user interfaces and workflows completed in collaboration with a community partner. The student will design and manage a major project and professionally communicate their analysis and results to a public audience.

Prerequisite: GIS 550
*Typically offered in Fall and Spring*

**GIS 595 Special Topics in Geospatial Information Science** (1-6 credit hours)
Special Topics in Geospatial Information Science

*Typically offered in Fall and Spring*

**GIS 601 Seminar in Geospatial Information Science** (1 credit hours)
Seminar in Geospatial Information Science

*Typically offered in Fall and Spring*

**GIS 609 Geospatial Forum** (1 credit hours)
The Geospatial Forum brings together researchers, educators, practitioners, and students of the geospatial sciences in an exciting, weekly series of lively presentations and facilitated discussions centered upon frontiers in geospatial analytics and geospatial solutions to complex challenges. Live discussions are recorded and made available online for students.

*Typically offered in Fall and Spring*

**GIS 610 Special Topics in Geospatial Information Science** (1-6 credit hours)
Special Topics in Geospatial Information Science

*Typically offered in Fall and Spring*

**GIS 630 Independent Study** (1-3 credit hours)
Advanced topics not otherwise included in curriculum for advanced graduate students on a tutorial basis. Determination of credits and content by participating faculty in consultation with Director of Graduate Programs. Departmental consent required

*Typically offered in Fall, Spring, and Summer*

**GIS 660 MGIST Professional Portfolio** (1 credit hours)
This course will focus on creating an effective digital portfolio, including content selection, description and reflection, and web site organization and design. The digital portfolio will present personal MGIST program accomplishments to demonstrate individual competences through knowledge, skills, and abilities of a geospatial science professional. Intended for students in their last semester in the MGIST Program.

Restriction: Graduate Student in the MGIST Program; Corequisite: GIS 590
*Typically offered in Fall and Spring*

**GIS 710 Geospatial Analytics for Grand Challenges** (3 credit hours)
Examination of sustainable solutions to grand societal challenges using geospatial analytics. Emphasis is placed on the roles that location, spatial interaction, and multi-scale processes play in scientific discovery and communication. Discussion of seminal and leading-edge approaches to problem-solving is motivated by grand challenges such as controlling the spread of emerging infectious disease, providing access to clean water, and creating smart and connected cities. Students also engage in several written and oral presentation activities focused on data science communication skills and professionalization.

*Typically offered in Fall only*

**GIS 711/CSC 711 Geospatial Data Management** (3 credit hours)
Data management principles and technologies for efficient implementation of geospatial applications. This course introduces students to: spatial and temporal data types, data models, geometry models, spatial predicates, spatial access methods, and spatial query processing. In addition, students will be exposed to modern data management systems for geospatial application development and data integration principles. Prior GIS programming knowledge and knowledge of database management systems and SQL is preferred.

*Typically offered in Spring only*

**GIS 712 Environmental Earth Observation and Remote Sensing** (3 credit hours)
Focus is on passive electro-optical (microwaves, infrared and visible) remote sensing and will cover the physics of remote sensing, light interactions with Earth surface materials, limitations, advantages and disadvantages of passive remote sensing techniques, estimation of bio/geo-physical parameters from remote sensing data, and sensor performance and mission design for applications including hydrology, cryosphere, atmosphere-ocean dynamics, ecosystems and carbon cycle, and land use land cover change. Students should have introductory knowledge of GIS and remote sensing.

*Typically offered in Fall only*

**GIS 713 Geospatial Data Mining** (3 credit hours)
This course equips students with the theoretical background and practical computational skills required to use data mining methodologies, including clustering, PCA, spatial autocorrelation, neural networks, classification and regression trees, and high performance, open source geocomputation. The course is designed around, and pays particular attention to, approaches for data with spatial components. Students are expected to have a working knowledge of basic geographic principles, statistical principles, GIS, and remote sensing. Some experience with R programming would also be beneficial.

*Typically offered in Fall only*

**GIS 714 Geospatial Computation and Simulation** (3 credit hours)
This course focuses on theoretical concepts and computational methods that describe, represent and simulate the functioning of real-world geospatial processes. We define the general properties of geospatial computing and explain the role of simulations in analysis and understanding of observed spatial phenomena, testing of hypotheses and theories, and prediction of spatio-temporal systems behavior. We discuss the current methods and techniques for simulations using deterministic, stochastic and rule-based models as well as agent-based simulation of complex systems. Hands-on component of the course will cover implementation of simulations in GIS and advanced applications driven by the student's research. Some prior programming experience is expected along with exposure to geospatial modeling, such as in GIS/MEA 582 or equivalent.

Restriction: 15GAPHD or Permission of Instructor
*Typically offered in Spring only*

**GIS 715 Geovisualization** (3 credit hours)
Geovisualizations are a powerful way to reveal patterns in geospatial data, attract attention, and convey a message to an audience quickly and clearly. This course equips students to make informed design decisions (based on visual feature hierarchy, color theory, and design principles) and automate map-making techniques for multi-layered data, multivariate data, spatial-temporal data, and data with uncertainty. Students are expected to have a working knowledge of Geographic Information Systems. Some experience with Python programming would also be beneficial.

Restriction: Graduate standing in Geospatial Analytics or Permission of Instructor
*Typically offered in Spring only*

**GIS 790 Special Topics in Geospatial Analytics** (1-6 credit hours)
Special Topics in Geospatial Analytics

*Typically offered in Fall, Spring, and Summer*

**GIS 810 Special topics in Geospatial Analytics** (1-6 credit hours)
Special topics in Geospatial Analytics

*Typically offered in Fall, Spring, and Summer*

**GIS 885 Doctoral Supervised Teaching** (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

*Typically offered in Fall and Spring*

**GIS 895 Doctoral Dissertation Research** (1-9 credit hours)
Dissertation Research

*Typically offered in Fall, Spring, and Summer*