

# GEOGRAPHIC INFORMATION SCIENCE (GIS)

## GIS 2010 - Introduction to Location Science

**Credit(s): 3 Credits**

This course introduces students to core concepts in Geographic Information Systems, location science, and spatial thinking. Students get experience using Geographic Information Systems software to make maps, manage data, perform analyses, and communicate visually. (Offered in Fall)

## GIS 2030 - Spatial Analysis

**Credit(s): 3 Credits**

This course introduces students to the basic theory and application of spatial analyses in Geographic Information Systems. Students learn about spatial analyses topics such as spatial statistics, surfaces, hydrology, network analyses, and geocomputation. Students get hands-on experience using Geographic Information Systems software to perform spatial analyses, displaying results, and communicating results. (Offered in Spring)

**Prerequisite(s):** GIS 2010\*

\* Concurrent enrollment allowed.

## GIS 2050 - Introduction to Global Positioning Systems: Theory and Applications

**Credit(s): 3 Credits**

This course introduces students to the basic theory and applications in Global Positioning Systems. Topics include calculating location, satellite orbits, GPS errors and biases, GPS data, applications, and other types of navigation systems. Students receive experience in determining location using GPS receivers and computer software to collect, process, and correct GPS data. (Offered in Spring)

**Prerequisite(s):** GIS 2010

## GIS 2930 - Special Topics

**Credit(s): 3 Credits** (Repeatable for credit)

**Attributes:** Natural Science Req (A&S)

## GIS 2980 - Independent Study

**Credit(s): 1 or 3 Credits** (Repeatable for credit)

**Attributes:** Natural Science Req (A&S)

## GIS 4010 - Introduction to Geographic Information Systems

**Credit(s): 3 Credits**

This class introduces concepts, science, and theory of GIS and provides hands-on learning experiences. After successful completion of the course, students will be able to demonstrate fundamental techniques of geospatial analysis and mapping. (Offered every fall.)

**Attributes:** Natural Science Req (A&S)

## GIS 4020 - Intermediate GIS

**Credit(s): 3 Credits**

This course covers intermediate and advanced topics in GIS, including remote sensing for GIS, geospatial statistics and social, economic, and environmental aspects of GIS. Each subject is presented by a professor who specializes in the subject area. (Offered every spring.)

**Attributes:** Natural Science Req (A&S)

## GIS 4030 - Geospatial Data Management

**Credit(s): 3 Credits**

This class teaches students how to design and implement spatial databases, topology, spatial data models, spatial query languages, relational database architecture, data storage and indexing, SQL, data mining, etc. Students learn data management skills including relational databases, server GIS, schemas, and enterprise data management using OGC standards, web application program Interfaces (iOS, Android), data security and risk management. (Offered in Spring)

**Prerequisite(s):** GIS 4010

**Attributes:** Natural Science Req (A&S)

## GIS 4040 - Introduction to Remote Sensing

**Credit(s): 3 Credits**

This course include fundamental knowledge on the physics of remote sensing; photogrammetry; multispectral, hyperspectral, and thermal imaging; RADAR; and LIDAR. Principles are reviewed in lectures, and lab assignments cover image processing, environmental modeling, and analysis. The course objective is to demonstrate applications of remote sensing in environmental sciences with software training in ENVI&IDL and SARscape. (Offered every fall.)

**Attributes:** Natural Science Req (A&S)

## GIS 4050 - Digital Image Processing

**Credit(s): 3 Credits**

This course will concentrate on the theories and applications of image processing and the extraction of thematic information from satellite images. Students learn key concepts and techniques of image processing through hands-on lab exercises involving image calibration, rectification, fusion, transform, filtering, classification, segmentation, and image quality & accuracy assessment. (Offered in Spring)

**Prerequisite(s):** GIS 4040

**Attributes:** Natural Science Req (A&S)

## GIS 4061 - Photogrammetry

**Credit(s): 3 Credits**

Photogrammetry studies the principles of precise location measurement from photographs. This course introduces the foundations and modern technologies of photogrammetry as it relates to remote sensing, computer vision, engineering, surveying, and location science. This course will also demonstrate practical photogrammetry data acquisition, processing, product generation, and quality assessment, as well as developing an understanding of the necessary optics, mathematics, sensor systems, image processing, and computer vision fundamentals. (Offered occasionally)

**Prerequisite(s):** GIS 4040

**Attributes:** Geospatial Elective

## GIS 4066 - UAS Remote Sensing

**Credit(s): 3 Credits**

This course will concentrate on UAS remote sensing sensors (Hyperspectral, LiDAR, multispectral, and thermal), flight planning, ground targets, data collection, calibration, post-processing, and applications. A brief overview of UAS rules, regulations, and safety procedures will be followed by consideration of UAS sensor products and standard operating procedures. Students will learn key techniques of UAS remote sensing through hands-on exercises involving UAS componentry, data collection flights, processing, and analysis.

## GIS 4080 - Digital Cartography and Geovisualization

**Credit(s): 3 Credits**

This course comprehensively covers concepts, methods, and applications in the visualization of geographic data using GIS and computer programming languages. (Offered in Spring)

**Attributes:** Geospatial Elective

**GIS 4090 - Introduction to Programming for GIS and Remote Sensing**  
**Credit(s): 3 Credits**

This course will introduce students to Python programming and its applications to remote sensing and GIS. Through completing this course, students will be able to use Python to perform common GIS and remote sensing analysis tasks, automate workflows, and develop custom Python tools. Topics will include describing data, manipulating data, automating spatial analysis tasks, creating Python scripts and tools, and using Python for imagery analysis."

**Attributes:** Geospatial Elective, Natural Science Req (A&S)

**GIS 4091 - Advanced Programming for GIS and Remote Sensing**  
**Credit(s): 3 Credits**

In this class, students will learn how to publish, consume, and analyze web services using Python, Javascript, and HTML. They will be introduced to more powerful, more advanced Python libraries such as Pandas, Numpy, ArcGIS, and Folium in addition to learning advanced geographic data visualization techniques that leverage Python, Javascript, and web APIs. They will also learn how to use the Javascript to create their first stand-alone web applications. This class builds on what students learned in GIS 4090 and helps them develop knowledge and skills that they will use throughout their careers.

**Attributes:** Geospatial Elective, Natural Science Req (A&S)

**GIS 4092 - Machine Learning for GIS and Remote Sensing**  
**Credit(s): 3 Credits**

Introduction to machine learning with a focus on applying ML techniques to problems in GIS and remote sensing. Topics to include regression, neural networks and deep learning, kernel methods, and clustering algorithms. Emphasis to be placed on geospatial analytics working with real data sets from practical applications such as crime and disease mapping, data fusion and image analysis, water quality and yield prediction. (Offered in Fall and Summer)

**Prerequisite(s):** (MATH 1510 or SLU Math Placement with a minimum score of 1520); (GIS 4040 or GIS 4090)

**Attributes:** Geospatial Elective, Natural Science Req (A&S)

**GIS 4100 - Microwave Remote Sensing: SAR Principles, Data Processing and Applications**  
**Credit(s): 3 Credits**

The course covers principles of synthetic aperture radar (SAR), SAR satellites and data sources, SAR image processing, interpretation and applications. Popular data processing techniques, including SAR intensity processing, InSAR and DInSAR techniques, polarimetry tools/classification methods, Persistent Scatterer Interferometry are discussed through detailed step-by-step lab work on the processing chain including measuring earthquake deformation, land subsidence, landslides, building sinking, and tree height/health estimation, DEM generation, and various environmental applications. Students will have experience on ordering, processing and interpreting SAR data, and an opportunity to discuss advantages and limitations of SAR remote sensing for their specific research, and to explore RADAR w/ LiDAR for its common applications in vegetation assessment and terrain characterization.

**Attributes:** Geospatial Elective, Natural Science Req (A&S)

**GIS 4110 - Interferometric Synthetic Aperture Radar (InSAR)**  
**Credit(s): 3 Credits**

This course focuses on providing application oriented forum on InSAR for geoscientists. Principles of InSAR, DInSAR, timeSAR are introduced through hands-on lab work on measuring earthquake deformation, volcanic unrest, land subsidence due to extraction of groundwater, oil, gas, and coal mining using both commercial and open-source software tools.

**GIS 4120 - Geospatial Analytics**  
**Credit(s): 3 Credits**

This class introduces geospatial solutions to grand societal challenges. Emphasis is placed on the roles that location intelligence and geospatial technology play in scientific discovery. Discussion of emerging technologies to tackle grand challenges such as controlling the spread of infectious disease, providing access to clean water, human mobility and migration, and creating smart and connected cities. (Offered in Spring)

**Prerequisite(s):** GIS 4010; GIS 4040

**Attributes:** Geospatial Elective

**GIS 4130 - Human Geography**  
**Credit(s): 3 Credits**

This class provides an overview of the major themes of human geography that comprise the complexities of systemic interactions between humans and the environment. Each lecture will highlight a specialized perspective and disciplinary skills that contribute to providing the human geography backdrop for a variety of global issues. Discussions will span data taxonomies and data visualization and analysis, biodiversity, cultures and geopolitics, a human security use case linking wildlife trafficking with disease vector analysis, and geopolitical for a and policies with human geography applications. (Offered in even years in Fall.)

**Attributes:** Geospatial Elective

**GIS 4140 - Satellite Geodesy**  
**Credit(s): 3 Credits**

This course introduces modern techniques that are used to study the Earth's shape, rotation, and gravitational field focusing on satellite-based measurements. Specific topics include satellite orbit perturbations due to the gravity field, satellite tracking systems, geodetic systems, datums and coordinate systems, Earth rotation and reference frames, ocean and solid Earth tides, and gravity field representations. (Offered occasionally)

**Prerequisite(s):** GIS 2010; GIS 2050

**Attributes:** Geospatial Elective

**GIS 4930 - Special Topics**

**Credit(s): 3 Credits** (Repeatable for credit)

**Attributes:** Natural Science Req (A&S)

**GIS 4960 - GIS Capstone**

**Credit(s): 3 Credits**

In this course, students will consolidate their coursework and demonstrate their mastery of professional remote sensing and/or GIS competencies through ongoing research projects. Depending on whether students' interests are in remote sensing or GIS, topics will cover spatial analysis, web GIS, database design, management and data mining with integration of GIS, remote sensing and GPS, InSAR, and various applications of techniques. (Offered as needed.)

**Attributes:** Natural Science Req (A&S)

**GIS 4980 - Independent Study**

**Credit(s): 1 or 3 Credits** (Repeatable for credit)

**Attributes:** Natural Science Req (A&S)

**GIS 5010 - Introduction to Geographic Information Systems**  
**Credit(s): 3 Credits**

This class introduces concepts, science, and theory of GIS and provides hands-on learning experiences. After successful completion of the course, students will be able to demonstrate fundamental techniques of geospatial analysis and mapping. (Offered every fall.)

**Attributes:** MPH-Behavior Sci & Health Equi, MPH-Biosecurity & Disaster Prp, MPH-Epidemiology, MPH-Global Health, MPH-Health Management & Policy, MPH-Maternal & Child Health, MPH-Biostatistics

**GIS 5020 - Intermediate Geographic Information Systems****Credit(s): 3 Credits**

This course covers intermediate and advanced topics in GIS, including remote sensing for GIS, geospatial statistics and social, economic, and environmental aspects of GIS. Each subject is presented by a professor who specializes in the subject area. (Offered every spring.)

**GIS 5030 - Geospatial Data Management****Credit(s): 3 Credits**

This class teaches students how to design and implement spatial databases, topology, spatial data models, spatial query languages, relational database architecture, data storage and indexing, SQL, data mining, etc. Students learn data management skills including relational databases, server GIS, schemas, and enterprise data management using OGC standards, web application program Interfaces (iOS, Android), data security and risk management. (Offered in Spring)

**Prerequisite(s):** GIS 5010 with a grade of C or higher

**GIS 5040 - Introduction to Remote Sensing****Credit(s): 3 Credits**

This course include fundamental knowledge on the physics of remote sensing; photogrammetry; multispectral, hyperspectral, and thermal imaging; RADAR; and LIDAR. Principles are reviewed in lectures, and lab assignments cover image processing, environmental modeling, and analysis. The course objective is to demonstrate applications of remote sensing in environmental sciences with software training in ENVI&IDL and SARscape. (Offered every fall.)

**Attributes:** Aviation Elective (Graduate), MPH-Epidemiology

**GIS 5050 - Digital Image Processing****Credit(s): 3 Credits**

This course will concentrate on the theories and applications of image processing and the extraction of thematic information from satellite images. Students learn key concepts and techniques of image processing through hands-on lab exercises involving image calibration, rectification, fusion, transform, filtering, classification, segmentation, and image quality & accuracy assessment. (Offered in Spring)

**Prerequisite(s):** GIS 5040 with a grade of C or higher

**GIS 5061 - Photogrammetry****Credit(s): 3 Credits**

Photogrammetry studies the principles of precise location measurement from photographs. This course introduces the foundations and modern technologies of photogrammetry as it relate to remote sensing, computer vision, engineering, surveying, and location science. This course will also demonstrate practical photogrammetry data acquisition, processing, product generation and quality assessment, as well as developing an understanding of the necessary optics, mathematics, sensor systems, image processing, and computer vision fundamentals. (Offered in Summer)

**Prerequisite(s):** GIS 5040 with a grade of C or higher

**GIS 5066 - UAS Remote Sensing****Credit(s): 3 Credits**

This course will concentrate on UAS remote sensing sensors (Hyperspectral, LiDAR, multispectral, and thermal), flight planning, ground targets, data collection, calibration, post-processing, and applications. A brief overview of UAS rules, regulations, and safety procedures will be followed by consideration of UAS sensor products and standard operating procedures. Students will learn key techniques of UAS remote sensing through hands-on exercises involving UAS componentry, data collection flights, processing, and analysis.

**GIS 5070 - Research Methods****Credit(s): 3 Credits**

Analysis of research procedures as practiced in geospatial science. Research objectives, literature searches and review, data collection design, data analysis techniques, and modes of presentation. Offered every fall.

**GIS 5080 - Digital Cartography and Geovisualization****Credit(s): 3 Credits**

Readings, discussion, and hands-on investigation of advanced cartography topics and contemporary geovisualization issues. Analytic cartography, spatial analysis, and visualization techniques. Offered every spring.

**GIS 5090 - Introduction to Programming for GIS and Remote Sensing****Credit(s): 3 Credits**

This course will introduce students to Python programming and its applications to remote sensing and GIS. Through completing this course, students will be able to use Python to perform common GIS and remote sensing analysis tasks, automate workflows, and develop custom Python tools. Topics will include describing data, manipulating data, automating spatial analysis tasks, creating Python scripts and tools, and using Python for imagery analysis."

**Attributes:** MPH-Epidemiology

**GIS 5091 - Advanced Programming for GIS and Remote Sensing****Credit(s): 3 Credits**

In this class, students will learn how to publish, consume, and analyze web services using Python, Javascript, and HTML. They will be introduced to more powerful, more advanced Python libraries such as Pandas, Numpy, ArcGIS, and Folium in addition to learning advanced geographic data visualization techniques that leverage Python, Javascript, and web APIs. They will also learn how to use the Javascript to create their first stand-alone web applications. This class builds on what students learned in GIS 5090 and helps them develop knowledge and skills that they will use throughout their careers.

**Prerequisite(s):** GIS 5090

**GIS 5092 - Machine Learning for GIS and Remote Sensing****Credit(s): 3 Credits**

This course will introduce applied machine learning techniques for GIS and remote sensing. Topics include machine learning regression, Convolutional Neural Networks, computer vision, nonlinear activation functions and optimization, image recognition and classification, deep learning, extreme learning machine.

**Prerequisite(s):** GIS 5090

**GIS 5100 - Microwave Remote Sensing: SAR Principles, Data Processing and Applications****Credit(s): 3 Credits**

The course covers principles of synthetic aperture radar (SAR), SAR satellites and data sources, SAR image processing, interpretation and applications. Popular data processing techniques, including SAR intensity processing, InSAR and DInSAR techniques, polarimetry tools/ classification methods, Persistent Scatterer Interferometry are discussed through detailed step-by-step lab work on the processing chain including measuring earthquake deformation, land subsidence, landslides, building sinking, and tree height/health estimation, DEM generation, and various environmental applications. Students will have experience on ordering, processing and interpreting SAR data, and an opportunity to discuss advantages and limitations of SAR remote sensing for their specific research, and to explore RADAR w/ LiDAR for its common applications in vegetation assessment and terrain characterization.

**GIS 5110 - Interferometric Synthetic Aperture Radar (InSAR)****Credit(s): 3 Credits**

This course focuses on providing application oriented forum on InSAR for geoscientists. Principles of InSAR, DInSAR, timeSAR are introduced through hands-on lab work on measuring earthquake deformation, volcanic unrest, land subsidence due to extraction of groundwater, oil, gas, and coal mining using both commercial and open-source software tools.

**GIS 5120 - Geospatial Analytics****Credit(s): 3 Credits**

This class introduces geospatial solutions to grand societal challenges. Emphasis is placed on the roles that location intelligence and geospatial technology play in scientific discovery. Discussion of emerging technologies to tackle grand challenges such as controlling the spread of infectious disease, providing access to clean water, human mobility and migration, and creating smart and connected cities.

**GIS 5130 - Human Geography****Credit(s): 3 Credits**

This class provides an overview of the major themes of human geography that comprise the complexities of systemic interactions between humans and the environment. Each lecture will highlight a specialized perspective and disciplinary skills that contribute to providing the human geography backdrop for a variety of global issues. Discussions will span data taxonomies and data visualization and analysis, biodiversity, cultures and geopolitics, a human security use case linking wildlife trafficking with disease vector analysis, and geo-political fora and policies with human geography applications. (Offered even years in Fall)

**Prerequisite(s):** GIS 5010 with a grade of C or higher

**GIS 5140 - Satellite Geodesy****Credit(s): 3 Credits**

This course introduces modern techniques that are used to study the Earth's shape, rotation, and gravitational field focusing on satellite-based measurements. Specific topics include satellite orbit perturbations due to the gravity field, satellite tracking systems, geodetic systems, datums and coordinate systems, Earth rotation and reference frames, ocean and solid Earth tides, and gravity field representations. (Offered occasionally)

**Prerequisite(s):** GIS 5040 with a grade of C or higher

**GIS 5930 - Special Topics****Credit(s): 3 Credits** (Repeatable for credit)**GIS 5970 - Research Topics****Credit(s): 0-3 Credits** (Repeatable for credit)

A non-classroom course in which a student engages in research on a topic that is related to the student's graduate work and career goals. Offered annually.

**GIS 5980 - Independent Study****Credit(s): 1 or 3 Credits** (Repeatable for credit)**GIS 5990 - Thesis Research****Credit(s): 0-6 Credits** (Repeatable for credit)

Research that leads to a Master's Thesis and defense of the Thesis. Offered every fall and spring.

**GIS 6990 - Dissertation Research****Credit(s): 0-6 Credits** (Repeatable for credit)

Dissertation Research.