

# GEOGRAPHIC INFORMATION SYSTEMS

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## Graduate Certificate in Geographic Information Systems

The certificate in Geographic Information Systems is offered online or on campus at the University of Denver in the evenings, or in a combination of both, to meet the needs of busy adults. College of Professional Studies offers the region's first complete graduate certificate program in Geographic Information Systems. Designed and delivered for busy adults, the Geographic Information Systems graduate certificate helps professionals add to their skillset with technology skills that help solve real-world spatial problems.

Certificate students receive applied instruction from professional practitioners who work in the fields in which they teach, as they learn to create, implement, and execute a project using GIS, GPS (Global Positioning Systems), Web GIS, remote sensing, or digital image processing. The GIS certificate allows students to explore training fundamentals at a very hands-on, applied level necessary to succeed in the field.

Students gain a contextual background in GIS, from the management of natural resources to public utility management, public works engineering, environmental impact assessment, and even market research. In a burgeoning integrative world, it is vital to grasp the diverse fundamentals of each topic within the Geographic Information Systems industry and gain an insider's perspective to specific fields as they each relate to GIS training.

Credits earned through this graduate certificate may apply toward a master's degree in Geographic Information Science offered in the Department of Geography and the Environment at the University of Denver or a master's degree in Information Technology offered through College of Professional Studies at the University of Denver.

This program prepares students to do the following:

- Analyze the nature of, uses for, and implementation processes for geographic data.
- Select appropriate applications of GIS technology to solve spatial problems based on organizational/client needs.
- Solve real-world problems through analysis and selection of appropriate GIS tools and processes to address the issues.

## Specialized Graduate Certificate in GIS and Unmanned Aircraft Systems

This specialized graduate certificate prepares students for the rapidly expanding UAS (Unmanned Aircraft Systems) application to GIS and mapping. Students will take four courses: GPS for GIS and then three focused courses; one on the use of UAS (Unmanned Aircraft Systems) in the GIS industry, a ground school where students will learn to fly, and photogrammetry where students will learn the science of preparing aerial photography products collected from drone platforms for GIS mapping and analysis.

**After completing this certificate, students will**

- Establish working knowledge for the safe and efficient use of UAS.
- Prove their ability to perform several aircraft maneuvers in a safe and efficient manner.
- Execute an aerial mapping exercise for use in GIS.

## Specialized Graduate Certificate in Geographic Information Systems in the Environment

The environmental movement decades ago gave rise to GIS as we know it today. In this specialized graduate certificate, students focus on GIS applications in the environment. Environmental assessment and natural resource management, conservation and preservation take center stage and look at natural hazard risk assessment and planning.

**After completing this certificate, students will**

- Evaluate the application of GIS technology, analytical techniques and data presentation methods that support facility site selection, environmental impact analyses, resource management, and characterization of environmental hazards.
- Participate in environmental assessment projects with introductory preparation for practice as GIS professionals in public agencies or in the private sector.
- Analyze applications that support hazard risk and assessment, mitigation, and emergency response planning.

## Certificate Admission

**Bachelor's degree:** All graduate applicants must hold an earned baccalaureate from a regionally accredited college or university or the recognized equivalent from an international institution.

**University GPA requirement:** The minimum grade point average for admission consideration for graduate study at the University of Denver must meet one of the following criteria:

- A cumulative 2.5 on a 4.0 scale for the baccalaureate degree.
- A cumulative 2.5 on a 4.0 scale for the last 60 semester credits or 90 quarter credits (approximately two years of work) for the baccalaureate degree.
- An earned master's degree or higher from a regionally accredited institution or the recognized equivalent from an international institution supersedes the minimum GPA requirement for the baccalaureate.
- A cumulative GPA of 3.0 on a 4.0 scale for all graduate coursework completed for applicants who have not earned a master's degree or higher.

### English Language Proficiency Test Score Requirements

The minimum TOEFL/IELTS/C1 Advanced/Duolingo English Test score requirements for this degree program are:

- Minimum TOEFL Score (Internet-based test): 80 with minimum of 20 on each sub-score
- Minimum IELTS Score: 6.5 with minimum of 6.0 on each band score
- Minimum C1 Advanced Score: 176
- Minimum Duolingo English Test Score: 115 with subscore minimums: Literacy, Comprehension-105; Conversation, Production-115. Tests prior to July 1, 2024: Literacy, Comprehension, Conversation-105; Production 95

## Graduate Certificate Program

### Graduate Certificate in Geographic Information Systems

Minimum number of credits required for certificate: 24 credits

Code	Title	Credits
<b>Core coursework requirements</b>		<b>8</b>
Complete the following two courses:		
GIS 4101	Introduction to Geographic Information Systems	
GIS 4504	Cartography and Geovisualization	
<b>Select four courses:</b>		<b>16</b>
GIS 4007	Creative Problem Solving and Programming Concepts	
GIS 4080	Python Programming in GIS	
GIS 4085	Python Programming II	
GIS 4100	Geospatial Technologies	
GIS 4110	Geographic Statistics	
GIS 4200	Geospatial Intelligence	
GIS 4510	GIS in Business	
GIS 4520	GIS in Telecommunications	
GIS 4530	Crime Mapping	
GIS 4540	Conservation GIS	
GIS 4570	Geographic Information Systems in Public Health	
GIS 4610	Open-Source GIS	
GIS 4620	Geodatabase Application	
GIS 4630	Public Domain Data for GIS	
GIS 4650	Demographic Analysis Using GIS	
GIS 4655	Community Intel	
GIS 4660	GIS in Municipal Government	
GIS 4670	GIS and the Law	
GIS 4680	Environmental Applications	
GIS 4683	GIS for Disaster Management	
GIS 4685	GIS and Natural Hazards	
GIS 4687	Hydrologic Modeling in GIS	
GIS 4690	GPS for GIS	
GIS 4700	Remote Sensing I	
GIS 4701	Topics in Geographic Information Systems	
GIS 4740	Remote Sensing II	

GIS 4750	UAS for GIS	
GIS 4760	UAS Photogrammetry	
GIS 4770	UAS Ground School Practical	
GIS 4860	Web GIS	
GIS 4980	Internship	
<b>Total Credits</b>		<b>24</b>

## Specialized Graduate Certificate Programs

### Specialized Graduate Certificate in GIS and Unmanned Aircraft Systems

Code	Title	Credits
GIS 4750	UAS for GIS	4
GIS 4760	UAS Photogrammetry	4
GIS 4770	UAS Ground School Practical	4
GIS 4690	GPS for GIS	4
<b>Total Credits</b>		<b>16</b>

Before registering for a four-course certificate course, students must have GIS software experience obtained via an introductory GIS course taken at the University of Denver or another institution and have earned a C- or better, or experience gained in the workplace. Please work with the academic advisor to verify your eligibility.

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### Specialized Graduate Certificate in GIS in the Environment

Code	Title	Credits
GIS 4540	Conservation GIS	4
GIS 4680	Environmental Applications	4
GIS 4685	GIS and Natural Hazards	4
GIS 4687	Hydrologic Modeling in GIS	4
<b>Total Credits</b>		<b>16</b>

Individuals enrolling in this certificate must have GIS software experience obtained via an introductory GIS course taken at the University of Denver or another institution and have earned a C- or better, or experience gained in the workplace. Please work with the academic advisor to verify your eligibility.

#### GIS 4007 Creative Problem Solving and Programming Concepts (4 Credits)

In this course students will develop, or improve upon, their problem-solving skills to analyze problems and create solutions. Students will document their solutions and translate them into running programs written in the enormously popular Python programming language. Students will learn programming concepts including the use of variables, program input and output, flow control, conditionals, interpreter- and code-file-based approaches, and error testing. Students will learn how to set up Integrated Development Environments (IDE) such as Visual Studio Code on their personal computers and/or utilize a Cloud IDE in which they will write programs.

#### GIS 4080 Python Programming in GIS (4 Credits)

This course introduces Python concepts and the Python scripting environment in a GIS environment. Python is a free, open-source scripting language that has been integrated with GIS. Python is a dynamic, interpreted language that can be used to automate redundant tasks and workflows in GIS. Students learn tools and techniques and proper Python syntax, script flow, and error handling. Students learn to write scripts that allow them to automate redundant tasks and workflows in GIS. Students learn to write scripts that allow them to automate geoprocessing processes and GIS work more efficiently. This course teaches fundamental concepts needed to create Python scripts in ArcGIS. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

#### GIS 4085 Python Programming II (4 Credits)

GIS 4085 builds on GIS Python fundamentals from GIS 4080, covering advanced applications of Python for developing and customizing GIS software, designing user interfaces, and solving complex geoprocessing tasks. Participants will engage with peers in weekly discussions and code reviews. Weekly exercises and assignments provide practical application of concepts. Prerequisites: GIS 4080.

#### GIS 4100 Geospatial Technologies (4 Credits)

This course is designed to familiarize students with the tools and technology needed to access, manipulate, and display geographic information. Students will also learn how to think spatially in order to help students know when to apply these tools. This course is a combined introduction to geographic information systems (GIS), remote sensing (RS), global positioning systems (GPS), and cartography (the science and art of mapmaking). Students will also learn about ethical issues regarding the use of geospatial technologies, as well as trends in the practical applications of these important tools.

**GIS 4101 Introduction to Geographic Information Systems (4 Credits)**

This introductory course is designed to provide a general overview of geographic information systems (GIS) including background, development, trends, and prospects in this rapidly evolving technological field. Basic components and functions of GIS as well as fundamental spatial and geographic concepts are explored through lecture notes, assigned readings, videos, discussions, and applied practical experience using GIS software.

**GIS 4110 Geographic Statistics (4 Credits)**

This course offers an overview of spatial statistics using GIS and publicly available data. This course provides information on the following: spatial statistics, methods, and interpretation; spatial data, collection methods, and resources; and GIS techniques to map and analyze spatial data. Using a popular PC-based desktop mapping software program and statistical package, students learn how to navigate through spatial data, identify data issues, statistically analyze spatial data, map the data, and interpret results from these analyses. Topics include descriptive spatial statistics, hypothesis testing, interpolation, clustering, and spatial regression. Several application areas, such as demographic analysis and facility planning, are used in sample exercises and ethical considerations, such as masking, are discussed. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4200 Geospatial Intelligence (4 Credits)**

Geospatial intelligence (GEOINT) is pivotal in linking geography to events and helping us gain insight into what is happening, where it's happening, and why it's happening. GEOINT is derived from the exploitation and analysis of imagery and geospatial information about features and events, with reference to space and time. This course serves as an introduction to the fundamentals of the geospatial intelligence community, core GEOINT technologies and operations, and the role of GEOINT in national, regional and local security affairs. This course is built on a framework of data, technology, and analysis in support of the GEOINT community, which may include natural disasters, first responders, military personnel, homeland defense, and law enforcement. Prerequisite: GIS-4101 Introduction to GIS.

**GIS 4504 Cartography and Geovisualization (4 Credits)**

The theory and art of map making developed over several thousand years and has been revolutionized by computer technology. This course is designed to expose students to the use of computer techniques in assessing technical design issues in the compilation of accurate and meaningful automated geographic mapping products. GIS software will be used in a series of hands-on lab exercises to produce typical GIS mapping products.

**GIS 4510 GIS in Business (4 Credits)**

Businesses continue to embrace GIS as an effective alternative to traditional manual mapping analysis methods. GIS has emerged as an affordable solution for performing essential revenue producing and expense reducing functions. Many years ago, successful GIS implementation required huge capital investment and a large staff of GIS experts; however, with the introduction of more powerful inexpensive computers and easier to use software, companies of all sizes are unleashing the business potential of GIS on the marketplace. This course exposes students to various business applications and uses of GIS as well as the underlying theories and technology behind the applications. This course emphasizes various business disciplines including Marketing, Real Estate, Transportation, and Oil & Gas using GIS in practical, hands-on exercises that demonstrate the theories and concepts discussed in the lectures. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4520 GIS in Telecommunications (4 Credits)**

Telecommunications is a thriving technology and business, accounting for a significant percentage of technical advances and revenue around the globe. GIS has emerged as a crucial tool in the telecommunications field for maintaining existing entities, planning for additional ones, and for gaining an advantage in this very competitive marketplace. The use of GIS in the telecom industry continues to grow because GIS technology accommodates the many CAD programs and drawings representing plant and transmission towers/coverage as well as the geographic representations of those items. Only a few years ago, introducing GIS into a telecom business required significant cash outlay, but through less expensive hardware and more user-friendly software, now even a modest CLEC can implement an effective GIS. This course exposes students to the various applications and uses for GIS in the telecom arena by breaking down the miscellaneous telecom requirements into GIS components and technological solutions. This course emphasizes specific telecom technology application requirements and allows students, through hands-on-lab work, to discover the power of GIS in delivering superior telecom solutions. This course also focuses on OSP/ISP applications and solutions, network connectivity issues as well as the exploding future of wireless technology. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4530 Crime Mapping (4 Credits)**

Municipal police departments, county sheriff departments, and other state and federal law enforcement agencies use GIS technology as a tool to analyze crime statistics and patterns. This course examines how GIS technology is used in law enforcement to provide strategic, tactical, and administrative crime analysis.

**GIS 4540 Conservation GIS (4 Credits)**

This course is designed to provide students with an introduction to the use of geographic information systems (GIS) in conservation. Students receive an introduction to the use of GIS in various types of conservation studies and preservation. Emphasis is placed on the types of applications and analytical techniques in environmental fields where GIS is commonly used as a mapping and analytical tool. The analytical techniques used in lab exercises consist of practical applications that support planning and management of land, species, and habitats. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4570 Geographic Information Systems in Public Health (4 Credits)**

GIS offers many applications and functionality that are tremendously beneficial to the Public Health industry. The ability to visualize cases in space (geographically) and time is invaluable in analyzing spatial clusters of health related events. Further the ability to model the spread of a potential epidemic can literally be a life saver. GIS is a natural choice for solving many Public Health issues including: analyzing the location of diseases; the spread of contagious diseases (both vector borne as well as the spread through human contact); the cause and effect of environmental factors; as well as the availability of Health facilities. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4610 Open-Source GIS (4 Credits)**

This applied course guides students in their investigation and research of special topics and current events through Open-Source geographic information systems (GIS). It builds upon geospatial skills previously acquired and is designed for participants to learn how geospatial work can be done when presented with a proposal or problem but given little to no data, budget, or access to commercial, off-the-shelf software, or other resources. In this course, students will choose their own topic and learn to navigate it by planning, implementing, and disseminating the outcomes of a geospatial project. Prerequisite: GIS 4101 Intro to GIS and additional coursework or experience with GIS Projects. Prerequisite: GIS 4101.

**GIS 4620 Geodatabase Application (4 Credits)**

This course in Geodatabase Application is logically broken into two separate component parts; the first section deals with Geodatabase concepts and provides a general overview of the Geodatabase structure and implementation including; background, object classes, feature classes, relationship classes, domains, validation rules, and Geodatabase topology. The second portion of the course focuses on Geodatabase Application introducing advanced features of Geodatabase, providing a solid foundation for the application of the Geodatabase to model and address complex real world issues. Geodatabase Linear Referencing, Geodatabase Surface Modeling, and Geocoding Services in the Geodatabase, are explored. This course incorporates a hands-on lab component. Computer lab exercises are designed to introduce the student to concepts and Geodatabase application. Strong emphasis is placed on Geodatabase design. Design objectives, design guidelines and functional requirements of the resulting Geodatabase model are addressed. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4630 Public Domain Data for GIS (4 Credits)**

Geospatial data are the foundation upon which GIS and spatial analysis rests. As GIS has matured, the challenge has evolved from generating data to managing the enormous volume of data from government agencies, nonprofit organizations, and industry, and increasingly, from ordinary citizens through citizen science and volunteered geographic information efforts. Key to working with this volume of data are essential issues such as privacy, copyright, public domain, cost recovery, metadata standards, and data quality that GIS professionals must grapple with to be effective in the 21st Century. This class discusses and applies these issues and works with a rich array of data sources to enable effective decision-making in a Geographic Information System. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4650 Demographic Analysis Using GIS (4 Credits)**

This course offers an overview of demographic analysis using GIS and U.S. Census data. This course provides pertinent information on the following: demographic concepts and methods; U.S. Census data, collection methods, and reports; and GIS and spatial statistical methods to analyze demographic data. Using a popular PC-based desktop GIS software program, students learn how to navigate through census files and create a variety of thematic maps. Several application areas, such as demographic analysis and facility planning, are used in sample exercises. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4655 Community Intel (4 Credits)**

Community Intelligence is about using geospatial data to gain insights and to make informed decisions regarding community demographics, opportunities, risks, and an overall deeper understanding of communities. Whether one is a small business owner, the CEO of fortune 500 companies, an Emergency Manager, or running a non-profit environmental organization, having insights into local and regional communities, and understanding how to engage in this public provides an incredible advantage while maximizing effort, time, and resources. In this course, you will learn how to capture and discover key insights often hidden in complex datasets, and how to strategize and communicate with these data for maximum organizational impact. Course Pre-requisites: GIS-4101 Introduction to GIS. Prerequisites: GIS 4101.

**GIS 4660 GIS in Municipal Government (4 Credits)**

There are many areas of government where desktop mapping can be extremely helpful in solving problems that are spatial in nature. This course explores the many types of data collected by city and county government agencies from crime and election data to building, assessment, and zoning data and how it can be displayed in map form. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4670 GIS and the Law (4 Credits)**

This course explores the legal and technical ramifications created by Geographic Information Systems (GIS), Mobility and the Law, including the legal and policy issues related to the science of GIS, the sharing of geographic information, the data generated by mobile devices, the intellectual property issues, security and privacy issues, business and contractual issues related to GIS, and the standards of care and liability related to GIS. This course also examines the types of issues and concerns that exist in the U.S. and the world created by geographic information science and the mobile device. The evolution of GIS and the mobile device directly impacts governments, companies, and individuals on a daily basis. In today's world, more than three billion people have smart phones in their hands constantly. This creates issues about how to handle data, security and privacy, civil and criminal laws, rules and regulations, contractual agreements, and service-level agreements between parties on many levels from service providers in different states, countries and parts of the world. All of these issues need to be balanced by the differing cultural standards and mores from all over the world and legal (and sometimes not so legal) methods of protecting governments and companies in this ever-changing "always-connected" world created by GIS and the mobile device. Prerequisite: GIS 4101 - Intro to GIS, and GIS 4700 - Remote Sensing I and/or similar GIS course and/or work experience.

**GIS 4680 Environmental Applications (4 Credits)**

This class provides students with an introduction to practical applications of computerized Geographic Information Systems (GIS) in environmental assessment and natural resource management. Emphasis is placed on automated analytical techniques and data presentation methods that support facility site selection, environmental impact analyses, resource management, and characterization of environmental hazards. This course is designed to provide students who participate in environmental assessment projects with introductory preparation for practice as GIS professionals in public agencies or in the private sector. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4683 GIS for Disaster Management (4 Credits)**

This course serves as an introduction to Geographic Information Systems and their application in Emergency Operations. The basic concepts of geography, cartography and Global Positioning Systems will be covered, along with the basic components and capabilities of a geographic information system. Students will learn about the fundamental types of GIS analysis and applications, focusing on those used in Emergency Operations.

Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4685 GIS and Natural Hazards (4 Credits)**

This course is designed to provide students with an introduction to the use of GIS in natural hazard assessment. Students receive an introduction to the use of geographical information systems (GIS) in various types of natural disasters and response management. Emphasis is placed on the types of applications and analytical techniques in environmental fields where GIS is commonly used as a mapping and analytical tool. The analytical techniques used in lab exercises consist of practical applications that support hazard risk and assessment, mitigation, and emergency response planning. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4687 Hydrologic Modeling in GIS (4 Credits)**

Hydrology is concerned with movement of the earth's waters through the hydrologic cycle, and the transport of constituents carried in its flow. In GIS, the landscape is represented by means of geographically referenced data describing the character and shape of relief features. A spatial hydrology model simulates the water flow and transport in a specific locale using GIS data structures. Hydrologic modeling in GIS allows us to automatically delineate a drainage system and quantify the characteristics of the system. It focuses on the movement of water across a land surface. This course looks at the basic inputs to hydrological modeling in GIS, walks students through established modeling procedures, and has students work on projects that are real and relevant as model applications. Instruction is largely hands-on, project-oriented. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4690 GPS for GIS (4 Credits)**

This course is an introduction to GPS (Global Positioning Systems) concepts, techniques, and applications as they relate to GIS data collection. Lectures focus on satellite surveying, GPS technology, error sources, program planning, data collection design, and Quality Control and Quality Assurance issues for data collection programs. Lab exercises include planning a GPS survey, designing a field data collection plan and associated data dictionary, field data collection, and data integration into a GIS. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4700 Remote Sensing I (4 Credits)**

This course provides a survey of remote sensing technologies, applications, and the industry. This course is designed for GIS, Geography and Geoscience students who seek to broaden their understanding of remote sensing in support of Geographic Information Systems. Introductions to the electromagnetic spectrum, energy sources, radiation principles, aerial cameras, and electronic imaging provide the student with the initial building blocks to a thorough understanding of remote sensing. This course provides an overview of the various high altitude and space-based collection systems and their characteristics, with a view toward future systems and capabilities. In addition, this course exposes students to the techniques of extracting relevant information from both hard copy and digital imagery. Pre-requisite: This course is a pre-requisite for GIS 4740 – Remote Sensing II.

**GIS 4701 Topics in Geographic Information Systems (2-5 Credits)**

The content of this course varies each time it is offered, depending on the interests and needs of the students. Each time the course is offered, the specific content is announced in the quarterly course schedule. Depending on the subject matter, students may be required to have completed prerequisite courses.

**GIS 4740 Remote Sensing II (4 Credits)**

The curriculum is a rigorous presentation of digital imaging processing theory with emphasis on its application to airborne and space borne imagery. The course includes computer laboratory exercises and workshops, where the students apply theory to satellite and air photo data. Interpretation of the digitally processed data is also included in the class exercises. Examples of vector and raster data integration are shown as well. Prerequisite: GIS 4700.

**GIS 4750 UAS for GIS (4 Credits)**

The purpose of this course is to introduce GIS students to the emerging world of using Unmanned Aircraft Systems (UAS) in the GIS workplace for data collection, reconnaissance, and research. UASs are in the news every day, highlighting their use in a military context. The Federal Aviation Administration (FAA) has released new rules and regulations governing the use of UASs in the civilian sector. This course will prepare students to be conversant in the world of UASs, basic aviation, safety, flying, mission planning, and general data gathering techniques for use in GIS. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4760 UAS Photogrammetry (4 Credits)**

Surveying, photogrammetric mapping, GPS, and remote sensing are critical components to working in the UAV and GIS domain. The second course in this two-course sequence will expand on the data collection process highlighted in the first class and deliver the foundations required by GIS professionals working with UAVs. Prerequisite: GIS 4101 or similar GIS course and/or work experience and GIS 4750-UAS and GIS.



**GIS 4770 UAS Ground School Practical (4 Credits)**

The purpose of this course is to provide skills and abilities to become a remote pilot in command (RPIC) within the United States. The class content will focus on 14 CFR 107, the rules and regulations that allow RPICs to operate Unmanned Aircraft Systems (UASs) safely and legally. In addition, students will be given hands-on training in the best practices for flying UASs. Course Overview/Purpose: The release of 14 CFR 107 by the FAA has set a legal framework for commercial UAS operations in the United States. The purpose of this course is to help students become well versed in 107 and gain hands-on experience operating UASs. Students will become proficient with UAS aeronautical operation standards, discover the rules and regulations of airspace that all RPICs must comply with, and evaluate the effects that weather has on UASs as well as sources of weather information. Students will also assess the performance abilities and limitations of UASs and explore standard UAS operations as outlined in the 107 regulations. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4860 Web GIS (4 Credits)**

Creating web-based maps allows government entities, businesses, and other organizations to publish, discover, and share geospatial information. This course examines web and mobile GIS software applications, where students will learn the framework for creating web apps. Students publish comprehensive projects resulting in the creation of a fully-developed web GIS.

**GIS 4980 Internship (0-4 Credits)**

GIS students may fulfill up to four quarter hours of electives by enrolling in a GIS internship with a GIS company or an agency actively engaged in GIS activities. Students incorporating professional work experience must work with an approved mentor, who evaluates the student's performance and learning. The internship is designed to provide practical experience to students without prior professional experience in the field. Students who are employed on a full-time basis in the GIS industry may not use paid work experience as part of the academic program.

**GIS 4991 Independent Study (1-8 Credits)**

This is an advanced course for students wishing to pursue an independent course of study. The student must be accepted in a degree program, have earned a grade point average of 3.0 or better, obtained the approval of the department director, and have completed the Independent Study form and filed the form with all appropriate offices before registering for the independent study. Independent Study is offered only on a for-credit basis.

**Courses****GIS 4007 Creative Problem Solving and Programming Concepts (4 Credits)**

In this course students will develop, or improve upon, their problem-solving skills to analyze problems and create solutions. Students will document their solutions and translate them into running programs written in the enormously popular Python programming language. Students will learn programming concepts including the use of variables, program input and output, flow control, conditionals, interpreter- and code-file-based approaches, and error testing. Students will learn how to set up Integrated Development Environments (IDE) such as Visual Studio Code on their personal computers and/or utilize a Cloud IDE in which they will write programs.

**GIS 4080 Python Programming in GIS (4 Credits)**

This course introduces Python concepts and the Python scripting environment in a GIS environment. Python is a free, open-source scripting language that has been integrated with GIS. Python is a dynamic, interpreted language that can be used to automate redundant tasks and workflows in GIS. Students learn tools and techniques and proper Python syntax, script flow, and error handling. Students learn to write scripts that allow them to automate redundant tasks and workflows in GIS. Students learn to write scripts that allow them to automate geoprocessing processes and GIS work more efficiently. This course teaches fundamental concepts needed to create Python scripts in ArcGIS. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4085 Python Programming II (4 Credits)**

GIS 4085 builds on GIS Python fundamentals from GIS 4080, covering advanced applications of Python for developing and customizing GIS software, designing user interfaces, and solving complex geoprocessing tasks. Participants will engage with peers in weekly discussions and code reviews. Weekly exercises and assignments provide practical application of concepts. Prerequisites: GIS 4080.

**GIS 4100 Geospatial Technologies (4 Credits)**

This course is designed to familiarize students with the tools and technology needed to access, manipulate, and display geographic information. Students will also learn how to think spatially in order to help students know when to apply these tools. This course is a combined introduction to geographic information systems (GIS), remote sensing (RS), global positioning systems (GPS), and cartography (the science and art of mapmaking). Students will also learn about ethical issues regarding the use of geospatial technologies, as well as trends in the practical applications of these important tools.

**GIS 4101 Introduction to Geographic Information Systems (4 Credits)**

This introductory course is designed to provide a general overview of geographic information systems (GIS) including background, development, trends, and prospects in this rapidly evolving technological field. Basic components and functions of GIS as well as fundamental spatial and geographic concepts are explored through lecture notes, assigned readings, videos, discussions, and applied practical experience using GIS software.

**GIS 4110 Geographic Statistics (4 Credits)**

This course offers an overview of spatial statistics using GIS and publicly available data. This course provides information on the following: spatial statistics, methods, and interpretation; spatial data, collection methods, and resources; and GIS techniques to map and analyze spatial data. Using a popular PC-based desktop mapping software program and statistical package, students learn how to navigate through spatial data, identify data issues, statistically analyze spatial data, map the data, and interpret results from these analyses. Topics include descriptive spatial statistics, hypothesis testing, interpolation, clustering, and spatial regression. Several application areas, such as demographic analysis and facility planning, are used in sample exercises and ethical considerations, such as masking, are discussed. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4200 Geospatial Intelligence (4 Credits)**

Geospatial intelligence (GEOINT) is pivotal in linking geography to events and helping us gain insight into what is happening, where it's happening, and why it's happening. GEOINT is derived from the exploitation and analysis of imagery and geospatial information about features and events, with reference to space and time. This course serves as an introduction to the fundamentals of the geospatial intelligence community, core GEOINT technologies and operations, and the role of GEOINT in national, regional and local security affairs. This course is built on a framework of data, technology, and analysis in support of the GEOINT community, which may include natural disasters, first responders, military personnel, homeland defense, and law enforcement. Prerequisite: GIS-4101 Introduction to GIS.

**GIS 4504 Cartography and Geovisualization (4 Credits)**

The theory and art of map making developed over several thousand years and has been revolutionized by computer technology. This course is designed to expose students to the use of computer techniques in assessing technical design issues in the compilation of accurate and meaningful automated geographic mapping products. GIS software will be used in a series of hands-on lab exercises to produce typical GIS mapping products.

**GIS 4510 GIS in Business (4 Credits)**

Businesses continue to embrace GIS as an effective alternative to traditional manual mapping analysis methods. GIS has emerged as an affordable solution for performing essential revenue producing and expense reducing functions. Many years ago, successful GIS implementation required huge capital investment and a large staff of GIS experts; however, with the introduction of more powerful inexpensive computers and easier to use software, companies of all sizes are unleashing the business potential of GIS on the marketplace. This course exposes students to various business applications and uses of GIS as well as the underlying theories and technology behind the applications. This course emphasizes various business disciplines including Marketing, Real Estate, Transportation, and Oil & Gas using GIS in practical, hands-on exercises that demonstrate the theories and concepts discussed in the lectures. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4520 GIS in Telecommunications (4 Credits)**

Telecommunications is a thriving technology and business, accounting for a significant percentage of technical advances and revenue around the globe. GIS has emerged as a crucial tool in the telecommunications field for maintaining existing entities, planning for additional ones, and for gaining an advantage in this very competitive marketplace. The use of GIS in the telecom industry continues to grow because GIS technology accommodates the many CAD programs and drawings representing plant and transmission towers/coverage as well as the geographic representations of those items. Only a few years ago, introducing GIS into a telecom business required significant cash outlay, but through less expensive hardware and more user-friendly software, now even a modest CLEC can implement an effective GIS. This course exposes students to the various applications and uses for GIS in the telecom arena by breaking down the miscellaneous telecom requirements into GIS components and technological solutions. This course emphasizes specific telecom technology application requirements and allows students, through hands-on-lab work, to discover the power of GIS in delivering superior telecom solutions. This course also focuses on OSP/ISP applications and solutions, network connectivity issues as well as the exploding future of wireless technology. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4530 Crime Mapping (4 Credits)**

Municipal police departments, county sheriff departments, and other state and federal law enforcement agencies use GIS technology as a tool to analyze crime statistics and patterns. This course examines how GIS technology is used in law enforcement to provide strategic, tactical, and administrative crime analysis.

**GIS 4540 Conservation GIS (4 Credits)**

This course is designed to provide students with an introduction to the use of geographic information systems (GIS) in conservation. Students receive an introduction to the use of GIS in various types of conservation studies and preservation. Emphasis is placed on the types of applications and analytical techniques in environmental fields where GIS is commonly used as a mapping and analytical tool. The analytical techniques used in lab exercises consist of practical applications that support planning and management of land, species, and habitats. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4570 Geographic Information Systems in Public Health (4 Credits)**

GIS offers many applications and functionality that are tremendously beneficial to the Public Health industry. The ability to visualize cases in space (geographically) and time is invaluable in analyzing spatial clusters of health related events. Further the ability to model the spread of a potential epidemic can literally be a life saver. GIS is a natural choice for solving many Public Health issues including: analyzing the location of diseases; the spread of contagious diseases (both vector borne as well as the spread through human contact); the cause and effect of environmental factors; as well as the availability of Health facilities. Prerequisite: GIS 4101 or similar GIS course and/or work experience.



**GIS 4610 Open-Source GIS (4 Credits)**

This applied course guides students in their investigation and research of special topics and current events through Open-Source geographic information systems (GIS). It builds upon geospatial skills previously acquired and is designed for participants to learn how geospatial work can be done when presented with a proposal or problem but given little to no data, budget, or access to commercial, off-the-shelf software, or other resources. In this course, students will choose their own topic and learn to navigate it by planning, implementing, and disseminating the outcomes of a geospatial project. Prerequisite: GIS 4101 Intro to GIS and additional coursework or experience with GIS Projects. Prerequisite: GIS 4101.

**GIS 4620 Geodatabase Application (4 Credits)**

This course in Geodatabase Application is logically broken into two separate component parts; the first section deals with Geodatabase concepts and provides a general overview of the Geodatabase structure and implementation including; background, object classes, feature classes, relationship classes, domains, validation rules, and Geodatabase topology. The second portion of the course focuses on Geodatabase Application introducing advanced features of Geodatabase, providing a solid foundation for the application of the Geodatabase to model and address complex real world issues. Geodatabase Linear Referencing, Geodatabase Surface Modeling, and Geocoding Services in the Geodatabase, are explored. This course incorporates a hands-on lab component. Computer lab exercises are designed to introduce the student to concepts and Geodatabase application. Strong emphasis is placed on Geodatabase design. Design objectives, design guidelines and functional requirements of the resulting Geodatabase model are addressed. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4630 Public Domain Data for GIS (4 Credits)**

Geospatial data are the foundation upon which GIS and spatial analysis rests. As GIS has matured, the challenge has evolved from generating data to managing the enormous volume of data from government agencies, nonprofit organizations, and industry, and increasingly, from ordinary citizens through citizen science and volunteered geographic information efforts. Key to working with this volume of data are essential issues such as privacy, copyright, public domain, cost recovery, metadata standards, and data quality that GIS professionals must grapple with to be effective in the 21st Century. This class discusses and applies these issues and works with a rich array of data sources to enable effective decision-making in a Geographic Information System. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4650 Demographic Analysis Using GIS (4 Credits)**

This course offers an overview of demographic analysis using GIS and U.S. Census data. This course provides pertinent information on the following: demographic concepts and methods; U.S. Census data, collection methods, and reports; and GIS and spatial statistical methods to analyze demographic data. Using a popular PC-based desktop GIS software program, students learn how to navigate through census files and create a variety of thematic maps. Several application areas, such as demographic analysis and facility planning, are used in sample exercises. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4655 Community Intel (4 Credits)**

Community Intelligence is about using geospatial data to gain insights and to make informed decisions regarding community demographics, opportunities, risks, and an overall deeper understanding of communities. Whether one is a small business owner, the CEO of fortune 500 companies, an Emergency Manager, or running a non-profit environmental organization, having insights into local and regional communities, and understanding how to engage in this public provides an incredible advantage while maximizing effort, time, and resources. In this course, you will learn how to capture and discover key insights often hidden in complex datasets, and how to strategize and communicate with these data for maximum organizational impact. Course Pre-requisites: GIS-4101 Introduction to GIS. Prerequisites: GIS 4101.

**GIS 4660 GIS in Municipal Government (4 Credits)**

There are many areas of government where desktop mapping can be extremely helpful in solving problems that are spatial in nature. This course explores the many types of data collected by city and county government agencies from crime and election data to building, assessment, and zoning data and how it can be displayed in map form. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4670 GIS and the Law (4 Credits)**

This course explores the legal and technical ramifications created by Geographic Information Systems (GIS), Mobility and the Law, including the legal and policy issues related to the science of GIS, the sharing of geographic information, the data generated by mobile devices, the intellectual property issues, security and privacy issues, business and contractual issues related to GIS, and the standards of care and liability related to GIS. This course also examines the types of issues and concerns that exist in the U.S. and the world created by geographic information science and the mobile device. The evolution of GIS and the mobile device directly impacts governments, companies, and individuals on a daily basis. In today's world, more than three billion people have smart phones in their hands constantly. This creates issues about how to handle data, security and privacy, civil and criminal laws, rules and regulations, contractual agreements, and service-level agreements between parties on many levels from service providers in different states, countries and parts of the world. All of these issues need to be balanced by the differing cultural standards and mores from all over the world and legal (and sometimes not so legal) methods of protecting governments and companies in this ever-changing "always-connected" world created by GIS and the mobile device. Prerequisite: GIS 4101 - Intro to GIS, and GIS 4700 - Remote Sensing I and/or similar GIS course and/or work experience.

**GIS 4680 Environmental Applications (4 Credits)**

This class provides students with an introduction to practical applications of computerized Geographic Information Systems (GIS) in environmental assessment and natural resource management. Emphasis is placed on automated analytical techniques and data presentation methods that support facility site selection, environmental impact analyses, resource management, and characterization of environmental hazards. This course is designed to provide students who participate in environmental assessment projects with introductory preparation for practice as GIS professionals in public agencies or in the private sector. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4683 GIS for Disaster Management (4 Credits)**

This course serves as an introduction to Geographic Information Systems and their application in Emergency Operations. The basic concepts of geography, cartography and Global Positioning Systems will be covered, along with the basic components and capabilities of a geographic information system. Students will learn about the fundamental types of GIS analysis and applications, focusing on those used in Emergency Operations.

Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4685 GIS and Natural Hazards (4 Credits)**

This course is designed to provide students with an introduction to the use of GIS in natural hazard assessment. Students receive an introduction to the use of geographical information systems (GIS) in various types of natural disasters and response management. Emphasis is placed on the types of applications and analytical techniques in environmental fields where GIS is commonly used as a mapping and analytical tool. The analytical techniques used in lab exercises consist of practical applications that support hazard risk and assessment, mitigation, and emergency response planning. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4687 Hydrologic Modeling in GIS (4 Credits)**

Hydrology is concerned with movement of the earth's waters through the hydrologic cycle, and the transport of constituents carried in its flow. In GIS, the landscape is represented by means of geographically referenced data describing the character and shape of relief features. A spatial hydrology model simulates the water flow and transport in a specific locale using GIS data structures. Hydrologic modeling in GIS allows us to automatically delineate a drainage system and quantify the characteristics of the system. It focuses on the movement of water across a land surface. This course looks at the basic inputs to hydrological modeling in GIS, walks students through established modeling procedures, and has students work on projects that are real and relevant as model applications. Instruction is largely hands-on, project-oriented. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4690 GPS for GIS (4 Credits)**

This course is an introduction to GPS (Global Positioning Systems) concepts, techniques, and applications as they relate to GIS data collection. Lectures focus on satellite surveying, GPS technology, error sources, program planning, data collection design, and Quality Control and Quality Assurance issues for data collection programs. Lab exercises include planning a GPS survey, designing a field data collection plan and associated data dictionary, field data collection, and data integration into a GIS. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4700 Remote Sensing I (4 Credits)**

This course provides a survey of remote sensing technologies, applications, and the industry. This course is designed for GIS, Geography and Geoscience students who seek to broaden their understanding of remote sensing in support of Geographic Information Systems. Introductions to the electromagnetic spectrum, energy sources, radiation principles, aerial cameras, and electronic imaging provide the student with the initial building blocks to a thorough understanding of remote sensing. This course provides an overview of the various high altitude and space-based collection systems and their characteristics, with a view toward future systems and capabilities. In addition, this course exposes students to the techniques of extracting relevant information from both hard copy and digital imagery. Pre-requisite: This course is a pre-requisite for GIS 4740 – Remote Sensing II.

**GIS 4701 Topics in Geographic Information Systems (2-5 Credits)**

The content of this course varies each time it is offered, depending on the interests and needs of the students. Each time the course is offered, the specific content is announced in the quarterly course schedule. Depending on the subject matter, students may be required to have completed prerequisite courses.

**GIS 4740 Remote Sensing II (4 Credits)**

The curriculum is a rigorous presentation of digital imaging processing theory with emphasis on its application to airborne and space borne imagery. The course includes computer laboratory exercises and workshops, where the students apply theory to satellite and air photo data. Interpretation of the digitally processed data is also included in the class exercises. Examples of vector and raster data integration are shown as well. Prerequisite: GIS 4700.

**GIS 4750 UAS for GIS (4 Credits)**

The purpose of this course is to introduce GIS students to the emerging world of using Unmanned Aircraft Systems (UAS) in the GIS workplace for data collection, reconnaissance, and research. UASs are in the news every day, highlighting their use in a military context. The Federal Aviation Administration (FAA) has released new rules and regulations governing the use of UASs in the civilian sector. This course will prepare students to be conversant in the world of UASs, basic aviation, safety, flying, mission planning, and general data gathering techniques for use in GIS. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4760 UAS Photogrammetry (4 Credits)**

Surveying, photogrammetric mapping, GPS, and remote sensing are critical components to working in the UAV and GIS domain. The second course in this two-course sequence will expand on the data collection process highlighted in the first class and deliver the foundations required by GIS professionals working with UAVs. Prerequisite: GIS 4101 or similar GIS course and/or work experience and GIS 4750-UAVS and GIS.

**GIS 4770 UAS Ground School Practical (4 Credits)**

The purpose of this course is to provide skills and abilities to become a remote pilot in command (RPIC) within the United States. The class content will focus on 14 CFR 107, the rules and regulations that allow RPICs to operate Unmanned Aircraft Systems (UASs) safely and legally. In addition, students will be given hands-on training in the best practices for flying UASs. Course Overview/Purpose: The release of 14 CFR 107 by the FAA has set a legal framework for commercial UAS operations in the United States. The purpose of this course is to help students become well versed in 107 and gain hands-on experience operating UASs. Students will become proficient with UAS aeronautical operation standards, discover the rules and regulations of airspace that all RPICs must comply with, and evaluate the effects that weather has on UASs as well as sources of weather information. Students will also assess the performance abilities and limitations of UASs and explore standard UAS operations as outlined in the 107 regulations. Prerequisite: GIS 4101 or similar GIS course and/or work experience.

**GIS 4860 Web GIS (4 Credits)**

Creating web-based maps allows government entities, businesses, and other organizations to publish, discover, and share geospatial information. This course examines web and mobile GIS software applications, where students will learn the framework for creating web apps. Students publish comprehensive projects resulting in the creation of a fully-developed web GIS.

**GIS 4980 Internship (0-4 Credits)**

GIS students may fulfill up to four quarter hours of electives by enrolling in a GIS internship with a GIS company or an agency actively engaged in GIS activities. Students incorporating professional work experience must work with an approved mentor, who evaluates the student's performance and learning. The internship is designed to provide practical experience to students without prior professional experience in the field. Students who are employed on a full-time basis in the GIS industry may not use paid work experience as part of the academic program.

**GIS 4991 Independent Study (1-8 Credits)**

This is an advanced course for students wishing to pursue an independent course of study. The student must be accepted in a degree program, have earned a grade point average of 3.0 or better, obtained the approval of the department director, and have completed the Independent Study form and filed the form with all appropriate offices before registering for the independent study. Independent Study is offered only on a for-credit basis.