COMPUTER SCIENCE, PHD

Program Description

The PhD program in Computer Science is designed to cultivate experts in the expansive domain of computer science, anchoring students in rigorous theoretical and practical concepts. For those with a keen interest in spatial analysis and the dynamic interplay between location and computational data, the program offers an optional specialization in Geospatial Informatics.

Student Learning Outcomes

The program's student learning outcomes are for students to:
• Produce innovative research that advances theory or methodology in computer science and optionally in geospatial informatics.
• Advance the science of to create new algorithms and applications for computational challenges in the field of research.
• Develop the professional skills necessary to present research outcomes orally to a professional or general audience as well as in writing for peer reviewed journals and conference proceedings

For Additional Information

Website:
http://gradschool.tamucc.edu/degrees/science/geo_comp_sci.html

Campus Address:
Center for Instruction, Room 301
Phone: (361) 825-2474

Mailing Address:
Program Coordinator, PhD Computer Science
College of Engineering and Computer Science
Texas A&M University-Corpus Christi
6300 Ocean Drive
Corpus Christi, Texas 78412-5825

Admission Requirements

1. Persons seeking admission to the GSCS program should first contact the program to identify a faculty member willing to serve as their graduate advisor. Applicants will not be admitted to the program without a graduate faculty advisor.
2. In addition to meeting all University requirements, students seeking admission to the graduate degree program in Computer Science must submit the following to the Office of Recruitment and Admissions:
   - An application and application fee,
   - Transcripts from regionally accredited institutions (international students will be required to submit relevant international transcripts),
   - An essay (500-1000 words) discussing why you are seeking admission to the program and what your research plans are,
   - A curriculum vitae,
   - GRE scores (within five years of the date of application), and
   - International students must submit TOEFL or IELTS scores and additional documents to the Office of Recruitment and Admissions. http://gradschool.tamucc.edu/international.htm
3. A student entering the program is expected to have adequate preparation in computer science, geographic information science, and mathematics. For computer science, this preparation must include successful completion of coursework in a high-level programming language, For geospatial science, students must have successfully completed course work in geospatial data analysis and visualization. In mathematics, students must have successfully completed course work in calculus plus one additional junior level or higher mathematics course such as linear algebra, numerical analysis, or applied probability and statistics.

Students who have not successfully completed the above courses may be required to take leveling courses in any missing subjects before being formally admitted into the program. Leveling coursework does not count towards the total credit hours required for the degree. All leveling courses must be completed with a grade of "B" or better. While taking leveling courses, a student can take regular courses that can be counted towards the degree once admitted into the program formally. However, the total credit hours of such courses must not exceed nine hours.

Program Requirements

There are two pathways that students can take to be admitted into the PhD in Computer Science degree program, those coming in with

1. a bachelor's degree in a related field, and
2. a master's degree in a related field.

Students entering the program with a bachelor's degree are required to take a minimum of 75 semester credit hours beyond the bachelor's degree. Of these 75 hours, students must take certain core courses, Graduate Seminar, electives, and research and dissertation credits.

Students entering the program with a master's degree are required to take a minimum of 57 semester credit hours beyond the master's degree. Of these 57 hours, students must take certain core courses, Graduate Seminar , electives, and research and dissertation credits.

More details on core, required, elective, and research courses are given below.

Additional courses may be assigned depending on the student's background. Students must file an approved degree plan by the end of their second semester in the program. A student's graduate advisory committee must approve the degree plan. All students must pass a final dissertation defense, to be administered by their advisory committee, during their last semester before graduation.

The PhD program, by default, enables a student to become a Computer Science scholar and teacher. There is an optional specialization for those students who want to become specialists in the field of geospatial informatics.

1. Default CS Track

Code	Title	Hours
(a) Core Courses (12 hours) [1,2]		
COSC 6334	Design and Analysis of Algorithms	3
COSC 6351	Advanced Computer Architecture	3
COSC 6352	Advanced Operating Systems	3
COSC 6370	Advanced Software Engineering	3
(b) Required Courses (3 hours) [3]		
GSCS 6302	Graduate Seminar	3
(c) Research Hours		
Minimum of 30 hours of research and defense from the following:		30
GSCS 6996	Research	

GSCS 6998	Dissertation Research (after advancement to candidacy)	
GSCS 6999	Dissertation Defense (minimum of 3 sem. hours)	
(d) Electives		
Select 12-30 hours from the following list: [4]		12-30
COSC 6327	Introduction to Computer Graphics	
COSC 6328	Advanced Computer Graphics	
COSC 6336	Database Management Systems [5]	
COSC 6338	Machine Learning	
COSC 6339	Deep Learning	
COSC 6340	Human-Computer Interaction	
COSC 6350	Advanced Topics in DBMS	
COSC 6353	Compiler Design and Construction	
COSC 6354	Artificial Intelligence	
COSC 6355	Data Communications and Networking	
COSC 6356	Theory of Computation	
COSC 6357	Wireless Sensor Networks	
COSC 6360	Parallel Computing	
COSC 6361	Parallel Algorithms	
COSC 6362	Mobile Software Development	
COSC 6374	Computer Forensics	
COSC 6375	Information Assurance	
COSC 6376	Network Security [5]	
COSC 6377	Applied Cryptography	
COSC 6379	Advanced Information Assurance	
COSC 6380	Data Analytics	
COSC 6590	Selected Topics	
GSCS 6321	Geospatial Data Structures	
GSCS 6331	Advanced Geospatial Computing	
GSCS 6390	Special Topics	
GSEN 6330	Spatial Systems Science	
GSEN 6355	Geospatial Programming Techniques	
GSEN 6356	Programming for Geospatial Data Science	
GSEN 6365	Spatial Database Design	
GSEN 6367	Geospatial Data Mining	
GSEN 6370	UAS for Surveying and Mapping	
GSEN 6371	Geopositioning Systems and Autonomous Navigation	
GSEN 6380	Applied Geospatial Statistics	
GSEN 6381	Cadastral Information Systems Design	
GSEN 6382	Policy and Legal Aspects of Spatial information Systems	
GSEN 6383	Advanced Geospatial Analytics	
GSEN 6384	Geospatial Visualization Design	
GSEN 6385	Photogrammetric Engineering and Lidar Scanning	
GSEN 6386	Remote Sensing and Image Analysis	
GSEN 6390	Advanced Topics	
Total Hours		**57-75**

1

All students must master the same core knowledge, and this content must be mastered prior to their candidacy exam. The core knowledge can be mastered with the following courses listed above. If any of the core courses have been previously taken by the student, one core course (3 hours) can be replaced by an approved transfer of credit or GSCS 6996 Research. Additional core courses (up to 9 hours) can be replaced by approved COSC electives.

2

Previously taken core courses must be deemed equivalent and validated by the syllabus, confirmed on the student's graduate transcript with a grade of B or better, and approved prior to enabling a transfer of credit or core replacement. Specific requirements must be met for courses that may transfer into a terminal degree at TAMU-CC as defined by the College of Graduate Studies (CGS). Credit used for another graduate degree cannot be applied to a graduate degree at TAMU-CC. Refer to the CGS Doctoral Student Handbook for more details on credit transfers.

3

Students should take GSCS 6302 within their first semester or year in the program. Exceptions are if the course is not offered within a given academic year due to low enrollment.

4

Students entering with a bachelor's degree must take at least 30 hours of electives. Student's entering with a master's degree must take at least 12 hours of electives. Electives will predominately come from COSC, GSCS, and GSEN graduate courses. Up to 6 hours can be from another graduate program at TAMU-CC with approval.

5

Students are required to take COSC 6336 Database Management Systems and COSC 6376 Network Security as part of their elective sequence unless the course (or equivalent) has been previously taken by the student at the graduate level. The student's transcript must show the course taken with a grade of B or better. Course equivalency will be validated by the course syllabus.

2. Optional Geospatial Informatics Specialization

Code	Title	Hours
(a) CS Core (12 hours) [1,2]		
COSC 6334	Design and Analysis of Algorithms	3
COSC 6351	Advanced Computer Architecture	3
COSC 6352	Advanced Operating Systems	3
COSC 6370	Advanced Software Engineering	3
Geospatial Informatics Core (6 hours)		
Select two from the following:		6
GSCS 6321	Geospatial Data Structures	
GSCS 6331	Advanced Geospatial Computing	
GSEN 6330	Spatial Systems Science	
(b) Required Courses (3 hours) [3]		
GSCS 6302	Graduate Seminar	3
(c) Research Hours		
Minimum of 30 hours of research and defense from the following:		30
GSCS 6996	Research	
GSCS 6998	Dissertation Research (after advancement to candidacy)	
GSCS 6999	Dissertation Defense (minimum of 3 sem. hours)	

(d) Electives		
Select 6-24 hours from the following list: [4]		6-24
COSC 6327	Introduction to Computer Graphics	
COSC 6328	Advanced Computer Graphics	
COSC 6336	Database Management Systems [5]	
COSC 6338	Machine Learning	
COSC 6339	Deep Learning	
COSC 6340	Human-Computer Interaction	
COSC 6350	Advanced Topics in DBMS	
COSC 6353	Compiler Design and Construction	
COSC 6354	Artificial Intelligence	
COSC 6355	Data Communications and Networking	
COSC 6356	Theory of Computation	
COSC 6357	Wireless Sensor Networks	
COSC 6360	Parallel Computing	
COSC 6361	Parallel Algorithms	
COSC 6362	Mobile Software Development	
COSC 6374	Computer Forensics	
COSC 6375	Information Assurance	
COSC 6376	Network Security [5]	
COSC 6377	Applied Cryptography	
COSC 6379	Advanced Information Assurance	
COSC 6380	Data Analytics	
COSC 6590	Selected Topics	
GSCS 6321	Geospatial Data Structures	
GSCS 6331	Advanced Geospatial Computing	
GSCS 6390	Special Topics	
GSEN 6330	Spatial Systems Science	
GSEN 6355	Geospatial Programming Techniques	
GSEN 6356	Programming for Geospatial Data Science	
GSEN 6365	Spatial Database Design	
GSEN 6367	Geospatial Data Mining	
GSEN 6370	UAS for Surveying and Mapping	
GSEN 6371	Geopositioning Systems and Autonomous Navigation	
GSEN 6380	Applied Geospatial Statistics	
GSEN 6381	Cadastral Information Systems Design	
GSEN 6382	Policy and Legal Aspects of Spatial information Systems	
GSEN 6383	Advanced Geospatial Analytics	
GSEN 6384	Geospatial Visualization Design	
GSEN 6385	Photogrammetric Engineering and Lidar Scanning	
GSEN 6386	Remote Sensing and Image Analysis	
GSEN 6390	Advanced Topics	
Total Hours		**57-75**

1

All students must master the same core knowledge, and this content must be mastered prior to their candidacy exam. The core knowledge can be mastered with the following courses listed above. If any of the core courses have been previously taken by the student, one core course (3 hours) can be replaced by an approved transfer of credit or GSCS 6996 Research. Additional core courses (up to 9 hours) can be replaced by approved COSC electives.

2

Previously taken core courses must be deemed equivalent and validated by the syllabus, confirmed on the student's graduate transcript with a grade of B or better, and approved prior to enabling a transfer of credit or core replacement. Specific requirements must be met for courses that may transfer into a terminal degree at TAMU-CC as defined by the College of Graduate Studies (CGS). Credit used for another graduate degree cannot be applied to a graduate degree at TAMU-CC. Refer to the CGS Doctoral Student Handbook for more details on credit transfers.

3

Students should take GSCS 6302 within their first semester or year in the program. Exceptions are if the course is not offered within a given academic year due to low enrollment.

4

Students entering with a bachelor's degree must take at least 24 hours of electives and at least 6 hours must come from geospatial informatics (GSEN, GSCS). Student's entering with a master's degree must take at least 6 hours of electives and at least 3 hours must come from geospatial informatics. Electives will predominately come from COSC, GSCS, and GSEN graduate courses. Up to 6 hours can be from another graduate program at TAMU-CC with approval.

5

Students are required to take COSC 6336 Database Management Systems and COSC 6376 Network Security as part of their elective sequence unless the course (or equivalent) has been previously taken by the student at the graduate level. The student's transcript must show the course taken with a grade of B or better. Course equivalency will be validated by the course syllabus.

Courses

Computer Science Courses

COSC 5300 Introductory Topics in Computer Science
3 Semester Credit Hours (3 Lecture Hours)
This course introduces students to the leveling topics in computer science. This course serves the needs of certain topics students lack for pursuing a Master's degree in computer science. Grade assigned will be "credit" (CR) or "no credit" (NC).

COSC 5313 Foundations of Computer Organization and Architecture
3 Semester Credit Hours (3 Lecture Hours)
A study of internal computer concepts with respect to the functioning of the hardware subsystems and their roles in the computing process. An in-depth study of machine and assembly language. (Does not count toward total hours required for MS in Computer Science.)

COSC 5320 Design and Implementation of Computerized Instructional Systems
3 Semester Credit Hours (3 Lecture Hours)
Provides a broad introduction to the development of computer-based learning environments. Covers the theory and practice of using the computer both in the classroom and individually for learning. Covers a wide range of possibilities from multimedia presentation of material to constructive environments and computer-based instructional systems.

COSC 5321 Data Structures
3 Semester Credit Hours (3 Lecture Hours)
A study of the logical structures used for the organization, storage and retrieval of data. These structures are addressed from both memory-resident and file-resident points of view. Algorithms for the creation, searching, and manipulation of standard data structures used in computing are stressed. (Does not count toward total hours required for MS in Computer Science.)
Co-requisite: COSC 5312, MATH 2305.

COSC 5324 Digital Image Processing
3 Semester Credit Hours (3 Lecture Hours)

COSC 5326 Computer Vision
3 Semester Credit Hours (3 Lecture Hours)
Prerequisite: COSC 5324.

COSC 5327 Introduction to Computer Graphics
3 Semester Credit Hours (3 Lecture Hours)
INTRODUCTION TO COMPUTER GRAPHICS This graduate course provides students with a foundation in basic principles and techniques for computer graphics on modern graphics hardware. Students will gain experience in interactive computer graphics using the OpenGL API. Topics include: graphics hardware, rendering, perspective, lighting, and geometry.

COSC 5328 Advanced Computer Graphics
3 Semester Credit Hours (3 Lecture Hours)
ADVANCED COMPUTER GRAPHICS This course covers advanced computer graphics techniques. Students will be introduced to state-of-the-art methods in computer graphics. This course will focus on techniques for real-time rendering and animation.
Prerequisite: COSC 4328 or 5327.

COSC 5331 Foundations of Computer System Software
3 Semester Credit Hours (3 Lecture Hours)
Introduction to operating systems concepts, principles, and design. Topics include: processes and threads, CPU scheduling, mutual exclusion and synchronization, deadlock, memory management, file systems, security and protection, networking, and distributed systems. Selected existing operating systems are discussed, compared, and contrasted. (Does not count toward total hours required for MS in computer science.)
Prerequisite: COSC 5313.
Co-requisite: COSC 5321.

COSC 5334 The Design and Analysis of Algorithms
3 Semester Credit Hours (3 Lecture Hours)
THE DESIGN AND ANALYSIS OF ALGORITHMS An advanced course that concentrates on the design and analysis of algorithms used to solve a variety of problems. The methods of design covered include such topics as: divide-and-conquer, the greedy method, dynamic programming, search and traversal techniques, and backtracking.
Prerequisite: COSC 5321, MATH 2413 and 2305.

COSC 5336 Database Management Systems
3 Semester Credit Hours (3 Lecture Hours)
DATABASE MANAGEMENT SYSTEMS A study of contemporary database management concepts. Performance (indexing, query optimization, update optimization), concurrency, security and recovery issues are discussed. Also includes the study of front-end environments that access the database.
Prerequisite: COSC 5335 and 5321.

COSC 5337 Data Mining
3 Semester Credit Hours (3 Lecture Hours)

COSC 5340 Human-Computer Interaction
3 Semester Credit Hours (3 Lecture Hours)
HUMAN-COMPUTER INTERACTION Graduate-level survey of the field of Human-Computer Interaction (HCI) focusing on design strategies for making software usable by real-world people for doing real-world work. Topics include the role of HCI in the software product life cycle, task analysis of the user's work, architectures for human-computer dialogues, new and traditional approaches to user interface design, and user interface standards.
Prerequisite: COSC 5331.

COSC 5350 Advanced Topics in DBMS
3 Semester Credit Hours (3 Lecture Hours)
ADVANCED TOPICS IN DBMS The study of emerging database technologies. Topics are chosen from data warehousing, distributed databases, spatial databases and web-based applications.
Prerequisite: COSC 5336.

COSC 5351 Advanced Computer Architecture
3 Semester Credit Hours (3 Lecture Hours)
COMPUTER ARCHITECTURE An overview of computer architecture, which stresses the underlying design principles and the impact of these principles on computer performance. General topics include design methodology, processor design, control design, memory organization, system organization, and parallel processing.
Prerequisite: COSC 5331.

COSC 5352 Advanced Operating Systems
3 Semester Credit Hours (3 Lecture Hours)
ADVANCED OPERATING SYSTEMS Introduction to advanced concepts in operating systems and distributed systems. Topics include distributed system architectures, interprocess communication, distributed mutual exclusion, distributed synchronization and deadlock, agreement protocols, distributed scheduling and process management, distributed shared memory, distributed file systems, multiprocessor system architectures and operating systems, recovery and fault tolerance.
Prerequisite: COSC 5331.

COSC 5353 Principles of Compiler Construction
3 Semester Credit Hours (3 Lecture Hours)
COMPILER DESIGN AND CONSTRUCTION This course introduces the basic concepts and mechanisms traditionally employed in language translators, with emphasis on compilers. Topics include strategies for syntactic and semantic analysis, techniques of code optimization and approaches toward code generation.
Prerequisite: COSC 5330 and MATH 2305.

COSC 5354 ARTIFICIAL INTELLIGENCE
3 Semester Credit Hours (3 Lecture Hours)
Fundamental concepts and techniques for the design of computer-based, intelligent systems. Topics include: a brief history, methods for knowledge representation, heuristic search techniques, programming in LISP or Prolog.
Prerequisite: COSC 5321 and MATH 2305.

COSC 5355 DATA COMMUNICATIONS NETWORKING
3 Semester Credit Hours (3 Lecture Hours)
DATA COMMUNICATION SYSTEMS Areas studied include principles of computer-based communication systems, analysis and design of computer networks, and distributed data processing.
Prerequisite: COSC 5331.

COSC 5356 THEORY OF COMPUTATION
3 Semester Credit Hours (3 Lecture Hours)
THEORETICAL ASPECTS OF COMPUTING An introduction to theoretical foundations of modern computing. Topics include finite state machine concepts, formal grammars, and basic computability concepts.
Prerequisite: COSC 5321 and MATH 2305.

COSC 5357 WIRELESS SENSOR NETWORKS
3 Semester Credit Hours (3 Lecture Hours)
This is a graduate level course on wireless sensor networks; one of the fastest developing areas in computer science and engineering. The focus of this course is on the design of optimized architectures and protocols for such unique networks. Topics include the design principles of wireless sensor networks, energy management, MAC protocols, naming and addressing, localization, routing protocols, applications of wireless sensor networks, and associated challenges and measures.

COSC 5360 CONCURRENCY: PARALLEL AND DISTRIBUTED PROCESSING
3 Semester Credit Hours (3 Lecture Hours)
PARALLEL COMPUTING Introduction to the hardware and software issues in parallel computing. Topics include motivation and history, parallel architectures, parallel algorithm design, and parallel performance analysis. Students will be introduced to a variety of parallel computing paradigms including message passing systems and shared memory systems.
Prerequisite: COSC 5331.

COSC 5362 MOBILE SOFTWARE DEVELOPMENT
3 Semester Credit Hours (3 Lecture Hours)
Survey of software development on mobile platforms including both native and cross-platform applications with topics such as: prototyping, programming, testing, debugging, and deploying. Coverage of software life cycle on mobile platforms and how mobile hardware differs from traditional computers. COSC 5321

COSC 5370 ADVANCED SOFTWARE ENGINEERING
3 Semester Credit Hours (3 Lecture Hours)
Areas studied include engineering principles and their application to the design, development, testing, and maintenance of large software systems, tools and processes for managing the complexities inherent in creating and maintaining large software systems.
Prerequisite: COSC 5321.

COSC 5374 COMPUTER FORENSICS
3 Semester Credit Hours (3 Lecture Hours)
This course will introduce students to the fundamentals of computer forensics and various software tools used in cyber-crime analysis. Students will be introduced to established methodologies for conducting computer forensic investigations, as well as to emerging international standards for computer forensics. Applicable laws and regulations dealing with computer forensic analysis will also be discussed.
Prerequisite: COSC 5312.

COSC 5375 INFORMATION ASSURANCE
3 Semester Credit Hours (3 Lecture Hours)
An introduction to information security and assurance. This course covers the basic notions of confidentiality, integrity, availability, authentication models, protection models, secure programming, audit, intrusion detection and response, operational security issues, physical security issues, personnel security, policy formation and enforcement, access controls, information flow, legal and social issues, classification, trust modeling, and risk assessment.
Prerequisite: COSC 5312.

COSC 5376 NETWORK SECURITY
3 Semester Credit Hours (3 Lecture Hours)
This course is a study of networking basics and security essentials with respect to information services provided over a computer network. The course covers the technical details of security threats, vulnerabilities, attacks, policies, and countermeasures such as firewalls, honeypots, intrusion detection systems, and cryptographic algorithms for confidentiality and authentication and the development of strategies to protect information services and resources accessible on a computer network.
Prerequisite: COSC 5375.

COSC 5377 APPLIED CRYPTOGRAPHY
3 Semester Credit Hours (3 Lecture Hours)
This course includes an introduction to cryptographic algorithms and protocols for encrypting information securely, techniques for analyzing vulnerabilities of protocols, approaches to digital signatures and information digests, and implementation approaches for the most significant cryptographic methodologies.
Prerequisite: COSC 5312.

COSC 5379 ADVANCED INFORMATION ASSURANCE
3 Semester Credit Hours (3 Lecture Hours)
This course encompasses a broad range of topics involving information security, communications security, network security, risk analysis, operational security, health information privacy, criminal justice digital forensics, homeland security, the human element and social engineering, and applicable national and international laws. An in-depth information assurance capstone project or research paper will be required of each student to satisfy the information assurance graduate option requirements.
Prerequisite: COSC 5375.

COSC 5390 Internship
3 Semester Credit Hours
Individual contract agreement involving student, faculty, and cooperating agency (discipline-related business, nonprofit organization, or government agency) to gain practical experience appropriate to computer science in off-campus setting. Grade assigned will be "credit" (CR) or "no credit" (NC).

COSC 5393 RESEARCH METHODS IN COMP SCIEN
3 Semester Credit Hours (3 Lecture Hours)
RESEARCH METHODS IN COMPUTER SCIENCE This course provides students with a range of experiences in conducting and communicating research. Students will learn major research methods and techniques. Experiences will be gained in all stages of research: reviewing literature, writing a proposal, designing an approach, and reporting results. Critical-reading/writing assignments and class discussions on state-of-the-art research in Computer Science will provide students with major research aspects. Fall, Spring

COSC 5395 GRADUATE PROJECT AND TECHNICAL REPORT
3 Semester Credit Hours
An applied research project in computing from problem definition to implementation in an area of particular interest to the student that relates to the course of study.
Prerequisite: COSC 5393 and 5370.

COSC 5396 DIRECTED INDEPENDENT STUDY
1-3 Semester Credit Hours
Study in areas of current interest. (A maximum of six hours may be counted toward the MS degree.) Fall, Spring, Summer.

COSC 5398 Thesis I
3 Semester Credit Hours (3 Lecture Hours)
This course is for Computer Science MS students choosing the thesis option. Upon choosing a thesis advisor, students will register for this course. This course is only credit/no credit. Students will be given a grade of In-Progress until successfully completing their thesis.
Prerequisite: COSC 6393*.
* May be taken concurrently.

COSC 5399 Thesis II
3 Semester Credit Hours (3 Lecture Hours)
This course is for Computer Science MS students choosing the thesis option. Students will continually register for this course until successful completion of their thesis. A grade of In-Progress will be assigned until either successful completion or failing to register. If failing to register students will receive a grade of No Credit for all 5399 and 5398 courses.
Prerequisite: COSC 5398.

COSC 5590 SELECTED TOPICS
1-5 Semester Credit Hours (1-5 Lecture Hours)
Variable content study of specific areas of computer and information systems. May be repeated for credit when topics vary. Offered on sufficient demand.

COSC 5999 Advanced Research in Computer Science
1-9 Semester Credit Hours (1-9 Lecture Hours)
Advanced work in a specialized area of computer science. Does not count as credit toward a degree in computer science. Course is taken as credit/non-credit.

COSC 6324 Digital Image Processing
3 Semester Credit Hours
This course introduces concepts and techniques for image processing. The purpose of this course is to introduce the fundamental techniques and algorithms used for processing and extracting useful information from digital images. The students will learn how to apply the image processing methods to solve real-world problems.

COSC 6326 Computer Vision
3 Semester Credit Hours
This graduate course introduces concepts and techniques for machine vision. Particular emphasis will be placed on methods used for object recognition, machine learning, content-based image retrieval, image matching, 3D vision, tracking, and motion analysis.
Prerequisite: COSC 6324.

COSC 6327 Introduction to Computer Graphics
3 Semester Credit Hours
This graduate course provides students with a foundation in basic principles and techniques for computer graphics on modern graphics hardware. Students will gain experience in interactive computer graphics using the OpenGL API. Topics include: graphics hardware, rendering, perspective, lighting, and geometry.

COSC 6328 Advanced Computer Graphics
3 Semester Credit Hours
This course covers advanced computer graphics techniques. Students will be introduced to state-of-the-art methods in computer graphics. This course will focus on techniques for real-time rendering and animation.
Prerequisite: COSC 4328 or 6327.

COSC 6334 Design and Analysis of Algorithms
3 Semester Credit Hours (3 Lecture Hours)
An advanced course that concentrates on the design and analysis of algorithms used to solve a variety of problems. The methods of design include topics such as: divide-and-conquer, the greedy method, dynamic programming, search and traversal techniques, and backtracking.

COSC 6336 Database Management Systems
3 Semester Credit Hours (3 Lecture Hours)
A study of contemporary database management concepts. Performance (storage and indexing) and Big Data techniques (management, processing, and analysis) are discussed. Also includes the study of spatial data management.

COSC 6337 Data Mining
3 Semester Credit Hours
This course introduces fundamental strategies and methodologies for data mining. Topics include data preprocessing, mining frequent data patterns, classification, clustering, and outlier detection.

COSC 6338 Machine Learning
3 Semester Credit Hours (3 Lecture Hours)
In this course, students will learn about the concepts as well as some applications of machine learning (ML) algorithms. The course includes many exercises on how these ML algorithms can be used in practical applications in both industry and basic science. Topics include such as artificial neural networks, fuzzy logic, hybrid systems, search and optimization, classification, clustering, and deep learning. Students will gain experiences on some programming tools and a variety of applications of machine learning algorithms.

COSC 6339 Deep Learning
3 Semester Credit Hours (3 Lecture Hours)
This course introduces advanced concepts and techniques for deep learning. Particular emphasis is placed on regularization and optimization of deep learning models, convolutional networks, recurrent neural networks, autoencoders, and generative models. The students will learn how to apply the deep learning methods to solve real-world problems and develop the insight necessary to use the tools and techniques to solve any new problem.
Prerequisite: COSC 6338.

COSC 6340 Human-Computer Interaction
3 Semester Credit Hours (3 Lecture Hours)
This graduate course introduces concepts and techniques for Human Computer Interaction (HCI). Students will investigate HCI through understanding its historical context and foundational elements. Other topics include the human factor, interaction elements, modeling interactions, scientific foundations of HCI research, and design of HCI experiments.

COSC 6350 Advanced Topics in DBMS
3 Semester Credit Hours (3 Lecture Hours)
The study of emerging database technologies. Topics are chosen from data warehousing, distributed databases, spatial databases, and web-based applications.
Prerequisite: COSC 6336.

COSC 6351 Advanced Computer Architecture
3 Semester Credit Hours (3 Lecture Hours)
An overview of computer architecture, which stresses the underlying design principles and the impact of these principles on computer performance. General topics include design methodology, processor design, control design, memory organization, system organization, and parallel processing.

COSC 6352 Advanced Operating Systems
3 Semester Credit Hours (3 Lecture Hours)
Introduction to advanced concepts in operating systems and distributed systems. Topics include distributed system architectures, inter-process communication, distributed mutual exclusion, distributed synchronization and deadlock, agreement protocols, distributed scheduling and process management, distributed shared memory, distributed file systems, multiprocessor system architectures and operating systems, recovery, and fault tolerance.

COSC 6353 Compiler Design and Construction
3 Semester Credit Hours (3 Lecture Hours)
This course introduces the basic concepts and mechanisms traditionally employed in language translators, with emphasis on compilers. Topics include strategies for syntactic and semantic analysis, techniques of code optimization and approaches toward code generation.

COSC 6354 Artificial Intelligence
3 Semester Credit Hours (3 Lecture Hours)
Fundamental concepts and techniques for the design of computer-based, intelligent systems. Topics include: a brief history, methods for knowledge representation, heuristic search techniques, programming in LISP or Prolog.
Prerequisite: COSC 5321.

COSC 6355 Data Communications and Networking
3 Semester Credit Hours (3 Lecture Hours)
Areas studied include principles of computer-based communication systems, analysis and design of computer networks, and distributed data processing.

COSC 6356 Theory of Computation
3 Semester Credit Hours (3 Lecture Hours)
An introduction to theoretical foundations of modern computing. Topics include finite state machine concepts, formal grammars, and basic computability concepts.
Prerequisite: COSC 5321.

COSC 6357 Wireless Sensor Networks
3 Semester Credit Hours
This is a graduate level course on wireless sensor networks; one of the fastest developing areas in computer science and engineering. The focus of this course is on the design of optimized architectures and protocols for such unique networks. Topics include the design principles of wireless sensor networks, energy management, MAC protocols, naming and addressing, localization, routing protocols, applications of wireless sensor networks, and associated challenges and measures.

COSC 6360 Parallel Computing
3 Semester Credit Hours
Introduction to the hardware and software issues in parallel computing. Topics include motivation and history, parallel architectures, parallel algorithm design, and parallel performance analysis. Students will be introduced to a variety of parallel computing paradigms including message passing systems and shared memory systems.

COSC 6361 Parallel Algorithms
3 Semester Credit Hours (3 Lecture Hours)
Introduces and evaluates important models of parallel and distributed computation. Topics include a selection of parallel algorithms for various models of parallel computation, combinational circuits, parallel prefix computation, divide and conquer, pointer based data structures, linear arrays, meshes and related models, and hypercubes.

COSC 6362 Mobile Software Development
3 Semester Credit Hours
Survey of software development on mobile platforms including both native and cross-platform applications with topics such as: prototyping, programming, testing, debugging, and deploying. Coverage of software life cycle on mobile platforms and how mobile hardware differs from traditional computers.

COSC 6365 Current Trends in Programming
3 Semester Credit Hours (3 Lecture Hours)
This is a survey of current trends in computer programming. The focus of this course is on the development of computer programs utilizing the latest technologies and paradigms. Topics include state-of-the-art in problem solving and software development, programming techniques and approaches, programming languages, development tools and environments, and software deployment methods.
Prerequisite: COSC 5321.

COSC 6370 Advanced Software Engineering
3 Semester Credit Hours
Areas studied include engineering principles and their application to the design, development, testing, and maintenance of large software systems, tools and processes for managing the complexities inherent in creating and maintaining large software systems.

COSC 6374 Computer Forensics
3 Semester Credit Hours
This course will introduce students to the fundamentals of computer forensics and various software tools used in cyber-crime analysis. Students will be introduced to established methodologies for conducting computer forensic investigations, as well as to emerging international standards for computer forensics. Applicable laws and regulations dealing with computer forensic analysis will also be discussed.

COSC 6375 Information Assurance
3 Semester Credit Hours (3 Lecture Hours)
An introduction to information security and assurance. This course covers the basic notions of confidentiality, integrity, availability, authentication models, protection models, secure programming, audit, intrusion detection and response, operational security issues, physical security issues, personnel security, policy formation and enforcement, access controls, information flow, legal and social issues, classification, trust modeling, and risk assessment.

COSC 6376 Network Security
3 Semester Credit Hours
This course is a study of networking basics and security essentials with respect to information services provided over a computer network. The course covers the technical details of security threats, vulnerabilities, attacks, policies, and countermeasures such as firewalls, honeypots, intrusion detection systems, and cryptographic algorithms for confidentiality and authentication and the development of strategies to protect information services and resources accessible on a computer network.
Prerequisite: COSC 6375.

COSC 6377 Applied Cryptography
3 Semester Credit Hours
This course includes an introduction to cryptographic algorithms and protocols for encrypting information securely, techniques for analyzing vulnerabilities of protocols, approaches to digital signatures and information digests, and implementation approaches for the most significant cryptographic methodologies.

COSC 6379 Advanced Information Assurance
3 Semester Credit Hours
This course encompasses a broad range of topics involving information security, communications security, network security, risk analysis, operational security, health information privacy, criminal justice digital forensics, homeland security, the human element and social engineering, and applicable national and international laws. A project and/or research paper will be needed to satisfy the course requirements.
Prerequisite: COSC 6375.

COSC 6380 Data Analytics
3 Semester Credit Hours (3 Lecture Hours)
This course will introduce state-of-the-art techniques to process and analyze different types of data, generate insights and knowledge from data, and make data-based decisions and predictions. Real-world examples will be used to familiarize students with the theory and applications. Main topics include data preprocessing, probability theory, tests of hypothesis, and various data analysis techniques (e.g., clustering, classification, prediction/forecasting, etc.) for different types of data including static, time-series, spatial, and spatiotemporal.

COSC 6393 Research Methods in Computer Science
3 Semester Credit Hours
This course provides students with a range of experiences in conducting and communicating research. Students will learn major research methods and techniques. Experiences will be gained in all stages of research: reviewing literature, writing a proposal, designing an approach, and reporting results. Critical-reading/writing assignments and class discussions on state-of-the-art research in Computer Science will provide students with major research aspects. Spring

COSC 6396 Directed Independent Study
1-3 Semester Credit Hours
This course is designed to provide an intensive, supervised professional experience in an approved counseling setting. Topics addressed in this course include counselor education, pedagogy, research, supervision, leadership and advocacy, consultation, and training. Students will be expected to earn a total of 300 clock hours and will receive supervision in the five core areas of counseling, supervision, teaching, research/scholarship, and leadership/advocacy. Students repeat the internship for another 300 clock hours and another 3 semester hours of credit. Students must earn a grade of 'B' or better to pass.

COSC 6590 Selected Topics
3 Semester Credit Hours (3 Lecture Hours)
Variable content study of specific areas of computer and information systems. May be repeated for credit when topics vary. Offered on sufficient demand.

Geospatial Computer Science Courses

GSCS 6102 Graduate Seminar
1 Semester Credit Hour (1 Lecture Hour)
Advanced topic study and presentation by students, faculty, or visiting scientists. Meets one hour weekly. Must be taken three times by all GSCS PhD students.

GSCS 6302 Graduate Seminar
3 Semester Credit Hours (3 Lecture Hours)
This is a 3-credit course that is intended to help facilitate the development of a student's dissertation research ideas and to contribute to the student's professional development as a doctoral level researcher in the field of geospatial computer science. The course focuses on developing professional research skills typically not provided in formal coursework such as methods for novel research, literature review, developing a research prospectus, presenting scientific research, research ethics, peer-review process, and professional society engagement. At the outcome, students will have a better understanding of the research process and a foundation to aid their development as a doctoral student and professional scientific researcher.

GSCS 6321 Geospatial Data Structures
3 Semester Credit Hours (3 Lecture Hours)
The representation of spatial data is an important issue in diverse areas including computer graphics, geographic information systems (GIS), robotics, and many others. Choosing an appropriate representation is a key to facilitate operations such as spatial search. This course will focus on representation of point data and object data, which are the important types of spatial data. Various fundamental data structures on spatial data, such as quadtrees, kd-trees, grid structures, kd-trees, and R-trees will be explored. The use of these structures to address some important problems will also be covered.

GSCS 6329 Scientific Visualization
3 Semester Credit Hours (3 Lecture Hours)
This course presents principles and methods for visualizing data resulting from measurements and calculations in both the physical sciences and the life sciences. The emphasis is on using 2D and 3D computer graphics to garner insight into multi-dimensional data sets for understanding and solving scientific problems. Topics include visualization software and techniques, human vision attributes and limitations, data encoding, data representation, volume rendering, flow visualization, and information visualization.
Prerequisite: COSC 5327 and GSCS 6321.

GSCS 6331 Advanced Geospatial Computing
3 Semester Credit Hours (3 Lecture Hours)
Seminar in reading and critical evaluation of academic literature in the field of and fields relating to geospatial computing. Student will design, implement, and evaluate an advanced, contemporary geospatial computing technology to solve a geospatial problem.

GSCS 6344 Ubiquitous Positioning
3 Semester Credit Hours (3 Lecture Hours)
The aim of this course is to introduce the principle of positioning indoors/outdoors using sensors and short-range radio frequency signals in smartphones. These sensors will include a GNSS receiver, an accelerometer, a gyroscope, a magnetometer, a barometer, and a camera, why short-range RF signals will include WiFi and Bluetooth signals. The course will concentrate on various positioning algorithms for fusing sensor measurements and RF signal measurements.
Prerequisite: GSCS 5321.

GSCS 6390 Special Topics
3 Semester Credit Hours (3 Lecture Hours)
Variable content study of specific areas of geospatial computing science. May be repeated for credit when topics vary. Offered on sufficient demand.

GSCS 6996 Research
1-9 Semester Credit Hours
Independent research conducted under supervision of an advisor. Open to Geospatial Computing Science students who have not yet passed the qualifying exam and with consent of their graduate advisor. The course is graded with an S or U, and may be repeated.

GSCS 6998 Dissertation Research
1-9 Semester Credit Hours
Research related to PhD dissertation. Open only to degree candidates having passed the qualifying exam in Geospatial Computing Science with consent of their graduate advisor. The course is graded with an S or U, and may be repeated.

GSCS 6999 Dissertation Defense
1-9 Semester Credit Hours
Open only to degree candidates in Geospatial Computing Science with consent of their graduate advisor. Students should enroll in this course during their last semester of the GSCS PhD program. To successfully complete this course the student must pass the dissertation defense as well as have a final copy of the dissertation signed by the full graduate committee and approved for binding and distribution. A grade of Credit/No Credit will be assigned for the class with the possibility to assign the grade of IP or In Progress. If a grade of IP is assigned, the course must be repeated the following semester(s) until the course is passed.

Geospatial Systems Engineering Courses

GSEN 5393 Graduate Creative Project
3 Semester Credit Hours
An applied research group project in geospatial surveying engineering from problem definition to implementation in an area provided by faculty in the course of study. Fall, Spring, and Summer.

GSEN 5397 Thesis I: Thesis Proposal
3 Semester Credit Hours (3 Lecture Hours)
This course is for Geospatial Systems Engineering MS students choosing the thesis option. Preparatory and developmental research for the graduate thesis resulting in the preliminary design and formal proposal of the graduate project. This thesis proposal must be reviewed and approved by the project chairperson to receive credit. Offered on a credit/no-credit basis only.

GSEN 5398 Thesis II: Thesis Research
3 Semester Credit Hours
This course is for Geospatial Systems Engineering MS students choosing the thesis option. Students will register for this course after completing GSEN 5397 Thesis I: Thesis Proposal. This course is only credit/no credit.
Prerequisite: GSEN 5397*.
* May be taken concurrently.

GSEN 5399 Thesis III: Thesis Defense
3 Semester Credit Hours (3 Lecture Hours)
This course is for Geospatial Systems Engineering MS students choosing the thesis option. Students will register for this course after completing GSEN 5398 Thesis II: Thesis Research. This course is only offered on a satisfactory/unsatisfactory (S/U) basis only, with grade of IP until completed. Credit will not be recorded until thesis is accepted by the Graduate Project Committee. May be repeated for credit. Offered Fall, Spring, and Summer semesters.
Prerequisite: GSEN 5398.

GSEN 6330 Spatial Systems Science
3 Semester Credit Hours (3 Lecture Hours)
Geospatial data management and analysis is a fundamental activity in describing, documenting, and modeling the built and natural environment. This course examines the use of various types of geospatial data, including remote sensing data, for characterization of geospatial phenomena. Topics covered include geodetic datums and coordinate systems, digital representation of geospatial data, positional accuracy and error propagation, spatial analysis and modeling techniques, and emerging topics such as geospatial AI. A GIS (ArcGIS Pro) will be used to investigate and visualize patterns and relationships using various types of geospatial data sets. Familiarity with basic concepts of probability and statistics; familiarity with calculus and matrix algebra is helpful for some topics though not required; experience working with ArcGIS or other GIS software is helpful.

GSEN 6355 Geospatial Programming Techniques
3 Semester Credit Hours (3 Lecture Hours)
Course teaches programming techniques in geospatial fields, such as how to automate GIS tasks using Python and other scripting languages. Automation can make your work easier, faster, and more accurate, and knowledge of a scripting language is a highly desired skill in GIS analysts. Fall.

GSEN 6356 Programming for Geospatial Data Science
3 Semester Credit Hours (3 Lecture Hours)
Handling, processing and analyzing spatial data in an open and reproducible way is critical in the emergence of geospatial data science. Various open source packages and tools for geospatial data and process are available and they provide an effective solution for flexibility, reproducibility and transparency in geospatial research and analysis. This course focuses on various programming skills in handling and manipulating spatial data through open source environments. Creating spatial database and queries, exploring spatial data, modeling spatial data, and visualizing spatial data through open source packages will be covered.

GSEN 6365 Spatial Database Design
3 Semester Credit Hours (3 Lecture Hours)
This course will focus on spatial database principles and the practical skills of design, implementation, and use of spatial databases. This course will first cover fundamentals of relational database design, and then focus on design and management of spatial databases utilizing geodatabase models. In addition, case studies of geodatabase design models in several applications will also be covered. This course is intended for students who want to design, create, maintain and manipulate data from a geospatial database. Spring.

GSEN 6367 Geospatial Data Mining
3 Semester Credit Hours (3 Lecture Hours)
Geospatial data mining is the process of automatically discovering interesting and useful spatial patterns in large geospatial datasets. This course begins by covering fundamental concepts and techniques in data mining. Specific topics covered include classification, association analysis, and cluster analysis. It then focuses on using these data mining techniques for handling spatial, temporal and spatial-temporal data. In addition, the data mining tools to implement applications in geoscience will also be covered. Spring.

GSEN 6370 UAS for Surveying and Mapping
3 Semester Credit Hours (3 Lecture Hours)
Introduces the fundamentals of mapping with small Unmanned Aircraft Systems (sUAS) using digital imaging sensors to produce high resolution, accurate geospatial surveying products. The course will cover the full spectrum of UAS mapping including technology, current regulations, operational factors, flight design, photogrammetric data processing, and data fidelity. Supporting concepts will include georeferencing and ground control, 3D reconstruction with structure-from-motion photogrammetry, orthorectification and image mosaicking, accuracy assessment, and current developments in UAS for geomatics. Processing and analysis workflows using commercial and open-source software will be conducted to transform UAS image sequences into geospatial data products, extract analytics, assess results, and optimize output. Spring.

GSEN 6371 Geopositioning Systems and Autonomous Navigation
3 Semester Credit Hours (3 Lecture Hours)
Addresses the foundations and computational techniques of Global Navigation Satellite Systems (GNSS) and inertial measurement units (IMUs) for autonomous navigation applications. Specifically, the course will cover concepts and principles of GNSS signal structures and the derivation of observables; error sources and corrections; point, differential, and kinetic positioning techniques; IMU linear and angular dynamics modeling; mechanization of inertial navigation and error propagation; global/local coordinate frames and conversion; and filtering techniques for GNSS/IMU integration. The course also covers current and future capabilities of emerging geopositioning systems as they relate to autonomous navigation and mobile devices. Fall.

GSEN 6380 Applied Geospatial Statistics
3 Semester Credit Hours (3 Lecture Hours)
This course will focus on geospatial statistics methods particularly multivariate statistics and applications of the statistical procedures to research geospatial problems. Research on geospatial problems often requires the application of multivariate statistical methods to produce new insight. Various existing statistic software is available to conduct multivariate statistical analysis, however, the interpretation of the results rely on solid understanding of statistic principles and theories. This course is intended for students who want to apply statistical methods to research geospatial problems.

GSEN 6381 Cadastral Information Systems Design
3 Semester Credit Hours (3 Lecture Hours)
A review of the evolution of European cadastral systems and land records traditions and alternatives. Examination of the goals and purposes of land tenure systems with attention to social, political, legal, economic, organizational, and technical issues. Exploration of U.S. modernization efforts and the problems of developing countries. Spring odd years.

GSEN 6382 Policy and Legal Aspects of Spatial information Systems
3 Semester Credit Hours (3 Lecture Hours)
A study of the current and emerging status of computer law in electronic environments. Covers issues related to: privacy, freedom of information, confidentiality, copyright, and legal liability; the impact of statue and case law on use of digital databases and spatial databases; and research of legal options of conflicts related to spatial data. Additional description: study of specific court cases specific to Texas boundary law. Introduction into International Boundaries and Treaties. Fall.

GSEN 6383 Advanced Geospatial Analytics
3 Semester Credit Hours (3 Lecture Hours)
This course will focus on the theory, techniques, and applications of advanced geospatial analytics. Topics covered include spatial point patterns, network analysis, area objects and spatial autocorrelation, and spatial interpolation. New approaches to geospatial analytics will also be covered. This course emphasizes the methods and the applied side of geospatial analytics that can be useful in students' own theses or projects for their current or potential employers.

GSEN 6384 Geospatial Visualization Design
3 Semester Credit Hours (3 Lecture Hours)
This course will ensure that students understand and apply cartographic theory for visual communication and visual thinking, and be able to create, evaluate, and critique reference and thematic maps using GIS software. Fall.

GSEN 6385 Photogrammetric Engineering and Lidar Scanning
3 Semester Credit Hours (3 Lecture Hours)
A study of the analytical and systems engineering foundations of airborne photogrammetry and geodetic imaging technologies for 2D and 3D mapping of natural and built environments. The course covers principles of digital imaging, camera calibration, stereo and multi-view photogrammetry, analytical photogrammetry, structure-from-motion, light detection and ranging (lidar) systems, and emergent scanning and imaging approaches. The course also details photogrammetric and lidar data processing, point cloud analysis, and applications.

GSEN 6386 Remote Sensing and Image Analysis
3 Semester Credit Hours (3 Lecture Hours)
Addresses the interpretation, processing and analysis techniques of remotely sensed data acquired by orbital and sub-orbital platforms. Physical principles and imaging mechanisms, remote sensing systems, data characteristics, image processing, and information extraction methods will be covered. Topics include passive optical imaging with multispectral, hyperspectral, and thermal sensing; active imaging with radar sensing; image corrections and rectification; spatial/frequency transforms and image filtering; image classification and feature extraction; and image processing with machine learning techniques. Applications in the course will be focused on geomatics and monitoring of natural and built environments. Fall.

GSEN 6390 Advanced Topics
3 Semester Credit Hours (3 Lecture Hours)
Variable content study of specific areas of geospatial surveying engineering. May be repeated for credit when topics vary. Offered on sufficient demand.

GSEN 6395 Geospatial Engineering Research
3 Semester Credit Hours (3 Lecture Hours)
Seminar in reading and critical evaluation of academic literature in the fields relating to geospatial engineering. Research methods for geospatial engineering will be introduced. Student will design, implement, and evaluate an advanced, contemporary geospatial engineering technology to solve a geospatial problem.

GSEN 6396 Directed Independent Study
3 Semester Credit Hours (3 Lecture Hours)
Study in areas of current interest. A maximum of 6 SCH of approved Directed Independent Study may count toward the MS degree.