DEPARTMENT OF COMPUTER SCIENCE

The Department of Computer Science offers a Master of Science degree and a Doctor of Philosophy degree in Computer Science.

Master of Science Degree in Computer Science

The Master of Science (M.S.) degree in Computer Science offers integrated studies involving software and hardware. A thesis option is available for students who wish to obtain research experience. The Department of Computer Science also offers Concentrations in Cyber Security, Software Engineering, and Data Science as part of the Master of Science degree.

The regulations for this degree comply with the general University regulations (refer to Student Policies, General Academic Regulations, and the Graduate Catalog, Master's Degree Regulations).

Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, a Bachelor of Arts or Bachelor of Science degree in Computer Science equivalent to that offered by UTSA is required. Students who do not qualify for unconditional admission may be admitted on a conditional basis. Students who are admitted on a conditional basis may be required to complete specific undergraduate courses as conditions of admission. If such courses are listed as deficiencies, they will not count toward the graduate degree. In such cases, students should anticipate that additional time will be required to complete the degree.

Degree Requirements

Candidates for the degree are required to successfully complete a minimum of 30 semester credit hours of graduate coursework as described in the program of study.

Program of Study

A. Core courses:		12
CS 5363	Programming Languages and Compilers	
CS 5513	Computer Architecture	
CS 5523	Operating Systems	
CS 5633	Analysis of Algorithms	
B. Electives:		12
Students must complete at least 12 semester credit hours of additional eligible graduate courses. With prior approval of the Graduate Advisor of Record, students may apply a maximum of 6 hours of graduate courses from other disciplines to the degree.		
C. Master's thesis or additional electives:		6
Students must either write a master's thesis and enroll in a minimum of 6 semester credit hours of CS 6981, CS 6982, or CS 6983 Master's Thesis or complete 6 hours of additional graduate coursework in the Department of Computer Science.		
D. Final oral examination:		
Students must pass a final comprehensive oral examination for completion of the degree program.		
Total Credit Hours		30

Concentration in Cyber Security

This concentration gives an overview of issues in computer and information security along with detailed technical experience in several specialty areas. All students pursuing this concentration must fulfill the degree requirements for the Master of Science in Computer Science. As part of the electives for the degree, students must take the following course:

CS 5323	Principles of Cyber Security	3
Select two of the following courses:		6
CS 5343	Developing Secure Systems and Software	
CS 6353	Unix and Network Security	
CS 6373	Applied Cryptography	
CS 6393	Advanced Topics in Computer Security	
Total Credit Hours		9

Concentration in Software Engineering

This concentration gives students a broad knowledge of current theories, models, and techniques in software engineering to provide a basis for problem identification and analysis, software design, development, implementation, verification, and documentation. All students pursuing this concentration must fulfill the degree requirements for the Master of Science in Computer Science. As part of the electives for the degree, students must take the following course:

CS 5103	Software Engineering	3
Select two of the following courses:		6
CS 5123	Software Testing and Quality Assurance	
CS 5153	User Interfaces and Usability	
CS 5343	Developing Secure Systems and Software	
CS 6133	Software Specification and Verification	
Total Credit Hours		9

Concentration in Data Science

This concentration provides students with the fundamental knowledge in data management, machine learning, data mining, statistics, data visualization, and communicating data. Students will have opportunities to specialize in applications such as health and life sciences as well as to learn critical, generalizable skills. All students pursuing this concentration must fulfill the degree requirements for the Master of Science in Computer Science. As part of the electives for the degree, students must take the following courses:

CS 5163	Data Science	3
Select two of the following courses (must include at least one of the courses marked with an *):		6
CS 5443	Database Management Systems *	
CS 5493	Large-Scale Data Management *	
CS 5473	Data Mining *	
CS 5483	Topics in Data Science	
CS 5263	Bioinformatics	
CS 6243	Machine Learning	
Total Credit Hours		9

Doctor of Philosophy Degree in Computer Science

The Department of Computer Science offers advanced coursework and research leading to the Doctor of Philosophy (Ph.D.) degree in Computer Science. Successful Ph.D. candidates must demonstrate an in-depth knowledge of computer science and must deliver an original contribution to the field.

The regulations for this degree comply with the general University regulations (refer to Student Policies, General Academic Regulations, and the Graduate Catalog, Doctoral Degree Regulations).

Admission Requirements

The minimum requirements for admission to the Doctoral degree program in Computer Science in addition to University-wide graduate admission requirements are as follows:

- A B.A., B.S., or M.S. degree in computer science or a related area
- The Graduate Record Examination (GRE) general test—verbal, quantitative, and analytical sections. When GRE scores are used to determine admission, applicants will be compared to applicants with similar socioeconomic backgrounds
- Three letters of recommendation attesting to the applicant's readiness for doctoral study
- Professional résumé or curriculum vitae
- Statement of research experience and interest

Admission is competitive. Satisfying the minimum requirements does not guarantee admission. Applicants will automatically be considered for scholarships and teaching and research assistantships.

Degree Requirements

Candidates for the degree are required to successfully complete a minimum of 72 semester credit hours of graduate coursework as described in the program of study.

Program of Study

A. Core courses:		12
CS 5363	Programming Languages and Compilers	
CS 5513	Computer Architecture	
CS 5523	Operating Systems	
CS 5633	Analysis of Algorithms	
B. Electives:		12
Students must complete at least 12 semester credit hours of additional eligible, organized graduate courses in the Department of Computer Science.		
C. Other Requirements:		48
Students must complete at least 48 semester credit hours of additional courses including		
A minimum of 3 semester credit hours of the following:		
CS 7123	Research Methods	
A minimum of 18 semester credit hours of the following:		
CS 7211	Doctoral Research	
CS 7212	Doctoral Research	
CS 7213	Doctoral Research	
CS 7216	Doctoral Research	
A minimum of 9 semester credit hours of the following:		
CS 7311	Doctoral Dissertation	
CS 7312	Doctoral Dissertation	
CS 7313	Doctoral Dissertation	
CS 7316	Doctoral Dissertation	
With prior approval of the Graduate Advisor of Record, students may apply a maximum of 6 hours of graduate courses from other disciplines to the degree.		
Total Credit Hours		72

Transfer of Credit

Students may transfer prior graduate study up to 30 semester credit hours from another institution toward the Doctor of Philosophy degree in Computer Science with the approval of the Graduate Studies Committee. Each student's transcript will be evaluated by the Graduate Studies Committee, and credit will be determined on a course-by-course basis to satisfy the requirements of the degree.

Admission to Candidacy

Students seeking a doctoral degree must be admitted to candidacy. The requirements for admission to candidacy are as follows:

- Achieve a grade point average of 3.3 or better in three required core courses, which include CS 5633 Analysis of Algorithms, CS 5523 Operating Systems, and one of CS 5513 Computer Architecture and CS 5363 Programming Languages and Compilers
- Pass written qualifying examinations on Algorithms and Operation Systems. Students should consult the Computer Science Ph.D. Program Handbook for additional details.
- Pass the Doctoral Dissertation Proposal Examination

Students should consult the University's Doctoral Degree Regulations in the Graduate Catalog for other requirements.

Doctoral Dissertation Proposal Examination

The Doctoral Dissertation Proposal Examination is an oral examination administered and evaluated by the student's Dissertation Committee and covers the proposal of a dissertation research. The student must submit a written proposal prior to the examination. The Doctoral Dissertation Proposal Examination consists of a formal presentation of the dissertation proposal followed by an oral examination. Unanimous approval of the Dissertation Committee is required to pass the examination.

Doctoral Dissertation and Final Oral Examination

Students seeking a doctoral degree must submit a Doctoral Dissertation and pass a Final Oral Examination. The Final Oral Examination is administered and evaluated by the student's Dissertation Committee and covers the dissertation and the general field of the dissertation. The Final Oral Examination consists of an open presentation of the dissertation followed by an oral examination. Unanimous approval of the Dissertation Committee is required to pass the Final Oral Examination. Also, the Doctoral Dissertation must be unanimously approved by the Dissertation Committee.

Graduate Certificate in Cloud Computing

The graduate certificate in Cloud Computing is a 12-semester-credit-hour program designed to equip technical professionals with the knowledge and technical skills necessary for a career in an organization that leverages cloud computing. The wide-range of use of cloud computing in today's business, government and academic environments requires a

broad range of competencies and understanding of how cloud computing influences a particular area. This certificate is designed to give a common framework of understanding cloud computing, as well as allow for specialization in specific areas, such as, cyber-security, cloud-infrastructure, and applications in cloud.

The certificate is administered by the College of Engineering in conjunction with the College of Business and the College of Sciences. The course requirements for each program focus may be found under the College of Engineering (http://catalog.utsa.edu/graduate/engineering/#certificatestext), the Department of Computer Science, and the Department of Information Systems and Cyber Security (http://catalog.utsa.edu/graduate/business/informationsystemscybersecurity/#certificatestext).

Certificate Requirements

To satisfy the requirements for the Graduate Certificate in Cloud Computing, students must complete 12 semester credit hours as follows:

A. Required Course		3
Select one entry course:		
CS 5573	Cloud Computing	
Or a cross-listed course in EE and IS. The entry course is taught through team teaching in which instructor from each college contributes to the subjects outlined in the course syllabus.		
B. Track Electives		6
Select two courses from one of the following tracks:		
Applications Track		
CS 5233	Artificial Intelligence	
CS 5263	Bioinformatics	
CS 5443	Database Management Systems	
CS 5463	Topics in Computer Science	
CS 5473	Data Mining	
CS 5493	Large-Scale Data Management	
CS 6243	Machine Learning	
CS 6293	Advanced Topics in Bioinformatics	
Security Track		
CS 5323	Principles of Cyber Security	
CS 6353	Unix and Network Security	
CS 6393	Advanced Topics in Computer Security	
IS 6363	Computer Forensics	
Infrastructure Track		
CS 5103	Software Engineering	
CS 5123	Software Testing and Quality Assurance	
CS 6463	Advanced Topics in Computer Science	
CS 6463	Advanced Topics in Computer Science (Topic: Parallel and Distribute Systems Software)	
CS 6523	Distributed Operating Systems	
CS 6543	Networks	
CS 6553	Performance Evaluation	
CS 6643	Parallel Processing	
C. Capstone Project		3
Select one course from the following (topics should be in the field of Cloud Computing):		
CS 5973	Directed Research	
CS 6953	Independent Study	
Total Credit Hours		12

Computer Science (CS) Courses

CS 5103. Software Engineering. (3-0) 3 Credit Hours.
Prerequisite: CS 4773 or software development experience. Introduction to methods and tools for the requirements analysis and design stages of software life cycles. Discussion of software requirements including elicitation, modeling notations, analysis, and documentation. Brief overview of process models and project management. Examination of major architectural styles in existing software systems, design methods, design patterns, and reverse engineering. Course will include design experience using CASE tools. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5113. Computer Graphics. (3-0) 3 Credit Hours.
Prerequisites: CS 3343 and MAT 2233. The course covers interactive 3-D computer graphics, polygonal representations of 3-D objects, boolean operations, interactive lighting models, interactive texture mapping, shadow generation as well as image-based techniques such as stencils, hidden-line removal, silhouette edges, rendering and global illumination. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5123. Software Testing and Quality Assurance. (3-0) 3 Credit Hours.
Prerequisite: CS 4773 or software development experience. Introduction of testing techniques for software systems: unit testing, integration testing, system testing, acceptance testing, and regression testing; test plan and test case design; quality assurance; verification and validation. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5153. User Interfaces and Usability. (3-0) 3 Credit Hours.
Prerequisite: CS 4773 or software development experience. This course focuses on the development of high-quality user interfaces. The course reviews the basics of user interface development, tools, and use-case driven design techniques; examines the elements of good design and usability, metrics for usability, and procedures for user testing. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5163. Data Science. (3-0) 3 Credit Hours.
Prerequisite: CS 3343 or consent of instructor. This course covers the fundamentals of data science. Topics include data management, data pre-processing, data visualization, data dissemination, and the mathematical and statistical foundations for data modeling. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5233. Artificial Intelligence. (3-0) 3 Credit Hours.
Prerequisite: CS 3343. This course covers the construction of programs that use knowledge representation and reasoning to solve problems. Major topics include informed search, logical and probabilistic inference, machine learning, planning, and natural language processing. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5253. Expert Systems. (3-0) 3 Credit Hours.
Prerequisite: CS 5233. This course presents an in-depth study of the area of artificial intelligence known as expert systems. Example expert systems are examined as a means of identifying the generally accepted methodologies for developing such systems as well as the basic research issues involved. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5263. Bioinformatics. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in Computer Science or consent of instructor. Introduction to bioinformatics. Problem areas such as sequence analysis and gene component analysis, structure prediction, gene ontology, phylogenetic inference, gene regulation, and pathway construction and analysis will be approached from a computational viewpoint. (Same as BME 6323. Credit cannot be earned for both BME 6323 and CS 5263.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5273. Penetration Testing. (3-0) 3 Credit Hours.
Prerequisite: CS 3873. Introduction to the principles and techniques associated with the cybersecurity practice known as penetration testing or ethical hacking. Topics include planning, reconnaissance, scanning, exploitation, post-exploitation, and result reporting. The student learns to use pentration testing tools, discover system vulnerabilities, and avoid exploitation of vulnerabilities. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5323. Principles of Cyber Security. (3-0) 3 Credit Hours.
Prerequisites: CS 3733 and CS 3873. An introduction to the protection of computer systems and networks. Topics include authentication, access controls, malicious logic, formal security methods, assurance and trust in computer systems and networks, firewalls, auditing and intrusion detection, cryptography and information hiding, risk management, computer forensics, and ethics. (Formerly titled Principles of Computer and Information Security.) Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5343. Developing Secure Systems and Software. (3-0) 3 Credit Hours.
Prerequisite: CS 3733. An examination of methods for designing secure computer systems, networks, and software. Topics include the security development process, security policies and models, threat modeling, security code reviews and testing, the formal verification process, validation, and assessments. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5353. Formal Languages, Automata, and Theory of Computation. (3-0) 3 Credit Hours.
Prerequisites: CS 2233 and CS 3343. Formal models of computation and syntax such as Turing machines, finite automata, non-determinism, formal languages, regular and context free grammars, complexity classes and NP-completeness. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5363. Programming Languages and Compilers. (3-0) 3 Credit Hours.
Prerequisites: CS 2233 and CS 3343. A study of programming languages with an emphasis on their implementation. Topics include lexical analysis, language syntax, control structures, the binding of names, procedures, and their implementation in compilers. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5443. Database Management Systems. (3-0) 3 Credit Hours.
Prerequisite: CS 3743. Design and implementation of database management systems. Topics include storage management, query optimization, concurrency control, crash recovery, integrity, and security in relational databases, object-oriented databases, object-relational databases, parallel databases, and distributed databases. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5463. Topics in Computer Science. (3-0) 3 Credit Hours.
Prerequisite: Graduate standing in Computer Science or consent of instructor. Topics in an area of computer science. May be repeated for credit when topics vary. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5473. Data Mining. (3-0) 3 Credit Hours.
Prerequisites: CS 3343 or consent of instructor. Concepts, principles, algorithms, performance, and applications of data mining and knowledge discovery. Topics may include data preprocessing, classification and prediction, clustering analysis, association and pattern analysis, outlier detection, and data mining software. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5483. Topics in Data Science. (3-0) 3 Credit Hours.
Prerequisite: CS 5163. Specialized topics in an area of data science. May be repeated for credit when topics vary. (Credit cannot be earned for both CS 5483 and CS 4973 on the same topic). Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5493. Large-Scale Data Management. (3-0) 3 Credit Hours.
Prerequisite: Graduate student standing in Computer Science or permission of instructor. Modern big data systems managing 3 Vs of big data (variety, volume, and velocity). Topics include, but not limited to overview of classic data management, web search, information retrieval, MapReduce, data integration, natural language processing at scale. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5513. Computer Architecture. (3-0) 3 Credit Hours.
Prerequisites: CS 3733 and CS 3853. Study of modern computer architecture, including parallel computers, multiprocessors, pipelines, and fault tolerance. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5523. Operating Systems. (3-0) 3 Credit Hours.
Prerequisites: CS 3733 and CS 3853. Operating systems concepts with an emphasis on distributed systems. Topics include process management and threads, inter-process communication, distributed objects and remote invocation, distributed naming and directory services, distributed file systems, middleware such as CORBA, access control and security. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5573. Cloud Computing. (3-0) 3 Credit Hours.
Prerequisites: CS 3733 and CS 3853. Introduction to Cloud Computing. A study of the system architecture, enabling technologies, software environment, and innovative applications of the Cloud Computing paradigm. Topics include data center virtualization, cloud platforms, cloud resource management, cloud programming and software environments, big data processing in the cloud, cloud performance and energy efficiency analysis. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5583. Kernel Concepts and Programming. (3-0) 3 Credit Hours.
Prerequisites: CS 3731 and CS 3733. Topics include system booting, memory management, process and scheduling, interrupt handling, system calls, file systems, networking, device drivers and module programming, runtime systems. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5623. Simulation Techniques. (3-0) 3 Credit Hours.
Prerequisites: CS 2123 and any statistics course. This course introduces discrete-event simulation techniques, statistical models in simulation, random number generation, input modeling, output analysis and comparisons, and verification and validation of simulation models. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5633. Analysis of Algorithms. (3-0) 3 Credit Hours.
Prerequisite: CS 3343. Models of computation and algorithm design and analysis techniques such as divide-and-conquer, greedy algorithms, dynamic programming, graph algorithms, amortized analysis. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5933. Internship in Computer Science. (0-0) 3 Credit Hours.
Prerequisites: An overall 3.0 grade point average, and permission in writing from the instructor, the Department Chair, and the Dean of the College of Sciences. The opportunity for a semester-long work experience in a private business or public agency in a computer science-related position. Not more than 3 semester credit hours of CS 5933, and not more than a total of 6 semester credit hours of CS 5933 and CS 6953 may count toward the Master of Science degree or Ph.D. degree in Computer Science. The grade report for this course is either "CR" (satisfactory participation in the internship) or "NC" (unsatisfactory participation in the internship). Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 5971. Directed Research. (0-0) 1 Credit Hour.
Prerequisites: Graduate standing in Computer Science and permission in writing (form available) of the instructor and the Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours of CS 5971, CS 5973, and CS 6953, regardless of discipline, will apply to a degree. This course will not apply to the Ph.D. degree. Course Fees: GS01 $30; LRS1 $5; STSI $5.

CS 5972. Directed Research. (0-0) 2 Credit Hours.
Prerequisites: Graduate standing in Computer Science and permission in writing (form available) of the instructor and the Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours of CS 5971, CS 5972, CS 5973, and CS 6953, regardless of discipline, will apply to a degree. This course will not apply to the Ph.D. degree. Course Fees: GS01 $60; LRS1 $10; STSI $10.

CS 5973. Directed Research. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing in Computer Science and permission in writing (form available) of the instructor and the Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours of CS 5971, CS 5973, and CS 6953, regardless of discipline, will apply to a degree. This course will not apply to the Ph.D. degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6133. Software Specification and Verification. (3-0) 3 Credit Hours.
Prerequisite: CS 5103. This course introduces the theory and practice of formal methods for the specification and verification of computer-based systems. It emphasizes various techniques for modeling behavior of sequential and concurrent systems and reasoning about properties of models using automated analysis tools. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6243. Machine Learning. (3-0) 3 Credit Hours.
Prerequisite: CS 5233 or CS 5633. This course studies machine learning techniques in the area of artificial intelligence. Topics include inductive learning, unsupervised learning, speedup learning, and computational learning theory. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6293. Advanced Topics in Bioinformatics. (3-0) 3 Credit Hours.
Prerequisite: CS 5263. Advanced topics in bioinformatics. Topics may include but are not limited to efficient combinatorial algorithms for manipulating sequences, data mining techniques for biological data, biological imaging, and structural bioinformatics. May be repeated for credit when topics vary. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6353. Unix and Network Security. (3-0) 3 Credit Hours.
Prerequisite: CS 5323. A technical survey of the fundamentals of computer and information security as it relates to networks and the UNIX operating system. Issues include authentication, common and advanced attack techniques for both the OS and networks, defensive strategies, intrusion detection, scan techniques and detection, forensics, denial of service techniques and defenses, libpcap, libdnet and libnet programming. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6363. Advanced Compiler Construction. (3-0) 3 Credit Hours.
Prerequisite: CS 4713 or CS 5363. Areas of study include code generation techniques for vector machines and multiprocessors, implementation of higher-level imperative and functional languages, and run-time system support for distributed programming languages. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6373. Applied Cryptography. (3-0) 3 Credit Hours.
Prerequisite: CS 5323. A course in applied cryptography with an emphasis on applying cryptographic techniques to solve real-world problems. Topics include a review of cryptographic primitives such as symmetric and asymmetric (public-key) cryptosystems, digital signatures, pseudo-random sequences, and hash functions. An emphasis will be placed on utilizing advanced protocols to solve problems such as key management in various environments and applications. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6393. Advanced Topics in Computer Security. (3-0) 3 Credit Hours.
Prerequisite: CS 5323. Analysis of computer security. The topics may include but are not limited to database and distributed systems security, formal models for computer security, privacy and ethics, intrusion detection, critical infrastructure protection, network vulnerability assessments, wireless security, trusted computing, and highly dependable systems. May be repeated for credit when topics vary. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6463. Advanced Topics in Computer Science. (3-0) 3 Credit Hours.
Prerequisites: Graduate standing in Computer Science and consent of instructor. Advanced topics in an area of computer science. May be repeated for credit when topics vary. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6513. Advanced Architecture. (3-0) 3 Credit Hours.
Prerequisites: CS 5513 and CS 5523. Areas of study include advanced architectures, including massively parallel and distributed systems. Issues of communication, fault tolerance, and performance are addressed. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6523. Distributed Operating Systems. (3-0) 3 Credit Hours.
Prerequisites: CS 5513 and CS 5523. Distributed operating systems issues, including migration, naming, reliability, security, resource allocation, and scheduling are addressed in heterogeneous and homogeneous systems. Time-critical data such as video and audio are considered. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6543. Networks. (3-0) 3 Credit Hours.
Prerequisite: CS 5523. This course introduces the underlying concepts and principles of modern computer networks, with emphasis on protocols, architectures and implementation issues in the internet. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6553. Performance Evaluation. (3-0) 3 Credit Hours.
Prerequisites: CS 5513 and CS 5523. This course introduces analytical modeling, simulation analysis, and experimental evaluation of computer systems and networks. Particular emphasis will be placed on the analysis and design of medium- to large-scale distributed computer systems and networks. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6643. Parallel Processing. (3-0) 3 Credit Hours.
Prerequisite: CS 5513. Parallel models of computation, performance measurement, and modeling of parallel algorithms and application studies on parallel computers. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6663. Advanced Parallel Processing and Systems. (3-0) 3 Credit Hours.
Prerequisites: CS 5513 and CS 5523. An advanced parallel computing course focusing on large-scale data processing. Topics may include parallel processing with non-CPU processors (such as GPUs, FPGAs, Application-specific Circuits), large-scale Non-Uniform Memory Access architectures, parallel data-processing frameworks, non-volatile memory chips and large-scale public clouds. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6723. Image Processing. (3-0) 3 Credit Hours.
Prerequisites: CS 5633 and MAT 2233 or an equivalent. Topics include image acquisition, enhancement, transformations, filters, compression, segmentation and edge detection, morphology, and recognition. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6953. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Graduate standing in Computer Science and permission in writing (form available) of the instructor and the Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours of CS 5971, CS 5973, and CS 6953, regardless of discipline, will apply to a degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6961. Comprehensive Examination. (0-0) 1 Credit Hour.
Prerequisite: Approval of the Graduate Program Committee to take the Comprehensive Examination. Independent study course for the purpose of taking the Comprehensive Examination. May be repeated as many times as approved by the Graduate Program Committee. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). Course Fees: GS01 $30; LRS1 $5; STSI $5.

CS 6973. Special Problems. (3-0) 3 Credit Hours.
Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Problems courses may be repeated for credit when topics vary, but not more than 6 hours, regardless of discipline, will apply to a degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 6981. Master's Thesis. (0-0) 1 Credit Hour.
Prerequisite: Consent of thesis advisor. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Course Fees: GS01 $30; LRS1 $5; STSI $5.

CS 6982. Master's Thesis. (0-0) 2 Credit Hours.
Prerequisite: Consent of thesis advisor. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Course Fees: GS01 $60; LRS1 $10; STSI $10.

CS 6983. Master's Thesis. (0-0) 3 Credit Hours.
Prerequisite: Consent of thesis advisor. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 7123. Research Methods. (3-0) 3 Credit Hours.
Prerequisites: Doctoral Student standing. Examine and learn practical research skills and research writing techniques. Review, present, and critique recent research publications in the areas of Computer Science. May be repeated for credit. May not be counted towards the Master of Science degree in Computer Science. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 7211. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisite: Doctoral Student standing and consent of Doctoral Advisor. May be repeated, a minimum of 18 hours is required for the Doctoral degree. Course Fees: GS01 $30; LRS1 $5; STSI $5.

CS 7212. Doctoral Research. (0-0) 2 Credit Hours.
Prerequisite: Doctoral Student standing and consent of Doctoral Advisor. May be repeated, a minimum of 18 hours is required for the Doctoral degree. Course Fees: GS01 $60; LRS1 $10; STSI $10.

CS 7213. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisite: Doctoral Student standing and consent of Doctoral Advisor. May be repeated, a minimum of 18 hours is required for the Doctoral degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 7216. Doctoral Research. (0-0) 6 Credit Hours.
Prerequisite: Successful completion of the Doctoral Qualifying Examination. May be repeated, a minimum of 18 hours is required for the Doctoral degree. Course Fees: GS01 $180; LRS1 $30; STSI $30.

CS 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated, a minimum of 9 hours is required for the Doctoral degree. Course Fees: GS01 $30; LRS1 $5; STSI $5.

CS 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated, a minimum of 9 hours is required for the Doctoral degree. Course Fees: GS01 $60; LRS1 $10; STSI $10.

CS 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated, a minimum of 9 hours is required for the Doctoral degree. Course Fees: GS01 $90; LRS1 $15; STSI $15.

CS 7316. Doctoral Dissertation. (0-0) 6 Credit Hours.
Prerequisite: Admission to candidacy for the Doctoral degree. May be repeated, a minimum of 9 hours is required for the Doctoral degree. Course Fees: GS01 $180; LRS1 $30; STSI $30.