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 a Concentration in Computer and Information Security, a Concentration in Software Engineering, and a Concentration in Data Science as part of the Master of Science degree.

The regulations for this degree comply with the general University regulations (refer to Chapter 2, General Academic Regulations, and Chapter 4, 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 36 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: 18
   - Students must complete at least 18 semester credit hours of additional eligible graduate courses, 12 hours of which must be in the Department of Computer Science. 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 36

Concentration in Computer and Information 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 Computer and Information 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 Introduction to 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
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 Chapter 2, General Academic Regulations, and Chapter 5, 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; and
- three letters of recommendation attesting to the applicant’s readiness for doctoral study.

Admission is competitive. Satisfying the minimum requirements does not guarantee admission. An application should also include a résumé and a statement of research experience and interest. 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 90 semester credit hours of graduate coursework as described in the program of study.

Program of Study

<table>
<thead>
<tr>
<th>A. Core courses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 5363 Programming Languages and Compilers</td>
</tr>
<tr>
<td>CS 5513 Computer Architecture</td>
</tr>
<tr>
<td>CS 5523 Operating Systems</td>
</tr>
<tr>
<td>CS 5633 Analysis of Algorithms</td>
</tr>
<tr>
<td>B. Electives:</td>
</tr>
<tr>
<td>Students must complete at least 18 semester credit hours of additional eligible, organized graduate courses in the Department of Computer Science.</td>
</tr>
<tr>
<td>C. Computer science research (42 semester credit hours minimum):</td>
</tr>
<tr>
<td>CS 7123 Research Methods (6 semester credit hours required. 3 semester credit hours may be replaced by CS 6953 Independent Study with permission)</td>
</tr>
<tr>
<td>Select a minimum of 18 semester credit hours of the following:</td>
</tr>
<tr>
<td>CS 7211 Doctoral Research</td>
</tr>
<tr>
<td>CS 7213 Doctoral Research</td>
</tr>
<tr>
<td>CS 7216 Doctoral Research</td>
</tr>
<tr>
<td>Select a minimum of 18 semester credit hours of the following:</td>
</tr>
<tr>
<td>CS 7311 Doctoral Dissertation</td>
</tr>
<tr>
<td>CS 7313 Doctoral Dissertation</td>
</tr>
<tr>
<td>CS 7316 Doctoral Dissertation</td>
</tr>
</tbody>
</table>

D. Flexible Electives:

Students must complete an additional 18 semester credit hours selected from organized graduate courses, independent study, research seminar, doctoral research and 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.

Transfer 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.

Completing Doctoral Qualifying Examination Requirements

The requirements for completing the doctoral qualifying examination include a minimum grade point average (GPA) on required core courses and passing written examinations in specific required courses.

Grade Point Average Requirements

Students must achieve a grade point average (GPA) of 3.3 or better in three required core courses, which include CS 5633 Analysis of Algorithms, CS 5523 Operating Systems, and either CS 5513 Computer Architecture or CS 5363 Programming Languages and Compilers.

Written Examinations

The written examinations will consist of the final examinations of CS 5633 Analysis of Algorithms and CS 5523 Operating Systems, and a one-hour extended examination for each of these two subjects covering more advanced topics.

The written examinations will be scheduled for each Fall and Spring semester. Students who fail their first attempt at the written examinations may make a second attempt in the following semester. No more than two attempts to pass the written examinations are permitted.

Time Limitation

Full-time students are required to satisfy the GPA requirements and pass the written examinations within the first year of enrollment in the program. Part-time doctoral students must meet (1) the GPA requirement by the time they complete the first 18 hours of computer science courses at UTSA while enrolled in the doctoral program, and (2) pass the written examinations prior to attempting more than 18 hours of computer science courses while enrolled in the doctoral program.

After completing the Doctoral Qualifying Examination requirements, a student should register for CS 7211-CS 7216 Doctoral Research with the student’s Doctoral Advisor. Consult the Computer Science Ph.D. Program Handbook for additional details of the Doctoral Qualifying Examination.
Admission to Candidacy

Students seeking a doctoral degree must be admitted to candidacy. The requirements for admission to candidacy include completion of the Doctoral Qualifying Examination and the Doctoral Dissertation Proposal Examination. Students should consult the University’s Doctoral Degree Regulations (Chapter 5 of this catalog) for other requirements.

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. After a student has passed the Doctoral Dissertation Proposal Examination, the student must register for CS 7311-CS 7316 Doctoral Dissertation every semester until the student completes the degree.

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/#certificatetestext), the Department of Computer Science, and the Department of Information Systems and Cyber Security (http://catalog.utsa.edu/graduate/business/informationsystems/cybersecurity/#certificatetestext).

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

Select one entry course:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 5573</td>
<td>Cloud Computing</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Select two courses from one of the following tracks:

<table>
<thead>
<tr>
<th>Applications Track</th>
<th>Infrastructure Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 5233 Artificial Intelligence</td>
<td>CS 5103 Software Engineering</td>
</tr>
<tr>
<td>CS 5263 Bioinformatics</td>
<td>CS 5123 Software Testing and Quality Assurance</td>
</tr>
<tr>
<td>CS 5443 Database Management Systems</td>
<td>CS 6463 Advanced Topics in Computer Science</td>
</tr>
<tr>
<td>CS 5463 Topics in Computer Science</td>
<td>CS 6463 Advanced Topics in Computer Science (Topic: Parallel and Distribute Systems Software)</td>
</tr>
<tr>
<td>CS 5473 Data Mining</td>
<td>CS 6523 Distributed Operating Systems</td>
</tr>
<tr>
<td>CS 5493 Large-Scale Data Management</td>
<td>CS 6543 Networks</td>
</tr>
<tr>
<td>CS 6243 Machine Learning</td>
<td>CS 6553 Performance Evaluation</td>
</tr>
<tr>
<td>CS 6293 Advanced Topics in Bioinformatics</td>
<td>CS 6643 Parallel Processing</td>
</tr>
</tbody>
</table>

C. Capstone Project

Select one course from the following (topics should be in the field of Cloud Computing):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 5973</td>
<td>Directed Research</td>
<td>3</td>
</tr>
<tr>
<td>CS 6953</td>
<td>Independent Study</td>
<td>3</td>
</tr>
</tbody>
</table>

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.

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.
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.

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.

CS 5163. Introduction to 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.

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.

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.

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).

CS 5323. Principles of Computer and Information 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.

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.

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.

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.

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.

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.

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.

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.).

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.

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.

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.

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.

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.
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.

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.

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).

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.
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.

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.

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).

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.

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.

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.

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.

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.

CS 7211. Doctoral Research. (0-0) 1 Credit Hour.
Prerequisite: Successful completion of the Doctoral Qualifying Examination. May be repeated, a minimum of 18 hours is required for the Doctoral degree.

CS 7213. Doctoral Research. (0-0) 3 Credit Hours.
Prerequisite: Successful completion of the Doctoral Qualifying Examination. May be repeated, a minimum of 18 hours is required for the Doctoral degree.