COMPUTER SCIENCE

Master of Science in Computer Science

School of Computer Science and Engineering

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MASTER OF SCIENCE IN COMPUTER SCIENCE

Requirements (45 units)

The Master of Science in Computer Science degree program provides a technically oriented postbaccalaureate scientific education for those who wish to acquire or extend their knowledge in the field of computer science. The program combines both the study of modern computer devices and their applications along with the study of the philosophical foundations which underlie the discipline.

In addition to the above goals and objectives, the program is also committed to improving the writing and communication skills of the student.

Admission to the Program

In addition to the general requirements of the university, specific requirements for admission to classified graduate status are:

1. An acceptable score on the GRE (general examination only);
2. Three letters of recommendation;
3. Completion of the graduate entrance writing requirement;
4. A statement of purpose from the student; and
5. Either A or B below:
   - A. A baccalaureate degree in computer science;
   - B. A baccalaureate degree in a related field with a cumulative grade point average of "B" (3.0) or better with no grade lower than "C+" (2.3) in a selection of program preparatory courses including:
     1. The equivalent of a one-year sequence of "Introduction to Computer Science" courses, as defined by the ACM Curriculum Committee as courses CS1 and CS2. This can be satisfied by the successful completion of:
        CSE 201. Computer Science I
        CSE 202. Computer Science II
        CSE 330. Data Structures
     2. Courses in calculus and discrete mathematics equivalent to:
        MATH 211. Basic Concepts of Calculus
        MATH 212. Calculus II
        MATH 213. Calculus III
        MATH 272. Discrete Mathematics
        MATH 372. Combinatorics
     3. Courses in computer science equivalent o:
        CSE 310. Digital Logic
        CSE 313. Machine Organization
        CSE 401. Contemporary Computer Architectures
        CSE 431. Algorithm Analysis
        CSE 455. Software Engineering
        CSE 460. Operating Systems
        CSE 500. Introduction to Formal Languages and Automata

Advancement to Candidacy

In order to be advanced to candidacy, a student must have:

1. Achieved classified standing;
2. Secured a major advisor from the School of Computer Science and Engineering for the preparation of the thesis or the implementation of a project;
3. Completed at least 12 quarter units and no more than 20 quarter units of work applicable to the degree program as a graduate student at this university with a minimum grade point average of 3.0 ("B");
4. Submitted a formal program of graduate study prepared in consultation with and approved by the School of Computer Science and Engineering graduate committee and/or the major advisor. This program of graduate study should include an abstract to serve as a thesis research proposal for thesis option or a tentative title and description of the project for the project option, or enrollment in CSE 689 for the exam option;
5. For students choosing the project option, satisfactory passage of the comprehensive oral examination to be administered by the graduate committee;
6. Obtained final approval of the program and of the candidacy itself by the School of Computer Science and Engineering graduate committee and the Dean of Graduate Studies.

Requirements for Graduation

1. A minimum of 45 quarter units of acceptable graduate-level work included in the formal program with 500- and 600-level courses in computer science. No more than eight units may be earned from 500-level courses;
2. Advancement to candidacy and approval of the specific program of study;
3. A public presentation for the thesis or project option;
4. Completion of a final oral examination concluded by acceptance of the thesis, for the thesis option; satisfactory completion of the comprehensive oral examination and completion of the project, for the project option; or satisfactory completion of the comprehensive written examination, for the examination option;
5. The program must be completed within a seven-year period. No more than seven years may elapse between the time of registration for the earliest course listed on the program and completion of all requirements for the degree;
6. A grade point average of at least 3.0 ("B") in all graduate course work fulfilling the requirements of the Master of Science in Computer Science and grades of "C" (2.0) or better in all courses in the program;
7. For the thesis option, the student will submit the written thesis in bound form to the department. For the project option, the student will submit the written software engineering documentation in bound form to the department;
8. The graduation writing requirement is met upon successful completion of term papers in the graduate courses taken by the student and the writing of the thesis or software engineering documentation of the project;
9. Any additional general requirements not cited above and listed on Page 368.

Department Graduate Committee and Major Advisor

The School of Computer Science and Engineering graduate committee consists of the graduate coordinators and two or more faculty members from the School of Computer Science and Engineering. The committee has general supervision over the work of students progressing towards the master's degree and will determine whether students are adequately prepared for graduate study. Each new graduate student should consult with the graduate coordinator for advice in the selection of the appropriate program of graduate study.

Students enrolled in the thesis or project option must choose and be accepted by a major advisor prior to their advancement to candidacy and the initiation of a thesis or project. The major advisor in consultation with the student will develop a program of graduate study consisting of specific courses and an acceptable thesis abstract or project proposal based on the student's interest, abilities and preparation. The major advisor will direct this research.

The program of graduate study as well as any subsequent modification of the thesis or project are subject to the approval of the School of Computer Science and Engineering graduate committee and the Dean of Graduate Studies.

Students enrolled in the exam option are advised by the graduate coordinator. The program of study for the exam option consists of declaring and choosing the exam option and may not be modified to the thesis or project option.

Thesis Preparation, Presentation and Examination

The student must conduct a research study, and from these efforts, write a thesis acceptable to the student's thesis committee and the Dean of Graduate Studies. The student's thesis committee shall be chaired by the major advisor and two other faculty members who are chosen by the student upon consultation with the major advisor and the graduate coordinator. The thesis topic and major advisor must be included on the program of graduate study submitted with the application to candidacy, although this may be amended.

The student shall enroll in CSE 699 at a rate of two to six units per quarter for all contiguous academic year quarters starting from the time of advancement to candidacy until the thesis is completed and accepted. Over that period, nine units of CSE 699 will count toward the degree.

The student, upon completion of the thesis, must give a public presentation of the research and stand for the defense of the thesis before the faculty made up of the thesis committee and any other faculty members who wish to attend. The student is given a maximum of five years from the time the student was advanced to candidacy to finish the degree.

Project Preparation, Presentation and Examination

The student must implement and complete a project acceptable to the student's project committee and the Dean of Graduate Studies. The student's project committee shall be chaired by the major advisor and two other faculty members who are chosen by the student after consultation with the major advisor and the graduate coordinator.

The project topic and major advisor must be included on the program of graduate study submitted with the application to candidacy, although this may be amended.

The student shall enroll in CSE 690 at the rate of two to five units per quarter for all contiguous academic quarters starting from the time of advancement to candidacy until the project is completed and accepted. Over that period, five units of CSE 690 will count toward the degree.

The student, upon completion of the project, must give a public presentation. The student is given a maximum of five years from the time the student was advanced to candidacy to finish the degree.

Comprehensive Written Examination

The student shall enroll in CSE 689 after consultation with the graduate coordinator and completion of the last core course(s). CSE 689 is an independent study course in preparation of the comprehensive examination and may be repeated only once. Students enrolled in CSE 689 must take and pass a written examination on the material in the core courses.

Degree Requirements (45 units)

1. CSE 602. Computation and Complexity Theory (4)
2. CSE 610. Modern Computer Architecture (4)
3. CSE 630. Theory of Algorithms and Their Analysis (4)
4. CSE 655. Software Engineering Concepts (4)
5. CSE 660. Operating Systems Concepts and Theory (4)
6. Twenty-five units from one of the following options:

A. Examination Option
   1. CSE 689. Comprehensive Examination (1)
   2. Twenty-four units of elective coursework chosen from 500- to 600-level computer science courses deemed appropriate by the department graduate committee. Up to eight units of 500-level computer science courses may be taken.

B. Project Option
   1. CSE 690. Master's Project (5)
   2. Twenty units of elective coursework chosen from 500- to 600-level computer science courses deemed appropriate by the department graduate committee. Up to eight units of 500-level computer science courses may be taken.

C. Thesis Option
   1. CSE 699. Thesis (9)
   2. Sixteen units of elective coursework chosen from 500- to 600-level computer science courses deemed appropriate by the department graduate committee. Up to eight units of 500-level computer science courses may be taken.

COURSE OFFERINGS IN COMPUTER SCIENCE AND ENGINEERING (CSE)

Effective Fall 2010, the designation for Computer Science and Engineering courses changes from CSCI to CSE.

Upper Division

500. Introduction to Formal Languages and Automata

Introduction to formal language theory. Finite state machines, regular grammars, context-free grammars, context-sensitive grammars, push-down automata, closure properties. Prerequisite: CSE 331 or consent of instructor. (4 units)

501. Introduction to Theory of Computation

Theoretical foundations of computer science: deterministic and nondeterministic Turing machines, models of computation; recursive functions, Church's thesis and undecidable problems; complexity classes P, NP, CO-NP and PSPACE. Formerly CSE 546. Prerequisite: CSE 500 or consent of instructor. (4 units)

510. Advanced Computer Architecture

High performance computer architectures and algorithms including pipeline, vector, array, multi-processor computer designs, applications, and programming. Also covered are data flow and systolic machines, interconnection networks, and graph and parallel graph algorithms. Formerly CSE 410. Three hours lecture and two hours laboratory. Prerequisite: CSE 401. (4 units)

511. Expert Systems

Expert systems components, problems and applications. Knowledge bases, inference "engines," and their integration within expert systems. Tools for building expert systems, system algorithms as related to hardware, implementation languages and examples of systems in operation. Prerequisite: CSE 330. (4 units)

512. Introduction to Artificial Intelligence

Problems and issues of artificial intelligence, current techniques and methods, and future prospects of machine intelligence. Three hours lecture and two hours activity laboratory. Formerly CSE 411. Prerequisite: CSE 330. (4 units)

513. Advanced Artificial Intelligence

Advanced issues and techniques in artificial intelligence; intelligent agents for problem solving, reasoning and learning; advanced artificial intelligence programming in LISP. Three hours lecture and two hours activity laboratory. Prerequisite: CSE 512 or consent of instructor. (4 units)

515. Automated Reasoning

Study of deduction algorithms for expert systems and the limitations thereof, propositional calculus, quantification theory, completeness and incompleteness theorems, Hebrand-Godel computability, resolution principle, equality and inequality relations. Prerequisite: CSE 431. (4 units)

520. Advanced Computer Graphics
Advanced computer graphics concepts, theory and implementation techniques. Topics include shading models, parametric curves and surfaces, hidden edge and surface removal, and anti-aliasing. Prerequisite: CSE 420. (4 units)

521. Field Programmable Gate Array Design
FPGA design rules, timing, latency, optimzations, ASIC conversion, state machines, implementing arithmetic, counters, memory, error detection and correction, simulation, and layout. Materials fee required. Three hours lecture and three hours laboratory. Prerequisite: CSE 401. (4 units)

524. Supercomputing and Visualization
Design and implementation of scientific applications on high performance computers emphasizing graphics and visualization techniques. Topics include parallel algorithm development, multiprocessor and multicomputer programming, and real-time visualization programming of computationally intensive problems in the sciences. Prerequisite: CSE 330 or consent of instructor. (4 units)

525. Parallel Algorithms and Programming
Topics include algorithm design, analysis, and programming of high performance computers. Also covered are control-parallel versus data-parallel approaches, PRAM algorithm design, and selected parallel programming languages. Four hours lecture. Prerequisite: CSE 401. (4 units)

530. Data Communications and Networks
Topics include baseband and broadband signals and modulation schemes. Error detecting and correcting codes, ISO protocol standard, packet switching and various local network schemes. Three hours lecture and two hours activity laboratory. Formerly CSE 430. Prerequisites: CSE 313 or 498 and 330. (4 units)

531. High Performance Networks
High performance network methodologies. Methods to develop network performance measures and models. Introduction to path cost estimation and service reliability issues. Three hours lecture and two hours laboratory. Formerly a topic under CSE 594. Prerequisite: CSE 530 or consent of instructor. (4 units)

535. Numerical Computation
Introduction to scientific computing. Algorithms related to approximations, zero findings, numerical differentiation and integration, data fitting and interpolation, nonlinear equations. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: senior standing or consent of instructor. (4 units)

540. System Simulation
Theory and implementation of computerized modeling. Examples will include administrative, physical and biological systems. Prerequisite: CSE 330 or consent of instructor. (4 units)

541. Robotics and Control
Theory and practice of robotic modeling, control, programming, and construction. Three hours lecture and three hours laboratory. Materials fee required. Prerequisites: CSE 310 and 313. (4 units)

550. Advanced Bioinformatics I: Sequence Analysis
Pairwise and multiple sequence alignment of strings and relations to biology. Building phylogenetic trees from sequences. Predicting and analyzing RNA secondary structure. Three hours discussion and two hours activity. Prerequisites: CSE 431 and senior standing or consent of instructor. (4 units)

551. Advanced Bioinformatics II: Numerical Modeling
Numerical techniques for the modeling and simulation of biological and chemical systems using ordinary and partial differential equations, and stochastic variables. Three hours discussion and two hours activity. Prerequisite: CSE 535. (4 units)

555. Software Design and Architecture
Common patterns of architectural design, tradeoff analysis at the architectural level, domain-specific architectures, automatic support for architectural design, and formal methods of software architecture. Three hours lecture and two hours laboratory. Prerequisite: CSE 330. (4 units)

556. Introduction to Formal Methods, Models and Languages
Applications of logic and mathematics in documenting problems, requirements, specifications, designs, and software. Formal modeling languages. Diagrammatic, algebraic, and tabular models. Model checking. Students prepare, check, and present models using techniques in the literature. (Also offered as CSE 656. Students may not receive credit for both.) Three hours lecture and two hours activity laboratory. Prerequisites: CSE 320 and 330. (4 units)

557. Computer Systems in Organizations
General system and information theory. Modeling organizations, activities, hardware, data, and software using current techniques with emphasis on human-computer interaction, systems engineering and project planning. Students will study parts of actual organizations. Formerly CSE 372. Prerequisites: CSE 330, MATH 262, or consent of instructor. (4 units)

565. Systems Programming
Concepts of, and implementation techniques for systems software such as assemblers, editors, interpreters, linkers, loaders and operating systems. Prerequisite: CSE 460. (4 units)

570. Compilers
Interpreter and compiler structures. Topics include symbol tables, lexical and syntactic scanners, and object code generation. Three hours lecture and two hours activity laboratory. Prerequisites: CSE 313, 320 and 330. (4 units)

572. Database Systems
Basic concepts of database design and theory, including underlying storage structures and alternative approaches to database models (relational, object-relational, network and hierarchical). Hands-on applications with one or more commercial database management systems. Three hours lecture and two hours activity laboratory. Materials fee required. Formerly CSE 480. Prerequisite: CSE 330. (4 units)

575. Internship in Computer Science
Supervised work and study in private or public organizations. Graded credit/no credit. Prerequisites: a minimum overall grade point average of 3.0, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken. (4 units)

580. Advanced Database Systems
Advanced study of components of general database systems and other topics such as implementation methods, query language design, reliability, integrity, performance measures, distributed database systems and database machines. Three hours lecture and two hours activity laboratory. Prerequisite: CSE 572. (4 units)

594. Topics in Computer Science
An in-depth consideration of selected areas of computer science. May be repeated for credit as topics change. Prerequisite: CSE 431 (or 331) or consent of instructor. (4 units)

595. Independent Study
Laboratory and/or library research conducted under the direction of a faculty member. A total of four units in CSE 595 may be applied toward the computer science, computer systems, computer engineering, and bioinformatics majors. Prerequisites: a minimum overall grade point average of 3.0, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken. (1-4 units)

598. Foundations of Computer Architecture
Boolean algebra and logic gates; combinational and sequential logic; processor design; data path design; control design; memory organization; and system organization. May not be counted as upper-division elective units for the B.S. in Computer Science, B.A. in Computer Systems, B.S. in Computer Engineering, or B.S. in Bioinformatics. Prerequisites: CSE 202, MATH 272, and consent of instructor. (4 units)

599. Foundations of Software Systems
Software development process which includes software life-cycles, software techniques and technologies used to produce large software systems; operating systems including processes, input/ output, memory management, and file systems. May not be counted toward the B.S. in Computer Science, B.A. in Computer Systems, B.S. in Computer Engineering, or B.S. in Bioinformatics. Prerequisites: CSE 330 and consent of instructor. (4 units)

Graduate/Postbaccalaureate
May not be taken by undergraduate students.

602. Computation and Complexity Theory
Theoretical foundations of computer science: deterministic and nondeterministic Turing machines, models of computation; recursive functions, Church's thesis and undecidable problems; complexity classes P, NP, CO-NP and PSPACE. May not be taken for credit by students who have received credit for CSE 501, 546, 646. Formerly CSE 600. Prerequisite: CSE 500 or consent of instructor. (4 units)

603. Advanced Computation and Complexity Theory
Advanced topics in theoretical foundations of computer science: models of computation; recursive functions; Church's thesis and undecidable problems; complexity classes P, NP, CO-NP and PSPACE. Formerly CSE 601 and 646. Prerequisite: CSE 602 or consent of instructor. (4 units)

610. Modern Computer Architecture
Study of the elements and construction of advanced computer systems, including parallel systems, vector processors, network scheduling, pipelining, array processors, and systolic arrays. May not be taken for credit by students who have received credit for CSE 510. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: CSE 401 or consent of instructor. (4 units)

611. VLSI Circuit Design
Fundamental design techniques for Very Large Scale Integrated (VLSI) circuits; physics of semi-conductor devices; design rules and circuit layouts; use of computer-aided design tools for design, layout and testing. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

620. Programming Languages Theory
Theory of programming languages, including implementation details, the required machine and data structures needed for user interfaces, coded parallelism, distributed processing facilities, functional and object oriented programming languages. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

621. Contemporary Computer Graphics
Theory and practice of modern graphics techniques. Topics include 3-D modeling, interaction, ray tracing, object representation, visualization, and animation techniques. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

624. Distributed Computer Systems
Open Systems Interconnection (OSI) transport, presentation and application layers; distributed control; access methods; reliability; heterogeneity; resilience; applications in network operating systems, distributed operating systems and distributed database systems. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

625. Multiprocessor and Parallel Processing
Tightly and loosely coupled multiprocessors; interconnection network; parallel programming languages; scheduling; problem decomposition; operating systems; performance; synchronization and communication; user-interface and programming environment; multiprocessor machine programming. May not be taken for credit by students who have received credit for CSE 525. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

630. Theory of Algorithms and Their Analysis
Algorithmic techniques, construction, time and space complexities, properties of taxonomic classes; survey of processing algorithms for graphs, trees, sets, and sequences; algebraic, numeric and geometric analysis techniques; dynamic programming, randomized algorithms, parallel algorithms; NP. Prerequisite: CSE 431 or consent of instructor. (4 units)

631. Advanced Data Communications
Topics include high bandwidth networks, formal models of network performance, traffic and congestion control, formal routing theory, quality of service, and internet protocol suite adaptations to high bandwidth networks. May not be taken for credit by students who have received credit for CSE 531. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: CSE 530 or consent of instructor. (4 units)

634. Neural Networks
Theory and applications of neural networks; current developments; perceptrons; Hopfield networks; self-organizing mappings and content-addressable memories; multi-layer networks. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

635. Numerical Algorithms and Simulation
Scientific computing and simulation. Systems of liner equations, linear least squares, backward error analysis and numerical stability, stiff equations, simulation, sparse matrices. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: CSE 535 or equivalent. (4 units)

640. Artificial Intelligence
Knowledge representations; heuristics; theory of problem solving; adaptive systems; natural language understanding; automatic theorem proving; learning and robotics systems. Three hours lecture and two hours laboratory. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

655. Software Engineering Concepts

Analyses of software requirements definitions, software systems design, implementation issues, verification and validation, and software maintenance techniques; rapid prototyping procedures; operational and transformational paradigms of software development; software engineering models and CASE tools including reverse engineering and module reusability concepts; applications in object-oriented programming languages. Three hours lecture and three hours laboratory. Materials fee required. Prerequisite: CSE 455, 555, or 556 or consent of instructor. (4 units)

656. Formal Methods, Models and Languages

Applications of logic and mathematics in documenting problems, requirements, specifications, designs, and software. Formal modeling languages. Diagrammatic, algebraic, and tabular models. Model checking. Students prepare, check, and present models using techniques in the literature for a research paper. Students may not receive credit for both CSE 556 and 656. Three hours lecture and two hours activity laboratory. Materials fee required. Prerequisite: classified status. (4 units)

660. Operating Systems Concepts and Theory

Operating system concepts and scheduling practices, including security, real time, multiprocessing, resource sharing, distributed file systems and peripherals access scheduling; distributed processing environments and parallel processing facilities. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: CSE 460 or consent of instructor. (4 units)

670. Compiler Design Theory

Compiler design for block structures, general purpose programming languages; automatic generation of lexical analyzers and parsers; error detection and correction; code optimization. Three hours lecture and two hours laboratory. Materials fee required. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

671. Advanced Compilers

Intermediate code generation, optimization, object code generation and architecture and optimized compiler co-design. Prerequisite: graduate standing in computer science or consent of instructor. An introductory course in compilers is recommended. (4 units)

680. Distributed Database Management Systems

Distributed database issues including methods of data distribution, types of remote database access, concurrency management, extensions to Structured Query Language (SQL) for remote databases, cooperative processing, database machines and intelligent databases. May not be taken for credit by students who have received credit for CSE 580. Three hours lecture and two hours activity laboratory. Materials fee required. Prerequisite: graduate standing in computer science or consent of instructor. (4 units)

689. Comprehensive Examination

Unsupervised study in preparation of the comprehensive examination. Topics include the material covered in the core courses: formal language and automata theory, computer architecture, algorithms, software engineering, and operating systems. May be repeated only once. Graded credit/no credit. Prerequisites: CSE 602, 610, 630, 655, 660 and consent of graduate coordinator. (1 unit)

690. Master's Project

Independent graduate project conducted under the guidance of a major advisor; total of at least five units of CSE 690 must be taken in contiguous quarters. Prerequisites: advancement to candidacy and consent of department major advisor. (2-5 units)

695. Graduate Independent Study

Independent graduate research in computer science. A total of four units in this course may be applied toward the M.S. degree. Prerequisites: graduate standing in computer science, consent of instructor, and approval of a written proposal of the research by the department graduate program coordinator. (2-4 units)

698. Continuous Enrollment for Graduate Candidacy Standing

Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Cannot be used to satisfy degree requirements. Students who enroll in 698 through the university have full use of all university facilities. See Page 370, Culminating Experience: Exam, Thesis, or Project. Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies. 698 is a variable unit course, see Page 43 for fee schedule. Earned units are not degree-applicable nor will they qualify for financial aid. (0-6 units)

699. Thesis

Independent graduate research conducted under the guidance of a major advisor; total of at least nine units for CSE 699 must be taken in contiguous quarters. Prerequisites: advancement to candidacy and consent of department major advisor. (2-6 units)