

# COMPUTER SCIENCE

Gary Laison, Ph.D., Director, Graduate Computer Science

This program is intended to provide a comprehensive approach to advanced study in computer science. It also prepares the student to hold a variety of professional and technical positions in areas of computing applications.

Typical graduates will find employment in research and development, computer software development, computer security, state-of-the-art graphics and animation technologies, the Internet, e-commerce and Web development. Graduates may pursue a doctoral program.

The main objectives of this program are to provide students with:

- the background necessary to stay abreast of current developments in computer science fields
- the ability to apply computer science problem-solving methodologies to research and industry-related problems
- the tools and knowledge necessary to take a leadership role in contributing to a highly technological society
- the preparation for advanced graduate work in computer science

## ADMISSION REQUIREMENTS AND PROCEDURES

Students seeking admission to the graduate program must have a baccalaureate degree from an accredited college or university. In addition, applicants should have the following undergraduate preparation:

Computer Science	The equivalent of the following courses currently required in the undergraduate program:
CSC 1401	Introduction to Computer Programming (or computer programming experience in C++/Java)
CSC 1601	Intermediate Computer Programming
Mathematics	The equivalent of the following courses in the undergraduate program:
MAT 1461	Linear Algebra
CSC 1671	Discrete Structures

*All new students must take the placement exam in these subjects.*

Students who are deficient in the above requirements must take and earn a grade of at least **B** in the appropriate courses without graduate credit.

Applicants should submit or have sent to Graduate Admissions the following:

- a completed application form accompanied by a non-refundable application fee,
- complete and official transcripts of all coursework from each undergraduate and graduate school attended, and
- two letters of recommendation appraising the applicant's capacity for graduate studies.

In addition, international students must submit the following documents:

- official translated copies of all college records,
- official score from the Test of English as a Foreign Language (TOEFL) (a minimum composite score of 550 (213 new style) is required on the TOEFL for students to be eligible for admission), and
- an affidavit of support signed by the sponsoring person or agency and a letter from a bank stating that sufficient funds are available to finance all educational and living expenses.

## PROGRAM OPTIONS

Students may choose to graduate with an:

- M.S. degree in computer science - General Option, or
- M.S. degree in computer science - Concentration Option

## DEGREE REQUIREMENTS FOR M.S. IN COMPUTER SCIENCE: GENERAL OPTION

A total of ten (six core and four elective) courses is the minimum required for the M.S. in Computer Science with General Option. Of these, a maximum of two courses may be for an approved research project.

**Requirements for Six Core Courses** - Students take the following six core courses:

- CSC 4005: Object Oriented Design and Data Structures
- CSC 4015: Design and Analysis of Algorithms
- CSC 4025: Computer Architecture
- CSC 4035: Computer Systems
- CSC 4045: Theory of Computation
- CSC 5105: Software Engineering

A student who receives a grade lower than a **B** in a core course must retake the course.

**Requirements for Four Elective Courses** - Students take any four CSC courses numbered 5000 and above.

## DEGREE REQUIREMENTS FOR M.S. IN COMPUTER SCIENCE: CONCENTRATION OPTION

A total of ten (four core and six elective) courses is the minimum for obtaining an M.S. degree in Computer Science in any of the following concentrations:

- Software Engineering
- Web and Database Technologies
- Graphics and Visualization
- System Security and Management
- Information Sciences

**Requirements for Four Core Courses** - Students who do not need prerequisite courses take the following two required core courses during their first and second semesters, respectively:

- CSC 4005: Object Oriented Design and Data Structures
- CSC 4015: Design and Analysis of Algorithms

The two elective core courses are taken from the following list:

- CSC 4025: Computer Architecture
- CSC 4035: Computer Systems
- CSC 4045: Theory of Computation
- CSC 5105: Software Engineering
- CSC 5215: Database Systems
- CSC 5805: Artificial Intelligence
- CSC 5815: Programming Paradigms

A student who receives a grade lower than a **B** in any core course must retake the course.

**Requirements for Six Elective (Concentration) Courses** - Students take four courses from the same concentration plus any other two CSC courses numbered 5000 and above to receive a specialized M.S. degree from that concentration:

### **Software Engineering Concentration**

- CSC 5105: Software Engineering
- CSC 5115: Human Computer Interfaces
- CSC 5125: Program Verification
- CSC 5135: Software Testing

### **Web and Database Technologies Concentration**

- CSC 5205: Internet Application Development
- CSC 5215: Database Systems
- CSC 5225: Advanced Database Concepts
- CSC 5235: Data Communications and Networking
- CSC 5245: Networks and Distributed Systems
- CSC 5255: Cryptography and Network Security
- CSC 5265: Web Technologies

### **Graphics and Visualization Concentration**

- CSC 5305: Introduction to Computer Graphics
- CSC 5315: Computer Vision
- CSC 5325: Interactive 3D Game Development
- CSC 5335: Advanced Graphics and Visualization
- CSC 5345: Computational Geometry

### **System Security and Management Concentration**

- CSC 5405: Advanced Operating Systems
- CSC 5415: System Security and Vulnerability
- CSC 5425: System Management & Maintenance
- CSC 5255: Cryptography and Network Security

### **Information Sciences Concentration\***

- MBA 4115 Creating and Measuring Shareholder Value
- MBA 4535 Empowering Human Potential at Work
- MBA 4415 Emerging Technology and E-business
- DSS 5045 Case Studies in Information Resource Management

\*Students whose business background is deficient may be required to take one or both of the following in addition to any mathematics or computer science prerequisite courses required: MBA 3115 Accounting Concepts, MBA 3515 Managing Work Organizations.

## **POST-MASTERS CERTIFICATE PROGRAM**

Those who have already completed a Master's degree in Computer Science may take additional courses in a Post-Masters Certificate Program. A minimum of four courses is required to complete this program, the choice of courses to be worked out with the Graduate Director. For further information contact the Graduate Director.

## PREREQUISITE COURSES

**CSC 3675: Discrete Structures** **3 credits**  
Mathematics needed for Computer Science. Topics covered include: functions, relations, propositional and first order predicate logic, set theory, proofs and their construction, counting and elementary probability. The course will use a declarative language as a tool to support concrete implementations of the mathematical ideas.

**CSC 3405/3605: Introductory and Intermediate Computer Programming 3/3 credits**  
This is an intensive, one-semester two-course sequence intended to provide students with the necessary background in programming for the graduate program. The use of the computer to solve problems. Students will learn general principles of program design at first by using libraries of predefined program units, and later by constructing complete programs. Emphasis is on developing techniques for program design that lead to correct, readable and maintainable programs. Intermediate programming techniques including the use of recursion. An introduction to encapsulated data structures. Lists and list sorting will be used to introduce a discussion of algorithm efficiency.

## CORE COURSES

**CSC 4005: Object Oriented Design and Data Structures** **3 credits**  
The course combines a strong emphasis on Object-Oriented Design principles and design patterns with the study of data structures. Fundamental Abstract Data Types, their implementations and techniques for analyzing their efficiency will be covered. Students will design, build, test, debug and analyze medium-size software systems and learn to use relevant tools. *Prerequisite:* CSC 3605 Intermediate Computer Programming or permission of the Graduate Director. *Corequisite:* CSC 3675 Discrete Structures.

**CSC 4015: Design and Analysis of Algorithms** **3 credits**  
Concepts of program complexity; basic approaches to complexity reduction: data structures and techniques; worst cases and expected complexity. Topics to be covered may include sorting, set manipulation, graph algorithms, matrix multiplication, and finite Fourier transforms, polynomial arithmetic, and pattern matching. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 4025: Computer Architecture** **3 credits**  
Overview of computer system organization, hardware components, and communications. Introduction to boolean algebra, combinational and sequential logic, arithmetic, the CPU, memory, microprocessors, and interfaces. CISC vs. RISC processors. Practical assembly language programming will be the emphasis with an introduction to micro architecture and microprogramming on a variety of processors.

**CSC 4035: Computer Systems** **3 credits**  
An overview of the software required to integrate computer hardware into a functional system. The following topics are covered. Operating systems a resource managers and as

virtual machines. System calls, in particular those required for process and file management; interrupt driven systems; concurrency; memory management; file systems and security. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures or permission of the Graduate Director.

**CSC 4045: Theory of Computation** **3 credits**  
Formal languages, formal grammars, abstract machines; models of computation (e.g. Turing machines); computational complexity (NP completeness); undecidability and uncomputability. *Prerequisite:* CSC 3675 Discrete Structures.

**CSC 5105: Software Engineering** **3 credits**  
(See description in Software Engineering Courses)

**CSC 5215: Database Systems** **3 credits**  
(See description in Web and Database Technologies Courses)

**CSC 5805: Artificial Intelligence** **3 credits**  
(See description in Free Distribution Courses)

**CSC 5815: Programming Paradigms** **3 credits**  
(See description in Free Distribution Courses)

## SOFTWARE ENGINEERING COURSES

**CSC 5105: Software Engineering** **3 credits**  
The purpose of this class is to teach the process of developing software. It combines a study of methods, tools, and techniques for creating and evolving software products, with the practical skills needed to deliver high-quality software products on schedule. The methods that are studied include requirements, specification, design, implementation, testing, and maintenance. The course includes a substantial group project. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5115: Human Computer Interaction** **3 credits**  
User models: conceptual, semantic and syntactic considerations; cognitive and social issues for computer systems; evaluating HCI; direct manipulation; the model view controller architecture; widgets and toolkits. Students will design a GUI based application. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5125: Program Verification** **3 credits**  
Symbolic logic and mechanized deduction; program specification; loop invariants; the proof methods of Floyd and Hoare; parallel computations; program semantics. *Prerequisite:* CSC 4015 Design and Analysis of Algorithms.

**CSC 5135: Software Testing****3 credits**

A systematic approach to software testing, in context of the software life cycle and as a branch of software engineering, building on students' prior knowledge of software engineering. Through both the breadth and depth of its coverage, the course prepares students to make an effective contribution to software testing as professional software engineers. *Prerequisite:* CSC 5105 Software Engineering.

**WEB AND DATABASE TECHNOLOGIES COURSES****CSC 5205: Internet Application Development****3 credits**

This course will attempt to give you experience in designing Internet applications. A student finishing this course should be able to design, implement, and maintain a large community or e-commerce web site. They should leave the course with an understanding of a variety of Internet protocols and markup languages, a knowledge of at least one common scripting tool, an understanding of how to implement a database back-end into a large-scale site, and the ability to critically assess the usability of both their design and the design others.

**CSC 5215: Database Systems****3 credits**

This course covers the concepts and structures necessary to design and implement a database management system. Topics to be covered: data models (entity-relationship and relational), SQL, normalization, storage structures, enterprise applications and database integrity. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5225: Advanced Database Concepts****3 credits**

Topics include stored procedures, triggers, query processing and optimization, web-based enterprise database applications, transaction management, concurrency control, distributed databases, data mining and web mining. The course includes programming projects involving SQL. *Prerequisite:* CSC 5215 Database Systems.

**CSC 5235: Data Communications and Networking****3 credits**

Topics include mathematical foundations of data communications, logical and physical organization of computer networks, the ISO and TCP/IP models, communication protocols, circuit and packet switching, the Internet, LAN/WAN, client/server communications via sockets, routing protocols, data encryption/ decryption and network security issues. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5245 Networks and Distributed Systems****3 credits**

Overview of networks; topologies; ISO levels; routing in networks, local area networks; distributed computing systems; network operating systems; networked databases; future trends. *Prerequisites:* CSC 4035 Computer Systems.

**CSC 5255: Cryptography and Network Security****3 credits**

Topics include classical cryptosystems, public and symmetric cryptography, key management, digital signatures, cipher techniques, authentication and federated identity

management. Course also covers concepts relating to cryptovirology, malware, viruses, Trojan horses, worms and other types of infectors as they relate to network security. Course includes programming projects. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5265: Web Technologies**

**3 credits**

Topics include organization of Meta-Markup languages, Document Type Definitions (DTDs), document validity and well-formedness, style languages, namespaces, Transformations, XML parsers, Web Services, and Web Security Specifications. Course includes programming projects. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**GRAPHICS AND VISUALIZATION COURSES**

**CSC 5305: Introduction to Graphics**

**3 credits**

The course provides an introduction to the principles of computer graphics. The emphasis will be placed on understanding how various elements that underlie computer graphics interact in the design of graphics software systems. Topics include pipeline architecture, graphics programming, 3D geometry and transformations, modeling, viewing, clipping and projection, lighting, shading and texture mapping and visibility determination. A standard graphics API will be used to reinforce concepts and the study of basic graphics algorithms. Students need some proficiency in C language and basic concepts from Linear Algebra. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5315: Computer Vision**

**3 credits**

Computer vision is the science of analyzing images and videos in order to recognize or model 3D objects, persons, and environments. Topics include the underlying image formation principles, extracting simple features like prominent points or lines in images, projecting a scene to a picture, tracking features and areas in images and make a mosaic, making an image-based positioning system, obtaining 3D models from two or more images, and techniques to recognize simple patterns and objects. The class includes programming exercises and hands-on work with digital cameras and laser scanners. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5325: Interactive 3D Game Development**

**3 credits**

This is a technology-based course that uses the latest computer games technology to teach advanced programming, mathematics, and software development. The course is ideal for students with an interest in computer games who plan to seek employment in one of the country's more profitable industries, or students looking for a career in new technologies or software development. The interactive entertainment industry in the US and throughout the world is entering a new phase. New technology platforms are forcing existing development firms to diversify. There are many aspects of game design, development, production, finance, and the distribution process. This course specializes in the programming and technology aspects of the industry. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5335: Advanced Computer Graphics and Visualization** **3 credits**

The goal of this course is to expose students to advanced techniques in modeling and rendering in computer graphics and visualization. Topics include parametric curves and surfaces, mesh representation, multiresolution modeling, and mesh simplification, ray-tracing, radiosity and volume rendering (iso-surface rendering and direct volume rendering), anti-aliasing and animation. *Prerequisite:* CSC 5305 Introduction to Graphics.

**CSC 5345 Computational Geometry** **3 credits**

The course covers design, implementation and analysis of data structures and algorithms for solving geometric problems concerning objects like points, lines, polygons in 2-dimensional space and in higher dimensions. The course emphasizes the applications of computational geometry. Topics include overview of geometric concepts, curves and surfaces, data structures for representing solid models, convex hulls, line segment intersection, multi-dimensional data structures (kd-trees, quadtrees and BSP trees), and range searching, point location, triangulations and Voronoi diagrams. *Prerequisite:* CSC 4015 Design and Analysis of Algorithms.

## **SYSTEM SECURITY AND MANAGEMENT COURSES**

**CSC 5405: Advanced Operating Systems** **3 credits**

Network and Distributed Operating systems, Distributed file systems, Loadable device drivers, Case studies from Linux and Windows. *Prerequisite:* CSC 4035 Computer Systems.

**CSC 5415: System Security and Vulnerability** **3 credits**

Students will be introduced to the issues surrounding the construction of high integrity systems. Case studies of system vulnerabilities will be examined. Specific topics to be covered include threat analysis; language support for high integrity systems; firewalls and protection policies and mechanisms. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

**CSC 5425: System Management and Maintenance** **3 credits**

A course designed to introduce students to the issues and concerns of managing shared systems. Students will manage a small system and explore mechanisms for maintaining data integrity, policies for users, record keeping, and system protection. *Prerequisite:* CSC 4035 Computer Systems.

## FREE DISTRIBUTION COURSES

### **CSC 5805: Artificial Intelligence** **3 credits**

The course covers fundamental concepts such as role of logic in reasoning, deductive proofs, and blind and informed search techniques. Additional topics may include inductive learning, genetic algorithms, decision trees, planning, natural language processing, game trees and perceptron learning. Course includes programming projects in a suitable language. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

### **CSC 5815: Programming Paradigms** **3 credits**

An exploration of the relationships between computational paradigms and the computer languages that support them. The Lambda calculus and functional programming, resolution and logic based languages, machine based models and imperative languages. The impact of the computational model on program structure and language design. Mid-sized programming project will be used to illustrate the concepts. *Prerequisite:* CSC 3675 Discrete Structures.

### **CSC 5825: Numerical Algorithms** **3 credits**

Exposition and analysis of numerical methods for modern computers; review of basic concepts in linear algebra; direct and iterative methods for solving linear and nonlinear problems in numerical algebra; basic problems in approximation theory, numerical differentiation and integration; numerical solutions of differential equations; forward and backward error analysis of algorithms; criteria for comparing the efficiency and suitability of numerical methods. *Prerequisite:* CSC 4005 Object Oriented Design and Data Structures.

### **CSC 5835: Information Theory and Coding** **3 credits**

Data encoding and transmission; variable length coding; the Kraft inequality for noiseless transmission channels; channel capacity; noisy channels and channel capacity; the Shannon coding theorem; algebraic coding schemes. *Prerequisite:* CSC 3675 Discrete Structures or equivalent.

### **CSC 5845: Complexity of Computation** **3 credits**

P and NP problems; NP-complete classes; concrete complexity and the P class of combinatorial problems; complexity reduction on graph and string problems; complexity of algebraic computations. *Prerequisite:* CSC 4015 Design and Analysis of Algorithms, CSC 4045 Theory of Computation.

### **CSC 5895: Topics in Computer Science** **3 credits**

The course introduces students to recent theoretical or practical topics of interest in computer science. Content and structure of the course are determined by the course supervisor. The special topics for a given semester will be announced prior to registration. With permission of the Graduate Director the course may be taken more than once. *Prerequisite:* CSC 4015 Object Oriented Design and Data Structures or permission of instructor.

**CSC 6005: Curricular Practical Training** **1 credit**  
An approved internship in advanced computer science.

**CSC 6015: Research Project I** **3 credits**  
Supervised independent research mentored by a graduate faculty member.  
*Prerequisite:* GPA of 3.5 and permission of the Graduate Director.

**CSC 6025: Research Project II** **3 credits**  
Supervised independent research mentored by a graduate faculty member.  
*Prerequisite:* GPA of 3.5 and permission of the Graduate Director.

**CSC 6035: Research Project I/II** **6 credits**  
Supervised independent research mentored by a graduate faculty member.  
*Prerequisite:* GPA of 3.5 and permission of the Graduate Director.

## **INQUIRIES**

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