Ph.D. in Computer and Cyber Sciences
Curriculum Requirements

Note: This document is intended to be temporary and represents general requirements for this program. The official requirements are found in the university catalog and this document will be replaced with a link to the catalog once it becomes available.

A. Breadth Requirement: Doctoral students are expected to demonstrate competency in Computer and Cyber Sciences by satisfying the Breadth Requirements. This is accomplished by taking courses in the following Breadth Tracks (following the rules listed later in this document).

1. A: Theoretical Foundations
2. B: Computer Systems
3. C: Applications
4. D: Cybersecurity

The following are the following are courses for each Breadth Track.

Track A. Courses in Theoretical Foundations
CSCI-7100 (3 credits): Algorithm analysis
CSCI-8250 (3 credits): Quantum computing
CSCI-8320 (3 credits): Verification of software
CSCI-7300 (3 credits): Programming Languages
CSCI-7500 (3 credits): Theory of computation
CSCI 8310 (3 credits): Proof Systems
CSCI-7350 (3 credits): Network and distributed algorithms
Track B. Courses in Computer Systems
CSCI-7110 (3 credits): Cyber-physical systems
CSCI-7410 (3 credits): Operating systems
CSCI-7580 (3 credits): Computer architecture
CSCI-7585 (3 credits): High Performance Computing
CSCI-7654 (3 credits): Computer Communication Networks
Track C. Courses in Applications
CSCI-7340 (3 credits): Machine learning
CSCI-7420 (3 credits): Human-computer interaction
CSCI-7620 (3 credits): Data science
CSCI-7810 (3 credits): Information management
Track D. Courses in Cybersecurity
CSCI-7120 (3 credits): Advanced topics in computer security
CSCI-7130 (3 credits): Software engineering
CSCI-7440 (3 credits): Evaluating cybersecurity

CSCI-7520 (3 credits): Applied cryptography
E. Other Courses in Addition to Breadth Requirements
CSCI-6900 (3 credits): Introduction to Research
CSCI-7011 (3 credits): Studies in Foundation of Computer and Cyber Sciences
CSCI-7012 (3 credits): Studies in Applications of Computer and Cyber Sciences
CSCI-7950 (3 credits): Selected topics
CSCI-8510 (3 credits): Independent Study
CSCI-8720 (3 credits): Problems in Computer and Cyber Sciences
CSCI-8940 (1-9 credits): Dissertation Research
CSCI-8970 (3 credit): Research Exposure

To satisfy the Breadth Requirements, the student must take 6 courses totaling 18 credit hours.

Among the 4 tracks, students choose, based on their interests and in consultation with their academic or dissertation advisor, 2 tracks in which they take 2 classes, and the other 2 tracks in which they take 1 class each.

To have the courses satisfy the Breadth Requirements, the student must receive a grade of B or better in each of the 6 courses and have more A's than B's in the 6 courses.
A course in a Breadth Track that is taken by a student but not used to satisfy Breadth Requirements is considered as Elective.

B. Preparation for Research.

All students take the preparation for research class (3 credits) in their first semester. Subsequently, students register for CSCI-8720, Problems in Computer and Cyber Sciences, under the supervision of a faculty member in the School. Students do not need to have a formal dissertation advisor at this stage.

C. Research Exposure.

Students register for CSCI-8970 (3 credits) Research Exposure. This course is a venue to discuss contemporary problems in Computer and Cyber Sciences.

D. Students take elective coursework adding to another 9 credits, across areas A, B, C, D, and E.

E. Dissertation.

After students have a formal advisor and have passed the comprehensive exam, they may register for CSCI-8940 (1-9 credits), Dissertation Research. A minimum of 36 credits of CSCI-8940 needs to be completed prior to graduation.

F. Credit Hours.

A doctoral student must earn a minimum of 72 credit hours during the course of the program.

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This is comprised of a minimum of 36 credits for coursework, including breadth classes, introduction to research classes, problems classes, research exposure, and electives, and a minimum of 36 credits for Dissertation Research.

Course Descriptions (check the university catalog for any descriptions not found here):

A. Courses in Theoretical Foundations

CSCI 8250 (3 credits) Quantum Computing
This course is a presentation of quantum computing as an emerging computing paradigm based on quantum mechanics. The course acquaints the student with architecture of quantum computing built from quantum gates and circuits, as well as design and performance of quantum algorithms. The course formalizes the concepts of quantum complexity and information and presents quantum algorithms in cryptography and fault-tolerant information processing.

B. Courses in Computer Systems

CSCI 7410 (3 credits) Operating Systems
This class considers modern time-sharing uniprocessors, multiprocessors, and distributed system. The main underlying themes, concurrency and scale, are highlighted to focus on correct, efficient, and resilient execution of applications on these systems. Both practical and theoretical considerations are covered.

CSCI 7580 (3 credits) Computer Architecture
This class discusses the design of modern computer chips. Quantitative design principles are emphasized throughout the class. Techniques underlying different components and aspects of modern chips are discussed with simulation and quantitative ways of comparing between the design points.

CSCI-7585 (3 credits) High Performance Computing:
This class focuses on extracting performance from modern systems. The type of systems considered include uniprocessors (where cache performance is crucial), modern chips that have shared memory parallelism and SIMD features, distributed memory parallel systems, and accelerators like GPUs. Programming models appropriate for each of these is presented. Application of concepts to scientific kernels and practical development are emphasized.

CSCI 7654 (3 credits) Computer Communication Networks
In this course, we trace the evolution of networks and identify the key concepts and functions that form the basis for layered architecture. We introduce examples of protocols and services and we explain how these services are supported by networks. We explore fundamental concepts in digital communication, and focus on error control techniques that include parity check, polynomial code, and Internet checksum. Sockets programming and security are also covered.

C. Courses in Applications

CSCI-7420 (3 credits) Human-computer Interaction

This course covers the fundamental concepts of human-computer interaction (HCI) including user interface design principles, human capabilities, interface technology, interface design methods and interface evaluation. Students will become familiar with the principles and characteristics of HCI as well as the processes involved in creating user-centered designs. Interfaces to emerging computing paradigms such as virtual and augmented reality, robotics, and wearable devices as well as the ethical and security implications of interface design will also be examined.

CSCI 7620 (3 credits) Data Science

This class focuses on methods for computer analysis of data with focus on gaining insights. A number of algorithm families (Clustering, Classification, Association Mining, Regression and Bayesian Models) are visited. Practical and efficient implementation of existing algorithms is emphasized together with application of developed implementations on actual datasets.

CSCI 7810 (3 credits) Information Management

This course presents database design and algorithms to students. There is a review of statistics and analytics as a background in data analysis. This course acquaints students with the principles of data analysis and mining, as well as reasoning about data security and privacy. There will be a discussion of case studies from application areas.

D. Courses in Cybersecurity

CSCI 7440 (3 credits) Evaluating Cybersecurity

This course teaches students the underlying principles and many of the techniques associated with the cybersecurity practice known as penetration testing or ethical hacking. The course will provide the fundamental information associated with each of the methods employed and insecurities identified. In all cases, remedial techniques will be explored. Students will develop an excellent understanding of current cybersecurity issues and ways that user, administrator, and programmer errors can lead to exploitable insecurities.

CSCI 7520 (3 credits) Principles of Cryptography

This course explains the basics of modern cryptography that was started in the 1970s and rooted in mathematics. It covers studying and analyzing constructions and algorithms that provide data confidentiality, data integrity, and authentication in the presence of third parties or the public. Cryptography is an essential element of any secure software, secure communication, and database.

E. Courses beyond the Breadth Requirements

CSCI 7011 (3 credits) Studies in Foundations of Computer and Cyber Sciences
Students undertake a study of a chosen foundational area of computer and cyber sciences under the supervision of their advisor or the graduate program director in preparation for more advanced courses. The mode of instruction is a combination of lectures and assigned readings. The students will demonstrate mastery of the selected material through homework assignments and examinations. The study culminates in a term paper in which the student demonstrates their knowledge of the material and the ability to identify potential research questions in the area of study.

CSCI 7012 (3 credits) Studies in Applications of Computer and Cyber Sciences

Students undertake a study of a chosen application area of computer and cyber sciences under the supervision of their advisor or the graduate program director in preparation for more advanced courses. The mode of instruction is a combination of lectures and assigned readings. The students will demonstrate mastery of the selected material through homework, programming assignments, and examinations. The study culminates in a term paper in which the student demonstrates their knowledge of the material and the understanding of the challenges in implementing systems in the area of study.

CSCI 8510 (3 credits) Independent Study

The student will work individually with the faculty advisor to design an individualized course of study, set course objectives and requirements, and designate student learning outcomes. This course is designed to provide students with in-depth knowledge related to an area of research that falls outside the current graduate course offerings.

CSCI 7950 (3 credits) Selected Topics

This is the SELECTED TOPICS course for the MS in Computer Science program. Subject and course content will vary.

CSCI 8720 (3 credits) Problems in Computer Science

The student and the advisor identify a topic of mutual interest and establish a list of papers to be carefully studied. The student studies the papers, writes a detailed and critical summary of the papers and synthesizes an understanding of the current state-of-the-art. This is followed by the formulation of open questions that will be worthy of future research. Interesting results are disseminated via presentation.

CSCI 8730 (3 credits) Problems in Cyber Science

The student and the advisor identify a topic of mutual interest and establish a list of papers to be carefully studied. The student studies the papers, writes a detailed and critical summary of the papers and synthesizes an understanding of the current state-of-the-art. This is followed by the formulation of open questions that will be worthy of future research. Interesting results are

disseminated via presentation.

CSCI 8940 1-9 credits) Dissertation Research

This course, designed for students in a research-focused doctoral program, provides students the opportunity to complete dissertation work specific to their individual area of research under the supervision of their research mentors.

CSCI 8970 (3 credit) Research Exposure

Presentations of selected recent research results. Students complete required readings related to their presentation prior to the class and write a critical summary. Guest speakers and participants deliver the presentations. Every student conducts a thorough survey of one chosen topic of interest and writes a paper analyzing the current state-of-the-art and identifies directions for future work.