M.S. with a Major in Computer Science

Candidates must satisfy a total of 30 credit hours (CH) with a minimum G.P.A. of 3.000 on a 4.000 scale.

All students must complete 12 credit hours (CH) of the core curriculum.

CSE 7330 File Organization and Database Management
A survey of current database approaches and systems, and the principles of design and use of these systems. Covers query language design and implementation constraints, and applications of large databases. Includes a survey of file structures and access techniques. Also, the use of a relational database management system to implement a database design project. *Prerequisite*: CSE 2341.

CSE 7343 Operating Systems and System Software
Theoretical and practical aspects of operating systems, including an overview of system software, time-sharing, and multiprogramming operating systems. Also, network operating systems and the Internet, virtual memory management, inter-process communication and synchronization, file organization, and case studies. *Prerequisite*: CSE 2341.

CSE 7350 Algorithm Engineering
Covers algorithm design techniques; methods for evaluating algorithm efficiency; data structure specification and implementation; and applications to fundamental computational problems in sorting and selection, graphs and networks, scheduling and combinatorial optimization, computational geometry, and arithmetic and matrix computation. Also, introduction to parallel algorithms and to computational complexity and a survey of NP-complete problems. *Prerequisites*: CSE 2341 and CSE 3353 (for non-CSE graduate students: CSE 2341).

CSE 7381 Computer Architecture
Introduces the state-of-   the art in uniprocessor computer architecture. The focus is on the quantitative analysis and cost-performance tradeoffs in instruction set, pipeline, and memory design. Covers quantitative analysis of performance and hardware costs, instruction set design, pipeline, delayed branch, memory organization, and advanced instruction-level parallelism.

CSE 8098 Computer Science Seminar
The course consists of the seminars and colloquia given by the resident faculty and invited guests in various specialized as well as general topics in computer science.

All students must complete 6 credit hours (CH) in a concentration area.

Algorithms (two of the following)
CSE 7380 VLSI Algorithms
Introduces problems, algorithms, and optimization techniques used in the design of high-performance VLSI design. Emphasis on algorithms for partitioning, placement, floor planning, wire routing, and layout compaction.

CSE 8350 Algorithms II
Analysis of dynamic data structures, lower bound theory, problem equivalence and reducibility, complexity theory, probabilistic algorithms, machine models of sequential and parallel computation, and parallel algorithms. *Prerequisite*: CSE 7350.

CSE 8351 Computer Arithmetic
Number representation and algorithms for arithmetic unit design; redundant radix representation; highly parallel add, multiply, divide, and square root algorithms; IEEE floating-point standard; directed roundings; base conversion; VLSI floating-point units; vector and matrix arithmetic; residue arithmetic; rational arithmetic; and online arithmetic. *Prerequisite*: Knowledge of computer organization, data structures, and algorithms, as taught in CSE 2341.

CSE 8355 Graph Theory: Algorithms and Applications
Development of algorithmic and computational aspects of graph theory, with application of concepts and techniques to solving problems of connectivity, set covering, scheduling, shortest paths, traveling salesmen, network flow, matching, and assignment. *Prerequisite*: CSE 7350 or permission of instructor.

Architecture (two of the following)
CSE 7380 VLSI Algorithms
Introduces problems, algorithms, and optimization techniques used in the design of high-performance VLSI design. Emphasis on algorithms for partitioning, placement, floor planning, wire routing, and layout compaction.

CSE 8377 Fault-Tolerant Computing
Faults, errors, and failures, hardware fault tolerance, reliability, availability, reliable distributed systems, check-pointing and recovery, atomic actions data and process resiliency, software fault tolerance, and case studies. *Prerequisite*: Permission of instructor.

CSE 8380 Parallel and Distributed Processing

Parallel and distributed processing is a fast-growing technology that permeates many aspects of computer science and engineering. This course emphasizes the strong interaction between parallel and distributed algorithms, architectures, and software. Topics include parallelism analysis in numeric and non-numeric algorithms, array processors, associative processors, multiprocessors, marker-propagation networks, distributed operating systems, networks of workstations, Internet computing, and case studies.
Prerequisites: Computer architecture and a high-level programming language.

CSE 8383 Advanced Computer Architecture

Advanced topics in computer architecture and parallel processing. *Prerequisite*: CSE 7381.

CSE 8387 Switching Theory and Applications in VLSI CAD

Advanced topics in switching theory and CAD methods. The underlying theory of the course topics is emphasized in addition to their application. Particular emphasis on the representation and properties of discrete functions and the synthesis and verification problems. Includes both binary and multiple-valued logic systems. Previous exposure to an HDL is highly beneficial but is not a prerequisite.
Prerequisites: Proficiency in using a modern programming language and CSE 7387 or equivalent.

Software (two of the following)

CSE 7314 Software Testing and Quality Assurance

The relationship of software testing to quality is examined with an emphasis on testing techniques and the role of testing in the validation of system requirements. Topics include module and unit testing, integration, code inspection, peer reviews, verification and validation, statistical testing methods, preventing and detecting errors, selecting and implementing project metrics, and defining test plans and strategies that map to system requirements. Testing principles, formal models of testing, performance monitoring, and measurement also are examined.

CSE 7319 Software Architecture and Design

Successful software development requires both an understanding of software design principles and a broader understanding of software architectures that provide a framework for design. The course explores the role of design in the software life cycle including different approaches to design, design trade-offs and the use of design patterns in modeling object-oriented solutions. It also focuses on important aspects of a system's architecture including the division of functions among system modules, synchronization, asynchronous and synchronous messaging, interfaces, and the representation of shared information.

CSE 7345 Advanced Application Programming

Covers advanced programming techniques that span a range of programming languages and technologies. Topics include server-side application development, client graphical user interface implementation, application frameworks, design patterns, model-based development, and multithreading. The specific programming language or languages covered may vary from term to term. *Prerequisite*: CSE 3345 or consent of instructor.

CSE 8313 Object-Oriented Analysis and Design Methodology

Object-oriented analysis and design is essential in developing high-quality object-oriented systems. The course will provide an overview of object-oriented analysis and design by integrating the work of Booch, Rumbaugh, Jacobson, and Wirfs-Brock. Topics will include use-case analysis, responsibility-driven design, object modeling, entity-relationship modeling, and the design notation of the Unified Modeling Language (UML). Additional topics will include object-oriented class libraries, object-oriented databases, and the Common Object Request Broker Architecture (CORBA).

CSE 8316 User Interface Design

Design methodologies for user interfaces. Includes life cycles for UI development, human factors issues, prototyping, user analysis and evaluation, and design techniques. Students perform the analysis, design, and evaluation of a UI through two iterations.

Data Science (two of the following)

CSE 7323 Mobile Applications for Sensing and Learning

Equips students with the practical skills necessary to develop mobile applications that take advantage of the myriad sensing and control capabilities of modern smartphones. Focuses on interfacing with phone hardware, efficient computing on the phone and in the cloud using virtualized servers, and efficient analysis of the peripheral sensor streams of today's smartphones. Students integrate real-time control and/or automation using a third-party hardware platform to interface with the mobile platform.

CSE 7331 Introduction to Data Mining and Related Topics

Introduces data mining topics, with an emphasis on understanding concepts through an applied, hands-on approach. Includes other related topics such as data warehousing and dimensional modeling. All material covered is reinforced through hands-on implementation exercises.
Prerequisite: CSE 2341.

CSE 7337 Information Retrieval and Web Search

Introduces the field of information retrieval, with an emphasis on its application in Web search. Also introduces the basic concepts of stemming, tokenizing and inverted indices, text similarity metrics, and the vector-space model. Students study popular Web search engines and apply the concepts in several Java-based projects. *Prerequisite*: CSE 3353 or permission of instructor.

CSE 7347 XML and the Enterprise

XML, the Extensible Markup Language, is widely used to define vocabularies for a wide range of applications, including software configuration, data exchange, and Web-based protocols. This course provides a detailed examination of XML as an enterprise technology. Focuses on APIs, interfaces, and standards that are driving this technology, including DTDs and XML Schema to structure XML data, XSLT to transform XML, XML protocols for distributed computing, and XML security initiatives. Students gain a broad understanding of XML and the technical issues and trade-offs among different alternatives for processing XML. *Prerequisites*: An understanding of object-oriented concepts and familiarity with Java and/or C++.

CSE 8331 Advanced Data Mining

Examines advanced data mining topics, including temporal mining. Web mining, spatial mining and text mining. Case studies and projects. *Prerequisite*: CSE 7331.

CSE 8337 Information Storage and Retrieval

Examination of techniques used to store and retrieve unformatted/textual data. Examination of current research topics of data mining, data warehousing, digital libraries, hypertext, and multimedia data. *Prerequisite*: CSE 7330.

Security (two of the following)

CSE 7338 Security Economics

Introduces economics as a tool for understanding and managing information security. Reviews key information security challenges and technologies in order to reason about the topics economically. Students are introduced to techniques of analytic and empirical modeling. Economic concepts reviewed include rationality, markets, and information. Presents models and metrics of security investment, along with cost-benefit analysis techniques, and techniques for empirical investigation and measurement of cybercrime. Security games are designed to capture the strategic interaction between defenders, as well as between attacker and defenders. Implications for public policy are discussed.

CSE 7339 Computer System Security

Investigates a broad selection of contemporary issues in computer security, including an assessment of state-of-the-art technology used to address security problems. Includes sources for computer security threats and appropriate reactions, basic encryption and decryption, secure encryption systems, program security, trusted operating systems, database security, network and distributed systems security, administering security, and legal and ethical issues. *Prerequisite*: CSE 5343 or equivalent.

CSE 7349 Data and Network Security

Covers conventional and state-of-the-art methods for achieving data and network security. Private key and public key encryption approaches are discussed in detail, with coverage of popular algorithms such as DES, Blowfish, and RSA. In the network security area, the course covers authentication protocols, IP security, Web security, and system-level security. *Prerequisites*: CSE 7339 or equivalent, and instructor permission.

CSE 7359 Software Security

As software is delivered across network and Web-based environments, security is critical to successful software deployment. This course focuses on software security issues that pertain to the network application layer in the classic OSI model. At the application network layer, issues related to encryption, validation, and authentication are handled programmatically rather than at the network level. Students work with APIs for cryptography, digital signatures, and third-party certificate authorities. The course also explores issues related to XML and Web services security by examining standards and technologies for securing data and programs across collaborative networks. *Prerequisite*: C- or better in CSE 7339.

CSE 7369 Hardware Security and Trojan Detection

Introduces several contemporary topics in hardware security, with a particular emphasis on hardware Trojans. Other topics include physically unclonable functions, the problem of counterfeiting, security implications of design for testability in hardware, intellectual property protection, and secure coprocessors and smart cards.

CSE 8349 Advanced Network Security

In-depth analysis of secure networks and systems, security audit, intrusion detection and prevention, storage security, firewall configurations, security log analysis, DMZs, honeypots, malicious codes, and mobile and grid computing security. *Prerequisite*: CSE 7349.

CSE 8352 (EE 8372) Cryptography and Data Security

Cryptography is the study of mathematical systems for solving two kinds of security problems on public channels: privacy and authentication. Covers the theory and practice of both classical and modern cryptographic systems. The fundamental issues involved in the analysis and design of a modern cryptographic system will be identified or studied. *Prerequisite*: EE/STAT/CSE 4340 or equivalent.

CSE 8359 Advanced Software Security

Advanced software security architectural patterns, software reverse engineering, and malware analysis. Advanced software exploitation techniques including shell coding, return-oriented programming, ASLR, and DEP bypassing. Advanced Web application security and secure coding principles/practices. Security testing techniques, fuzzing, operating system security, and root kits. *Prerequisite*: CSE 5359, CSE 7359, or equivalent.