CS F101  Computers and Society
3 Credits
Computer literacy for everyone. Overview of computing machines and automatic data processing. Interaction between social institutions and automated decision-making. Introduction to business applications software and electronic mail. Some programming for understanding, not for skill development.
Prerequisites: Two years of high school mathematics, including at least one year of algebra.
Lecture + Lab + Other: 3 + 0 + 0

CS F102  Introduction to Computer Science
3 Credits
Introduction to computer science including a discussion of binary numbers, data representation, hardware, software, programming layers, operating systems, applications and networks. This web-based course is offered through eLearning & Distance Education.
Prerequisites: Two years of high school mathematics including at least one year of algebra.
Lecture + Lab + Other: 3 + 0 + 0

CS F103  Introduction to Computer Programming
3 Credits
Programming for non-majors and for those computer science students without the background for CS F201. Concepts of object-oriented programming and algorithm design within the syntax of the JAVA programming language.
Prerequisites: Math placement at the 100-level.
Lecture + Lab + Other: 3 + 0 + 0

CS F201  Computer Science I
3 Credits
The discipline of computer science including problem solving, algorithm development, structured programming, top-down design, good programming style, object-oriented programming and elementary data structures. Concepts implemented with extensive programming experience in a structured language and with a group programming project.
Prerequisites: One year high school level programming or CS F103; mathematics placement at the F200-level.
Lecture + Lab + Other: 3 + 0 + 0

CS F202  Computer Science II
3 Credits
The discipline of computer science including problem solving, algorithm development, structured programming, top-down design, good programming style, object-oriented programming and elementary data structures. Concepts implemented with extensive programming experience in a structured language and with a group programming project.
Prerequisites: CS F201.
Lecture + Lab + Other: 3 + 0 + 0

CS F205  C Programming
3 Credits
Offered As Demand Warrants
A high-level programming course using C for students with some experience in other programming languages such as Java, Perl, Basic, Pascal or Fortran.
Prerequisites: One year high school programming, CS F103 or CS F201 or ES F201.
Lecture + Lab + Other: 3 + 0 + 0

CS F301  Assembly Language Programming
3 Credits
Offered Fall
Organization of computer registers, I/O and control. Digital representation of data. Symbolic coding, instructions, addressing modes, program segmentation, linkage, macros and subroutines.
Prerequisites: CS F201.
Lecture + Lab + Other: 3 + 0 + 0

CS F307  Discrete Mathematics
3 Credits
Logic, counting, sets and functions, recurrence relations graphs and trees. Additional topics chosen from probability theory.
Prerequisites: MATH F252X; or permission of instructor.
Cross-listed with MATH F307.
Lecture + Lab + Other: 3 + 0 + 0

CS F311  Data Structures and Algorithms
3 Credits
Data structures and the algorithms for their manipulation. Object-oriented programming, arrays, tables, stacks, queues, trees, linked lists, sorting, searching and hashing.
Prerequisites: CS F202.
Lecture + Lab + Other: 3 + 0 + 0

CS F321  Operating Systems
3 Credits
Offered Spring
Functions of files and operating systems. Review of required architectural features. The PROCESS concept. Storage management, access methods and control, interrupt processing, scheduling algorithms, file organization and management, and resource accounting.
Prerequisites: CS F301.
Lecture + Lab + Other: 3 + 0 + 0

CS F331  Programming Languages
3 Credits
Offered Spring
Syntax and semantics of widely differing programming languages. Syntax specification, block structure, binding, data structures, operators and control structures. Comparison of several languages such as ALGOL, LISP, SNOBOL and APL.
Prerequisites: CS F311.
Lecture + Lab + Other: 3 + 0 + 0

CS F361  Systems Security and Administration
3 Credits
Offered Alternate Fall Odd-numbered Years
Advanced systems programming including privileged instructions and system services, authentication technologies, host-based and network-based security issues. Applications to asynchronous I/O, process control and communication, device drivers and file management.
Prerequisites: CS F301.
Lecture + Lab + Other: 3 + 0 + 0

CS F371  Computer Ethics and Technical Communication
3 Credits
Offered Fall
This course explores the social, legal and ethical issues aggravated, transformed or created by computer technology. Additional focus is on technical communication skills needed in the computer industry.
Prerequisites: ENGL F211X or ENGL F213X; COMM F131X or COMM F141X; CS F202.
Lecture + Lab + Other: 3 + 0 + 0
CS F372  Software Construction
3 Credits
Offered Spring
Methods for programming and construction of complete computer applications, including refactoring, performance measurement, process documentation, unit testing, version control, integrated development environments, debugging and debuggers, interpreting requirements, and design patterns.
Prerequisites: CS F311.
Lecture + Lab + Other: 3 + 0 + 0

CS F381  Computer Graphics
3 Credits
Offered Fall
Creation of computer-generated images on programmable 3-D graphics hardware. Color, lighting, textures, hidden surfaces, 3-D geometric transformations, curve and surface representations, 2-D and 3-D user interfaces, and the visual modeling of physical phenomena.
Prerequisites: CS F202; MATH F253X or MATH F314.
Lecture + Lab + Other: 3 + 0 + 0

CS F392  Seminar
1-6 Credits
Lecture + Lab + Other: 0 + 0 + 0

CS F405  Introduction to Artificial Intelligence
3 Credits
Offered Spring Even-numbered Years
Examine diverse branches of AI placing AI in larger context of computer science and software engineering. Knowledge representation formalism and search technology. Programming methodologies; procedural systems such as expert systems and blackboard systems and non-procedural systems such as neural networks. Software engineering aspects of problem selection, knowledge acquisition, verification and validation. Individual projects.
Prerequisites: CS F311 or permission of instructor.
Lecture + Lab + Other: 3 + 0 + 0

CS F411  Analysis of Algorithms
3 Credits
Offered Fall
Analysis of classic algorithms, their implementation and efficiency. Topics from combinatorics (sets, graphs), algebra (integer arithmetic, primes, polynomial arithmetic, GCD, Diophantine equations, encryption), systems (parsing searching, sorting) and theory (recursion, Turing machines). The complexity classes P, NP and NP complete.
Prerequisites: MATH F307, CS F311.
Lecture + Lab + Other: 3 + 0 + 0

CS F421  Distributed Operating Systems (W)
3 Credits
Offered Fall
Detailed level study of distributed operating system algorithms, functions and associated implementation. Distributed operating system tuning methods and security. Role of distributed operating systems in net-centric computing. Programming, documentation and evaluation of distributed operating system segments as projects.
Prerequisites: CS F321; ENGL F111X; ENGL F211X or ENGL F213X; or permission of instructor.
Lecture + Lab + Other: 3 + 0 + 0

CS F425  Database Systems
3 Credits
Offered Spring Odd-numbered Years
Data independence, modeling, relationships and organization. Hierarchical, network and relational data models; canonical schema. Data description languages, SQL, query facilities, functional dependencies, normalization, data integrity and reliability. Review of current database software packages.
Prerequisites: CS F311; CS F321.
Lecture + Lab + Other: 3 + 0 + 0

CS F431  Programming Language Implementation (W)
3 Credits
Offered As Demand Warrants
Design and implementation of major phases of high level language translators including scanning, parsing, translation, code generation and optimization. Students develop a compiler for a language in a group project which emphasizes good software engineering practices in structured design, testing and documentation.
Prerequisites: CS F331; ENGL F111X; ENGL F211X or ENGL F213X or permission of instructor.
Lecture + Lab + Other: 3 + 0 + 0

CS F441  System Architecture
3 Credits
Offered Fall
Computer design fundamentals, performance and cost, pipelining, instruction-level parallelism, memory hierarchy design, storage systems, and vector processing.
Prerequisites: CS F321; EE F341.
Lecture + Lab + Other: 3 + 0 + 0

CS F442  Computer Communication and Networks
3 Credits
Offered Fall Even-numbered Years
Study of computer networks using the ISO/OSI layered model as a framework. Design issues and trade-offs, protocols and selected standards. Emphasis on ISO/OSI Layers 1-4/(Physical, Data Link, Network and Transport Layers), plus medium access sublayers (LAN’s, etc.).
Prerequisites: CS F321.
Lecture + Lab + Other: 3 + 0 + 0

CS F451  Automata and Formal Languages
3 Credits
Offered Spring Odd-numbered Years
Finite automata, regular languages, phrase structured grammars, context free language, push down automata, deterministic context free languages, recursive and recursively enumerable languages, Turing machines, decision problems, and undecidability.
Prerequisites: MATH F307; CS F201.
Lecture + Lab + Other: 3 + 0 + 0

CS F460  Introduction to Digital Forensics
3 Credits
Offered Fall Odd-numbered Years
Takes a hands-on approach to the forensics examination of computer technology. Focuses on the forensic process, methods, and tools utilized to collect and preserve and examine digital evidence. Course topics include: collection, preservation and examination of evidence from computers including file systems, email and malicious code.
Prerequisites: CS F321; or permission of instructor.
Lecture + Lab + Other: 3 + 0 + 0
CS F462 Intrusion Detection Systems  
3 Credits  
Offered Fall Even-numbered Years  
Focus on IDS theory and practice and its importance; the origin and resolution of common security threats and vulnerabilities; host and network approaches to IDS implementation; and the legal, ethical, and privacy issues associated with IDS use and policies.  
**Prerequisites:** CS F361; or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

CS F463 Cryptography and Data Security  
3 Credits  
Offered Spring Odd-numbered Years  
Specialized study of cryptography and its application in securing data systems, with an emphasis on applied cryptography. Topics include history of cryptography, encryption, digital signatures, authentication, electronic commerce, key distribution and management, private and public key cryptography, and protocols.  
**Prerequisites:** MATH F307; CS F311; or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

CS F471 Senior Capstone I (W)  
3 Credits  
Offered Fall  
Introduction to basic software engineering principles, techniques, methods and standards as applied to the engineering of complex software systems. Topics from software system development process models, multiple view system modeling and specification using UML, classification of software systems, project management and legal issues.  
**Prerequisites:** Senior standing; CS F311; ENGL F314 or CS F371.  
Lecture + Lab + Other: 3 + 0 + 0

CS F472 Senior Capstone II (O, W)  
3 Credits  
Offered Spring  
Group projects in a real computer industry environment and produce appropriate documentation and reports. Nature, ethics, and legal considerations of the computer science profession are discussed with an emphasis on ethics. Additional topics include project management, design methodologies, technical presentation, human-machine interface and programming team interactions.  
**Prerequisites:** Senior standing; CS F471.  
Lecture + Lab + Other: 3 + 0 + 0

CS F480 Topics in Computer Science  
3 Credits  
Offered As Demand Warrants  
Topics include, but are not limited to; computational linear algebra, cryptography, parallel algorithm development and analysis. Note: Course may be repeated when topics change.  
Lecture + Lab + Other: 0 + 3 + 0

CS F481 Graphics Rendering  
3 Credits  
Offered Spring Even-numbered Years  
High-quality rendering techniques used in computer graphics: raytracing, shadows, antialiasing, volume rendering, radiometry and radiosity. Also topics such as particle systems, shading, image processing, computer aided design, video effects, animation and virtual environments.  
**Prerequisites:** CS F381.  
Lecture + Lab + Other: 3 + 0 + 0

CS F482 Simulations in Computer Graphics  
3 Credits  
Offered Spring Odd-numbered Years  
Software to simulate physical phenomena for use in interactive visualization, such as particle systems, Navier-Stokes fluid dynamics, and finite element solid mechanics. Includes Lagrangian and Eulerian meshes, stability, and discretization order. Our focus is high performance qualitatively correct simulations, rather than high-precision solutions.  
**Prerequisites:** CS F381 and PHYS F212X.  
Lecture + Lab + Other: 3 + 0 + 0

CS F490 Student Internship  
1-3 Credits  
Students work on computer science project under the joint direction of a faculty member and participating industry or governmental agency.  
**Prerequisites:** Junior standing and acceptance in an approved internship program.  
Lecture + Lab + Other: 0 + 0 + 0

CS F600 Professional Software Development  
4 Credits  
Offered Fall  
Participate in a group project to explore the technical, social and ethical aspects of software development. Topics include: requirements engineering, enterprise-level data storage, software architecture, security, software testing, legal issues, computer ethics, risk management and project management.  
**Prerequisites:** CS F472.  
Lecture + Lab + Other: 4 + 0 + 0

CS F601 Algorithms, Architecture and Languages  
4 Credits  
Offered Spring  
Current research on, and cross-cutting interrelationships between computer algorithms, machine architecture and languages. Covers asymptotic performance analysis including NP-completeness, modern parallel hardware including multicore, and grammars and parsing from regular expressions to BNF.  
**Prerequisites:** CS F331; CS F411; CS F441 or EE F443.  
Lecture + Lab + Other: 4 + 0 + 0

CS F602 Software Project Management  
3 Credits  
Offered Spring  
Work in an IT project environment to produce appropriate documentation and reports. Nature, ethics and legal considerations of managing IT projects are discussed. Includes project management, design methodologies, scope management, risk management, human-machine interface and IT team interactions.  
**Prerequisites:** Graduate standing or permission of instructor.  
Lecture + Lab + Other: 3 + 0 + 0

CS F605 Artificial Intelligence  
3 Credits  
Offered Spring Even-numbered Years  
**Prerequisites:** Graduate standing or permission of CS graduate advisor.  
Lecture + Lab + Other: 3 + 0 + 0
CS F611 Complexity of Algorithms
3 Credits
Offered Fall
Theoretical analysis of various algorithms: topics include sorting, searching, selection, polynomial evaluation, NP completeness, decidability.
Prerequisites: CS F411.
Lecture + Lab + Other: 3 + 0 + 0

CS F621 Advanced Systems Programming
3 Credits
Offered As Demand Warrants
Multiprogramming and multiprocessing systems. File and program security. Scheduling optimization and system tuning, I/O processing, archiving and system recovery, and initialization. Study of current systems.
Prerequisites: CS F311 and CS F321.
Lecture + Lab + Other: 3 + 0 + 0

CS F625 Database Systems Design
3 Credits
Offered Fall
The design and analysis of database systems including data independence, relationships, and organization. Focus on data models, file organization and security, index organization, data integrity and reliability. Review of current database software packages. Design and implementation of a database application project.
Prerequisites: CS F311.
Lecture + Lab + Other: 3 + 0 + 0

CS F631 Programming Language Implementation
3 Credits
Offered Fall
Formal treatment of programming language translation and compiler design. Parsing context-free languages, translation specifications, machine independent code, NBF, scanners, symbol tables, parsers and recursive descent. Programming of compiler or interpreter segments as projects.
Prerequisites: CS F331.
Lecture + Lab + Other: 3 + 0 + 0

CS F641 Advanced Systems Architecture
3 Credits
Offered Spring
A study of advanced single processor systems. Detailed study of multiprocessor architectures, such as vector architectures, massively parallel processors and shared-memory multi-processors.
Prerequisites: CS F441 or permission of Computer Science graduate advisor.
Lecture + Lab + Other: 3 + 0 + 0

CS F642 Advanced Computer Networks
3 Credits
Offered Fall
A study of networks of interacting computers. The problems, rationales and possible solutions for both distributed processing and distributed databases will be examined. Major national and international protocols will be presented.
Prerequisites: Graduate standing or permission of Computer Science graduate advisor.
Lecture + Lab + Other: 3 + 0 + 0

CS F651 The Theory of Computation
3 Credits
Offered Spring Odd-numbered Years
Languages and formal models of algorithms: Turing machines, phrase structured grammars and recursive functions. Undecidability, the halting problem, Rice's Theorem.
Prerequisites: CS F451.
Lecture + Lab + Other: 3 + 0 + 0

CS F661 Optimization
3 Credits
Offered Fall Even-numbered Years
Linear and nonlinear programming, simplex method, duality and dual simplex method, post-optimal analysis, constrained and unconstrained nonlinear programming, Kuhn-Tucker condition. Applications to management, physical and life sciences. Computational work with the computer.
Prerequisites: Knowledge of calculus, linear algebra, and computer programming.
Cross-listed with MATH F661.
Lecture + Lab + Other: 3 + 0 + 0

CS F670 Computer Science for Software Engineers
3 Credits
Offered Fall
An overview and survey of the theoretical underpinnings of computer science. Topics are taken from the areas of algorithms and data structures; computer architecture; computer networks, communications and operating systems; computability and formal languages; languages and compilation.
Prerequisites: Graduate standing.
Cross-listed with SWE F670.
Lecture + Lab + Other: 3 + 0 + 0

CS F671 Advanced Software Engineering
3 Credits
Offered Spring
Advanced software development as an engineering discipline. Includes investigation of current tools, standards, foundation and trends in software engineering from component-ware, software system composition, e-systems, software architecture and CASE tools.
Prerequisites: CS F471.
Cross-listed with SWE F671.
Lecture + Lab + Other: 3 + 0 + 0

CS F672 Software Process Improvement
3 Credits
Offered Spring Odd-numbered Years
Commonly applied methods for improving the software development process. Emphasis on the Software Engineering Institute's Capability Maturity Model, and specifically on the key process areas of Level 2 and Level 3 of that model. These include software configuration management, software quality assurance and software standards.
Prerequisites: CS F671 or permission of instructor.
Cross-listed with SWE F672.
Lecture + Lab + Other: 3 + 0 + 0
**CS F673   Software Requirements Engineering**
3 Credits
Offered As Demand Warrants
Focus on the requirements analysis phase of the software development life cycle. Study ways to obtain, analyze and specify complete and correct sets of requirements. Critique of selected requirements analysis models. Study of current large scale software developments that have failed or are failing. Development of software requirements specifications for large and real software systems via team efforts.
Prerequisites: CS F671 or permission of instructor.
Cross-listed with SWE F673.
Lecture + Lab + Other: 3 + 0 + 0

**CS F674   Software Architecture**
3 Credits
Offered Spring
Software architectural styles are introduced and defined as structural descriptions of software systems. Methods for constructing and binding software systems are introduced and specified as operational views. The architectural approach, as a classical engineering method for describing structure and behavior of technical artifacts, will be applied for the composition of software systems.
Prerequisites: CS F671.
Cross-listed with SWE F674.
Lecture + Lab + Other: 3 + 0 + 0

**CS F680   Topics in Computer Science**
1-4 Credits
Offered As Demand Warrants
Example topics include, but are not limited to, software requirements engineering, cryptography, parallel algorithm development and analysis. May be repeated for credit with change of topic.
Prerequisites: Varies with each topic.
Recommended: Varies with each topic.
Lecture + Lab + Other: 1-4 + 0 + 0

**CS F681   Topics in Computer Graphics**
3 Credits
Offered Spring
Hardware, software and techniques used in computer graphics taken from topics such as refresh, storage, raster scan technology, volume rendering, particle systems, shading, image processing, computer aided design, video effects, animation and virtual environments.
Prerequisites: CS F481 and MATH F314.
Lecture + Lab + Other: 3 + 0 + 0

**CS F690   Graduate Seminar and Project**
1-6 Credits
Offered Fall
First semester of a two-semester seminar in which students will, individually or in teams, work on and present the results of major programming or literature survey projects in computer science or software engineering. Written and oral reports will be required.
Prerequisites: 12 credits in graduate computer science or software engineering courses; or permission of Computer Science or Software Engineering graduate advisor.
Cross-listed with SWE F691.
Lecture + Lab + Other: 1-6 + 0 + 0

**CS F691   Graduate Seminar and Project**
3 Credits
Offered Spring
Second semester of a two-semester seminar in which students will, individually or in teams, work on and present the results of major programming or literature survey projects in computer science or software engineering. Written and oral reports will be required.
Prerequisites: CS F690; 12 credits in graduate computer science or software engineering courses; or permission of Computer Science or Software Engineering graduate advisor.
Cross-listed with SWE F691.
Lecture + Lab + Other: 3 + 0 + 0

**CS F692   Seminar**
1-6 Credits
Lecture + Lab + Other: 1-6 + 0 + 0

**CS F698   Non-Thesis Research/Project**
1-9 Credits
Lecture + Lab + Other: 0 + 0 + 0

**CS F699   Thesis**
1-9 Credits
Lecture + Lab + Other: 0 + 0 + 0