Computer Science (CS)

Courses

CS 102. Fundamentals of Computer and Information Security. 4 Credits.
This course introduces fundamental concepts, terminologies, principles, methods, and scenarios of computer and information security.
Additional Information:
Science Area

CS 109. Introduction to Artificial Intelligence. 4 Credits.
Students in any major will learn how modern artificial intelligence (AI) systems works and how they can be employed responsibly and effectively. No programming or advanced mathematics is required.
Additional Information:
Science Area

CS 110. Introduction to Computing with AI. 4 Credits.
CS 110 is an introduction to computing with AI. The course teaches fundamentals about the landscape of computing and how to leverage this landscape to solve problems by using AI-based coding. Students develop computational thinking skills—approaches to problem-solving that draw on concepts fundamental to computing. The course is designed for students from all majors and backgrounds, and will foster skills to apply computational thinking in their own fields of study.
Additional Information:
Science Area

CS 111. Introduction to Web Programming. 4 Credits.
Project-based approach to learning computer programming by building interactive web pages using JavaScript and HTML. Programming concepts including structured and object-oriented program design. CS 110 recommended preparation.
Requisites: Prereq: MATH 101 or equivalent.
Additional Information:
Science Area
BS Math

CS 122. Introduction to Programming and Problem Solving. 4 Credits.
Computational problem solving, algorithm design, data structures, and programming using a multi-paradigm programming language. Introduces techniques for program design, testing, and debugging.
Requisites: Prereq: MATH 101 or equivalent.
Additional Information:
Science Area
BS Math

CS 196. Field Studies: [Topic]. 1-2 Credits.
A series of practical experiences on or off campus to understand principles or develop skills in performing selected tasks.
Repeatable 99 times

CS 198. Workshop: [Topic]. 1-2 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

CS 199. Special Studies: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

CS 199L. Special Studies in Computer Science: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

CS 210. Computer Science I. 4 Credits.
Basic concepts and practices of computer science. Topics include algorithmic problem solving, levels of abstraction, object-oriented design and programming, software organization, analysis of algorithm and data structures. Sequence with CS 211, CS 212.
Requisites: Prereq: MATH 112Z. Prior programming experience strongly encouraged.
Additional Information:
Science Area
BS Math

CS 211. Computer Science II. 4 Credits.
Basic concepts and practices of computer science. Topics include algorithmic problem solving, levels of abstraction, object-oriented design and programming, software organization, analysis of algorithm and data structures. Sequence with CS 210, CS 212.
Requisites: Prereq: CS 210.
Additional Information:
Science Area
BS Math

CS 212. Computer Science III. 4 Credits.
Basic concepts and practices of computer science. Topics include algorithmic problem solving, levels of abstraction, object-oriented design and programming, software organization, analysis of algorithm and data structures. Sequence with CS 210, CS 211.
Requisites: Prereq: CS 211.
Additional Information:
Science Area
BS Math

CS 299. Special Studies: [Topic]. 1-5 Credits.
Repeatable.
Repeatable 99 times

CS 313. Intermediate Data Structures. 4 Credits.
Design and analysis of data structures as means of engineering efficient software; attention to data abstraction and encapsulation. Lists, trees, heaps, stacks, queues, dictionaries, priority queues.
Requisites: Prereq: CS 210, CS 211, CS 212, MATH 231, MATH 232 with grades of B- or better.

CS 314. Computer Organization. 4 Credits.
Introduction to computer organization and instruction-set architecture -- digital logic design, binary arithmetic, design of central processing unit and memory, machine-level programming.
Requisites: Prereq: CS 210, CS 211, CS 212 with grades of B- or better.

CS 315. Intermediate Algorithms. 4 Credits.
Algorithm design, worst-case and average-behavior analysis, correctness, computational complexity.
Requisites: Prereq: CS 313.

CS 322. Introduction to Software Engineering. 4 Credits.
A project-intensive introduction to software engineering intended to build skills, knowledge, and habits of mind that prepare students for 400-level computer science courses, internships, and other software.
Requisites: Prereq: CS 210, CS 211, CS 212 with grades of B- or better.

CS 330. C/C++ and Unix. 4 Credits.
Practical software design and programming activities in a C/C++ and Unix environment, with emphasis on the details of C/C++ and good programming style and practices.
Requisites: Prereq: CS 314.

CS 332. System and Security Administration Lab. 4 Credits.
This lab course is designed to help students develop hands-on skills in system and security administration, based on the following relevant Cyber Defense knowledge units defined by the National Security Agency (NSA) National Centers of Academic Excellence in Cybersecurity (NCAE-C): Operating System Administration (OSA), which provides students with skill to perform basic operations involved in system administration of operating systems; and Operating Systems Hardening (OSH), which provides students with the ability to apply methods such as managing applications, services, and network ports to improve the security and robustness of operating systems.
Requisites: Prereq: CS 330.

CS 333. Applied Cryptography. 4 Credits.
This course provides a systematic study of cryptography and its application. It covers cryptographic algorithms, including symmetric-key cryptography, public-key cryptography, cryptanalysis, cryptographic hash functions, and their usage toward message authentication codes, digital signatures, key management and distribution, and user authentication protocols.
Requisites: Prereq: CS 212.

CS 372M. Machine Learning for Data Science. 4 Credits.
Introduction to Machine Learning, with an emphasis on topics relevant for data science. Multilisted with DSCI 372M.
Requisites: Prereq: CS 212; DSCI 345M or MATH 345M; MATH 342.
Equivalent to: DSCI 372M

CS 399. Special Studies: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times when topic changes

CS 401. Research: [Topic]. 1-16 Credits.
Disciplined inquiry of a topic with varying techniques and assignments suited to the nature and conditions of the problem being investigated. Often pursued in relation to a dissertation or thesis.
Requisites: Prereq: CS 313.
Repeatable 99 times

CS 402. Supervised College Teaching. 1-2 Credits.
A student, under faculty supervision and sponsorship, accepts responsibility for teaching a university course.
Requisites: Prereq: CS 313.
Repeatable 99 times

CS 403. Thesis. 1-12 Credits.
A written document resulting from study or research and submitted as a major requirement for a degree.
Requisites: Prereq: CS 313.
Repeatable 99 times

CS 404. Internship: [Topic]. 1-4 Credits.
Professional practice in an organization that integrates concepts studied at the university with career-related work experience.
Requisites: Prereq: CS 313.
Repeatable 99 times

CS 405. Reading and Conference: [Topic]. 1-12 Credits.
A particular selection of material read by a student and discussed in conference with a faculty member.
Requisites: Prereq: CS 313.
Repeatable 5 times

CS 406. Practicum: [Topic]. 1-2 Credits.
Supervised consulting. Students provide learning assistance in computer science courses.
Requisites: Prereq: CS 313.
Repeatable 3 times for a maximum of 4 credits

CS 407. Seminar: [Topic]. 1-5 Credits.
Opportunity to study in greater depth specific topics arising out of other courses.
Requisites: Prereq: CS 313.
Repeatable 99 times when topic changes

CS 408. Workshop: [Topic]. 1-21 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Requisites: Prereq: CS 313.
Repeatable 99 times

CS 409. Terminal Project. 1-12 Credits.
A presentation incorporating the knowledge and skills acquired from course work completed for a degree.
Requisites: Prereq: CS 313.
Repeatable 99 times

CS 410. Experimental Course: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times when topic changes

CS 413. Advanced Data Structures. 4 Credits.
Complex structures, storage management, sorting and searching, hashing, storage of texts, and information compression.
Requisites: Prereq: CS 315.

CS 415. Operating Systems. 4 Credits.
Principles of operating system design. Process and memory management, concurrency, scheduling, input-output and file systems, security.
Requisites: Prereq: CS 330.

CS 420. Automata Theory. 4 Credits.
Provides a mathematical basis for computability and complexity. Models of computation, formal languages, Turing machines, solvability. Nondeterminism and complexity classes.
Requisites: Prereq: CS 315.

CS 422. Software Methodology I. 4 Credits.
Technical and nontechnical aspects of software development, including specification, planning, design, development, management and maintenance of software projects. Student teams complete projects.
Requisites: Prereq: CS 313.

CS 423. Software Methodology II. 4 Credits.
Application of concepts and methodologies covered in CS 422. Student teams complete a large system design and programming project. Final system specification, test plan, user documentation, and system walk throughs.
Requisites: Prereq: CS 422 with a grade of B- or better.

CS 425. Principles of Programming Languages. 4 Credits.
Syntax and semantics. Scope rules, environments, stores, denoted and expressed values, procedures, and parameters. Definitional interpreters. Types, overloading, parametric polymorphism, and inheritance. Varieties of abstraction.
Requisites: Prereq: CS 315.

CS 429. Computer Architecture. 4 Credits.
RISC (reduced instruction-set computer) and CISC (complex instruction-set computer) design, storage hierarchies, high-performance processor design, pipelining, vector processing, networks, performance analysis.
Requisites: Prereq: CS 313, CS 314, CS 330.

CS 431. Introduction to Parallel Computing. 4 Credits.
Parallel architecture, theory, algorithms, and programming with emphasis on parallel programming, focusing on models, languages, libraries, and runtime systems.
Requisites: Prereq: CS 330.

CS 432. Introduction to Networks. 4 Credits.
Principles of computer network design. Link technologies, packet switching, routing, inter-networking, reliability. Internet protocols. Programming assignments focus on protocol design.
Requisites: Prereq: CS 330. CS 415 recommended.

CS 433. Computer and Network Security. 4 Credits.
Security for various aspects of computers and networks. Elementary cryptography, program security, trusted operating systems, network security, privacy, and legal and ethical issues.
Requisites: Prereq: CS 415.

CS 434. Computer and Network Security II. 4 Credits.
This course covers security threats and solutions for distributed systems and networks, particularly the Internet, the Internet of Things, and distributed systems based on them.
Requisites: Prereq: CS 433.

CS 436. Secure Software Development. 4 Credits.
This course establishes a foundation for applying security principles to the lifecycle of software development in order to minimize software vulnerabilities and counter cyber threats.
Requisites: Prereq: CS 330.

CS 437. Computer and Network Security Practicum. 4 Credits.
This course is designed to help students solidify knowledge and develop hands-on skills in computer network security. Students will practice various attack and defense techniques. Specifically, we will systematically study each layer of the Internet, discuss the design and implementation vulnerabilities at each layer, and demonstrate how attacks may exploit the vulnerabilities. This course will cover many classic attacks in great technical detail in addition to high-level concepts and theories, to help students deeply understand why and how each attack works. We'll also discuss how each attack may be handled, and students will learn defense techniques such as firewalls, etc.
Requisites: Prereq: CS 433.

CS 441. Introduction to Computer Graphics. 4 Credits.
Introduction to the hardware, geometrical transforms, interaction techniques, and shape representation schemes that are important in interactive computer graphics. Programming assignments using contemporary graphics hardware and software systems.
Requisites: Prereq: CS 330.

CS 443. User Interfaces. 4 Credits.
Introduction to user interface software engineering. Emphasis on theory of interface design, understanding the behavior of the user, and implementing programs on advanced systems.
Requisites: Prereq: CS 313.

CS 445. Modeling and Simulation. 4 Credits.
Theoretical foundations and practical problems for the modeling and computer simulation of discrete and continuous systems. Simulation languages, empirical validation, applications in computer science.
Requisites: Prereq: CS 315, CS 330.

CS 451. Database Processing. 4 Credits.
Fundamental concepts of DBMS. Data modeling, relational models and normal forms. File organization and index structures. SQL, embedded SQL, and concurrency control. Students cannot receive credit for both CS 451 and DSCI 431.
Requisites: Prereq: CS 313, CS 314.
Equivalent to: DSCI 431

CS 453. Data Mining. 4 Credits.
Databases, machine learning, artificial intelligence, statistics, and data visualization. Examines data warehouses, data preprocessing, association and classification rule mining, and cluster analysis. Students cannot receive credit for both CS 453 and DSCI 435.
Requisites: Prereq: CS 451.
Equivalent to: DSCI 435

CS 461. Introduction to Compilers. 4 Credits.
Lexical analysis, parsing, attribution, code generation.
Requisites: Prereq: CS 314, CS 425. CS 420 strongly recommended.

CS 471. Introduction to Artificial Intelligence. 4 Credits.
Basic themes, issues, and techniques of artificial intelligence, including agent architecture, knowledge representation and reasoning, problem solving and planning, game playing, and learning.
Requisites: Prereq: CS 315.

CS 472. Machine Learning. 4 Credits.
A broad introduction to machine learning and its established algorithms. Topics include concept learning, decision trees, neural network.
Requisites: Prereq: CS 315.

CS 473. Probabilistic Methods for Artificial Intelligence. 4 Credits.
Fundamental techniques for representing problems as probability distributions, performing inference, and learning from data. Topics include Bayesian and Markov networks, variable elimination, loopy belief propagation, and parameter.
Requisites: Prereq: CS 315.

CS 480. Game Programming. 4 Credits.
Introduction to theory topics related to game programming, including linear algebra, 3D graphics, lighting, audio, physics, and artificial intelligence. This course provides an opportunity to build games using a commercial game engine, reinforced by best practices in terms of implementation and project management.
Requisites: Prereq: CS 313, CS 314. MATH 341 recommended.

CS 503. Thesis. 1-16 Credits.
A written document resulting from study or research and submitted as a major requirement for a degree.
Repeatable 99 times

CS 507. Seminar: [Topic]. 1-5 Credits.
Opportunity to study in greater depth specific topics arising out of other courses.
Repeatable 99 times when topic changes

CS 508. Workshop: [Topic]. 1-21 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

CS 510. Experimental Course: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

CS 513. Advanced Data Structures. 4 Credits.
Complex structures, storage management, sorting and searching, hashing, storage of texts, and information compression.

CS 520. Automata Theory. 4 Credits.
Provides a mathematical basis for computability and complexity. Models of computation, formal languages, Turing machines, solvability. Nondeterminism and complexity classes.

CS 522. Software Methodology I. 4 Credits.
Technical and nontechnical aspects of software development, including specification, planning, design, development, management and maintenance of software projects. Student teams complete projects.

CS 523. Software Methodology II. 4 Credits.
Student teams complete a large system design and programming project. Final system specifications, test plan, user documentation, and system walk-through.
Requisites: Prereq: CS 522.

CS 529. Computer Architecture. 4 Credits.
RISC (reduced instruction-set computer) and CISC (complex instruction-set computer) design, storage hierarchies, high-performance processor design, pipelining, vector processing, networks, performance analysis.

CS 531. Introduction to Parallel Computing. 4 Credits.
Parallel architecture, theory, algorithms, and programming with emphasis on parallel programming, focusing on models, languages, libraries, and runtime systems.

CS 532. Introduction to Networks. 4 Credits.
Principles of computer network design. Link technologies, packet switching, routing, inter-networking, reliability. Internet protocols. Programming assignments focus on protocol design.

CS 533. Computer and Network Security. 4 Credits.
Security for various aspects of computers and networks. Elementary cryptography,program security, trusted operating systems, network security, privacy, and legal and ethical issues.

CS 534. Computer and Network Security II. 4 Credits.
This course covers security threats and solutions for distributed systems and networks, particularly the Internet, the Internet of Things, and distributed systems based on them.
Requisites: Prereq: CS 532, CS 533.

CS 536. Secure Software Development. 4 Credits.
This course establishes a foundation for applying security principles to the lifecycle of software development in order to minimize software vulnerabilities and counter cyber threats.

CS 537. Computer and Network Security Practicum. 4 Credits.
This course is designed to help students solidify knowledge and develop hands-on skills in computer network security. Students will practice various attack and defense techniques. Specifically, we will systematically study each layer of the Internet, discuss the design and implementation vulnerabilities at each layer, and demonstrate how attacks may exploit the vulnerabilities. This course will cover many classic attacks in great technical detail in addition to high-level concepts and theories, to help students deeply understand why and how each attack works. We'll also discuss how each attack may be handled, and students will learn defense techniques such as firewalls, etc.

CS 541. Introduction to Computer Graphics. 4 Credits.
Introduction to the hardware, geometrical transforms, interaction techniques, and shape representation schemes that are important in interactive computer graphics. Programming assignments using contemporary graphics hardware and software systems.

CS 543. User Interfaces. 4 Credits.
Introduction to user interface software engineering. Emphasis on theory of interface design, understanding the behavior of the user, and implementing programs on advanced systems.

CS 545. Modeling and Simulation. 4 Credits.
Theoretical foundations and practical problems for the modeling and computer simulation of discrete and continuous systems. Simulation languages, empirical validation, applications in computer science.

CS 551. Database Processing. 4 Credits.
Fundamental concepts of DBMS. Data modeling, relational models and normal forms. File organization and index structures. SQL, embedded SQL, and concurrency control. Students cannot receive credit for both CS 551 and DSCI 531.

CS 553. Data Mining. 4 Credits.
Databases, machine learning, artificial intelligence, statistics, and data visualization. Examines data warehouses, data preprocessing, association and classification rule mining, and cluster analysis. Students cannot receive credit for both CS 553 and DSCI 535.
Requisites: Prereq: CS 551.
Equivalent to: DSCI 535

CS 561. Introduction to Compilers. 4 Credits.
Lexical analysis, parsing, attribution, code generation.
Requisites: Prereq: CS 520 strongly recommended.

CS 571. Introduction to Artificial Intelligence. 4 Credits.
Basic themes, issues, and techniques of artificial intelligence, including agent architecture, knowledge representation and reasoning, problem solving and planning, game playing, and learning.

CS 572. Machine Learning. 4 Credits.
A broad introduction to machine learning and its established algorithms. Topics include concept learning, decision trees, neural network.

CS 573. Probabilistic Methods for Artificial Intelligence. 4 Credits.
Fundamental techniques for representing problems as probability distributions, performing inference, and learning from data. Topics include Bayesian and Markov networks, variable elimination, loopy belief propagation, and parameter.

CS 580. Game Programming. 4 Credits.
Introduction to theory topics related to game programming, including linear algebra, 3D graphics, lighting, audio, physics, and artificial intelligence. This course provides an opportunity to build games using a commercial game engine, reinforced by best practices in terms of implementation and project management.

CS 601. Research: [Topic]. 1-16 Credits.
Disciplined inquiry of a topic with varying techniques and assignments suited to the nature and conditions of the problem being investigated. Often pursued in relation to a dissertation or thesis.
Repeatable 99 times

CS 603. Dissertation. 1-16 Credits.
A written document resulting from study or research and submitted as a major requirement for a degree.
Repeatable 99 times

CS 604. Internship: [Topic]. 1-4 Credits.
Professional practice in an organization that integrates concepts studied at the university with career-related work experience.
Repeatable 99 times

CS 605. Reading and Conference: [Topic]. 1-16 Credits.
A particular selection of material read by a student and discussed in conference with a faculty member.
Repeatable 99 times

CS 606. Field Studies: [Topic]. 1-16 Credits.
A series of practical experiences on or off campus to understand principles or develop skills in performing selected tasks.
Repeatable 99 times

CS 607. Seminar: [Topic]. 1-5 Credits.
Research topics are presented.
Repeatable 99 times

CS 608. Workshop: [Topic]. 1-16 Credits.
An intensive experience, limited in scope and time, in which a group of students focus on skills development rather than content mastery.
Repeatable 99 times

CS 609. Terminal Project. 1-16 Credits.
Final project for master's degree without thesis.
Repeatable 99 times

CS 610. Experimental Course: [Topic]. 1-5 Credits.
Experimental course - topic varies.
Repeatable 99 times

CS 621. Algorithms and Complexity. 4 Credits.
Design and analysis of algorithms, strategies for efficient algorithms, introduction to complexity theory including NP-completeness.
Requisites: Prereq: CS 520 recommended.

CS 630. Distributed Systems. 4 Credits.
Principles of distributed computer systems: interprocess communication, distributed file systems, distributed timing and synchronization, distributed programming, transactions, process scheduling, distributed shared memory.
Requisites: Prereq: CS 529.

CS 631. Advanced Parallel Computing. 4 Credits.
Advanced topics in parallel processing including massively parallel computer architecture, supercomputers, parallelizing compiler technology, performance evaluation, parallel programming languages, parallel applications.
Requisites: Prereq: CS 529.

CS 633. Advanced Network Security. 4 Credits.
Classic and state-of-the-art research topics in network security; threats and attacks, defense algorithms and mechanisms, measurement and evaluation of both security problems and solutions. Offered alternate years.
Requisites: Prereq: CS 533.

CS 640. Writing in Computer Research. 2 Credits.
Students learn to provide and accept constructive criticism of writing samples in a workshop format.

CS 670. Data Science. 4 Credits.
Data science is the development of methods to study large and complex data sets. Methods that scale to very large data sets are of particular interest. This course introduces state-of-art data science methods focused on processing very large data sets of real-world data.
Requisites: Prereq: CS 551.