CS-Computer Science Courses

Courses

CS 102. Principles of Computer Science. 3 Hours.
This is an introductory course for non-CS majors to learn the fundamental concepts and topics of Computer Science (CS), and how CS is now impacting and changing every person's way of life. Students will explore the use of block-based and/or text-based programming languages to form computational solutions to problems. The main topics covered include program design, software development, abstract thinking, information analysis, the Internet, algorithmic methodology. The course will also discuss other topics including (but not limited to) modeling real-life phenomena, computing as a creative activity, social uses and abuses of information, and the foundations of cybersecurity. This course has a laboratory component.
Prerequisites: MA 102 [Min Grade: C] or MA 105 [Min Grade: C] or MA 106 [Min Grade: C] or MA 107 [Min Grade: C] or MA 125 [Min Grade: C] or MA 126 [Min Grade: C] or MA 225 [Min Grade: C] or MA 227 [Min Grade: C]

CS 102L. Principles of Computer Science Lab. 0 Hours.
Laboratory to accompany CS102.

CS 103. Introduction to Computer Science in Python. 4 Hours.
An introduction to computation and computational thinking, explored through programming in Python. Python is a scripting programming language that encourages exploration and quick development. This course assumes no prior programming experience and is appropriate for students in any discipline, such as linguistics, biology, business, and art. The student will leave the course with the ability to write clear and well-designed programs that solve interesting problems, and an appreciation of the power and beauty of computation. Strings, tuples, lists, dictionaries; branching, iteration, abstraction through functions, recursion, higher order programming; insertion sort, binary search, turtle graphics, binary numbers, introduction to classes. Principles of software development are emphasized, including specification, documentation, testing, debugging, exception handling. This course has a laboratory component.
Prerequisites: MA 106 [Min Grade: C] or MA 107 [Min Grade: C] or MA 125 [Min Grade: C] or MA 126 [Min Grade: C] or MA 225 [Min Grade: C] or MA 227 [Min Grade: C] or MA 226 [Min Grade: C]

CS 103L. Introduction to Computer Science in Python Lab. 0 Hours.
Laboratory to accompany CS103.

CS 104. Data Science for All. 4 Hours.
Spurred by the recent proliferation of large datasets and the maturation of techniques such as machine learning, data science is revolutionizing modern computer science in the twenty-first century. In this introductory course, students will develop an understanding of the modern use of computer science to analyze data, to make predictions from large datasets, to cluster and classify data, to analyze the reliability of conclusions drawn from data, and to communicate data visually. Empirical analysis includes datasets from areas including economics, medicine, and geography. The course introduces Python to explore and analyze data in code (no previous experience with Python is necessary). Computational tools covered include sequences, tables, data visualization, randomness, basic probability, basic statistics, hypothesis testing, estimation, prediction, inference, and linear regression. This course meets Blazer Core Curriculum Scientific Inquiry.
Prerequisites: MA 102 [Min Grade: C] or MA 105 [Min Grade: C] or MA 106 [Min Grade: C] or MA 107 [Min Grade: C] or MA 125 [Min Grade: C] or MA 225 [Min Grade: C]

CS 104L. Data Science for All Laboratory. 0 Hours.
Laboratory to accompany CS104.

CS 130. Introduction to Cyber Security. 3 Hours.
This course introduces students to the rapidly evolving and critical international arenas of privacy, information security, and critical infrastructure, and is designed to develop knowledge and skills for security of information and information systems at both individual and organizational levels. Stakeholders of information security and privacy. Framework of information security and privacy. Nature of common information hazards. Common cyber attacks and counter-measures. Operation and limitations of information and system safeguards. Ethics, privacy, policy and information decisions. Legal aspects, professional practices, and standards for information security and privacy. Security of national critical infrastructures.

CS 131. Safe and Effective Digital Life. 3 Hours.
This course introduces students to safe and effective use of digital technologies in students' academic studies and everyday lives. Students will learn various fundamental concepts and techniques that help them navigate cyberspace in a secure and productive manner. Topics include types of digital technology platforms, learning management systems, mobile technology and apps, financial applications, communication technology, security and privacy, cyber fraud and cyber crime, digital health, and effective information search and organization techniques.

CS 198. Selected Topics in Computer Science. 3 Hours.
Selected topics in computer science. This course does not have a laboratory component.

CS 199. Special Topics in Computer Science. 3 Hours.
Selected topics in computer science. This course has a laboratory component.

CS 199L. Special Topics Lab. 0 Hours.
Project oriented hands-on approach lab. Mandatory first day of attendance.

CS 203. Object-Oriented Programming in Java. 4 Hours.
A second course in computational thinking, through the lens of object oriented programming. Fundamental concepts of object oriented programming and basic data structures. Types, classes, objects, inheritance, containers, OO software design, program structure and organization, reflection, generic programming. Lists, trees, stacks, queues, heaps, search trees, hash tables, graphs, complexity analysis. This course has a laboratory component.
Prerequisites: CS 103 [Min Grade: C]

CS 203L. Object-Oriented Programming Lab. 0 Hours.
Laboratory to accompany CS203.

CS 221. Web Development. 3 Hours.
Fundamental concepts of web development. Client side application development using web languages and technologies. Client-server communication. Responsive design. User interaction models. Server-side development. This course has a laboratory component.

CS 221L. Web Development Laboratory. 0 Hours.
Laboratory to accompany CS 221.

CS 250. Discrete Structures. 3 Hours.
Discrete mathematics for computer science, including elementary propositional and predicate logic, sets, relations, functions, counting, elementary graph theory, proof techniques including proof by induction, proof by contradiction, and proof by construction.
Prerequisites: CS 103 [Min Grade: C] and (MA 106 [Min Grade: C] or MA 107 [Min Grade: C] or MA 125 [Min Grade: C] or MA 225 [Min Grade: C] or MA 226 [Min Grade: C] or MA 126 [Min Grade: C] or MA 227 [Min Grade: C])

CS 300. Advanced Object-Oriented Programming in C++. 3 Hours.
Object-oriented programming concepts in C++ including templates, multiple inheritance, const correctness. Types, streams, containers, references, pointers, iterators, operator overloading, evolution of C++ in C++11/14/17/20, using the Standard Template Library (STL). Current techniques and tools for software development in C++: unit testing, compilation, version control using git, linters.
Prerequisites: CS 203 [Min Grade: C]

CS 300L. Advanced Object-Oriented Programming in C++ Lab. 0 Hours.
Laboratory to accompany CS300.

CS 303. Algorithms and Data Structures. 3 Hours.
Techniques for design and analysis of algorithms; efficient algorithms for sorting, searching, graphs, and string matching; and design techniques such as divide-and-conquer, recursive backtracking, dynamic programming, and greedy algorithms.
Prerequisites: CS 250 [Min Grade: C] and CS 203 [Min Grade: C]

CS 303L. Algorithms and Data Structures Laboratory. 0 Hours.
Project oriented hands-on approach to accompany CS 303.

CS 330. Computer Organization and Assembly Language Programming. 3 Hours.
Register-level architecture of modern digital computer systems, digital logic, machine-level representation of data, assembly-level machine organization, and alternative architectures. Laboratory emphasizes machine instruction execution, addressing techniques, program segmentation and linkage, macro definition and generation, and computer solution of problems in assembly language.
Prerequisites: CS 250 [Min Grade: C] and CS 203 [Min Grade: C]

CS 330L. Computer Organization and Assembly Language Programming Lab. 0 Hours.
Laboratory to accompany CS330.

CS 332. Systems Programming. 3 Hours.
Unix architecture and internals with an emphasis on Linux, shell scripting, distributions of Linux for various computing platforms including large and desktop computers, and embedded computing devices, introduction to the C programming language, systems programming in C covering signals and process control, networking, I/O, concurrency and synchronization, memory allocation, threads, debugging, library development and usage.
Prerequisites: CS 203 [Min Grade: C] and CS 250 [Min Grade: C]

CS 332L. Systems Programming Laboratory. 0 Hours.
Laboratory to accompany CS332.

CS 334. Networking. 3 Hours.
Underlying network technology, including IEEE 802.11. Interconnecting networks using bridges and routers. IP addresses and datagram formats. Static and dynamic routing algorithms. Control messages. Subnet and supernet extensions. UDP and TCP. File transfer protocols. E-mail and the World Wide Web. Network address translation and firewalls. Mandatory weekly Linux-based lab.
Prerequisites: CS 250 [Min Grade: C] and CS 203 [Min Grade: C]

CS 334L. Networking Lab. 0 Hours.
Project oriented hands-on approach to accompany CS 334. Mandatory first day of class.

CS 350. Automata and Formal Languages. 3 Hours.
Finite-state automata and regular expressions, context-free grammars and pushdown automata, Turing machines, NP-completeness, Halting Problem.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 355. Probability and Statistics in Computer Science. 3 Hours.
Introduction to probability and statistics with applications in computer science. Counting, permutations and combinations. Probability, conditional probability, Bayes theorem. Standard probability distributions. Measures of central tendency and dispersion. Central Limit Theorem. Hypothesis testing. Random number generation. Random algorithms. Estimating probabilities by simulation.
Prerequisites: CS 250 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C]) and CS 203 [Min Grade: C]

CS 380. Matrix Computation. 3 Hours.
Matrix computation is the foundation of data science, of many key areas of computer science (machine learning, computer graphics, computer vision, high performance computing), and of companies like Google. The main object of study in this course is the matrix, including matrix computation (matrix multiplication, null space, solution of linear systems, least squares) and applications (e.g., image filtering, face detection, compression).
Prerequisites: CS 203 [Min Grade: C] and CS 250 [Min Grade: C]

CS 391. Special Topics. 3 Hours.
Selected Topics in Computer Science.

CS 392. Special Topics. 3 Hours.
Selected Topics in Computer Science.

CS 398. Undergraduate Honors Research. 1-3 Hour.
Research project under supervision of faculty sponsor. Prerequisite: 18 semester hours in Computer Science with grade point average of 3.5 in Computer Science and permission of instructor.

CS 399. Directed Readings. 1-3 Hour.
Selected readings, research and project development under the direction of a faculty member. Permission of instructor.
Prerequisites: CS 203 [Min Grade: D] and CS 250 [Min Grade: D]

CS 401. Programming Paradigms. 3 Hours.
The course will introduce students to major programming paradigms, such as functional programming and logic programming, and their realization in programming languages. Students will solve problems using different paradigms and study the impact on program design and implementation. The course enables students to assess strengths and weaknesses of different languages for problem solving. Other topics to be covered include lexing, parsing, type systems, and ways to formalize a language's semantics.
Prerequisites: CS 303 [Min Grade: C]

CS 401L. Programming Paradigms Laboratory. 0 Hours.
Laboratory to accompany CS401.

CS 402. Compiler Design. 3 Hours.
Study the design and implementation of compilers, including front-end (lexer, parser, type checking), to mid-end (intermediate representations, control-flow analysis, dataflow analysis, and optimizations) to back-end (code generation). Students will get hands-on experience by implementing several compiler components.
Prerequisites: CS 303 [Min Grade: C] and CS 332 [Min Grade: C] and CS 350 [Min Grade: C]

CS 403. Cloud Computing. 3 Hours.
Introduction to cloud computing architectures and programming paradigms. Theoretical and practical aspects of cloud programming and problem-solving involving compute, storage and network virtualization. Design, development, analysis, and evaluation of solutions in cloud computing space including machine and container virtualization technologies.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 403L. Cloud Computing Lab. 0 Hours.
Laboratory to accompany CS403.

CS 410. Database Application Development. 3 Hours.
Relational model of databases, structured query language, relational database design and application development, database normal forms, and security and integrity of databases.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 415. Multimedia Databases. 3 Hours.
Multimedia information processing, multimedia database architecture, multimedia database retrieval, semantic models for multimedia databases.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 416. Big Data Programming. 3 Hours.
Introduction to Big Data, Properties of Big Data, platforms, programming models, applications, business analytics programming, big data processing with Python, R, and SAS, MapReduce programming with Hadoop.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 417. Database Security. 3 Hours.
Database fundamentals, introduction to database security, overview of security models, access control models, covert channels and inference channels, MySQL security, Oracle security, Oracle label security, developing a database security plan, SQL server security, security of statistical databases, security and privacy issues of data mining, database applications security, SQL injection, defensive programming, database intrusion prevention, audit, fault tolerance and recovery, Hippocratic databases, XML security, network security, biometrics, cloud database security, big database security.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 419. Investigating Online Crimes. 3 Hours.
Introduction to cyber-investigative techniques involving network forensics. Students will develop and learn to apply new programs and techniques to automatically evaluate digital evidence from network packet captures, emails, server logs, social media, darknets and online forums related to cyber crime cases from both a law enforcement and incident response perspective.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 420. Software Engineering. 3 Hours.
Design and implementation of large-scale software systems, software development life cycle, software requirements and specifications, software design and implementation, verification and validation, project management and team-oriented software development. Lecture and laboratory.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 420L. Software Engineering Laboratory. 0 Hours.
Laboratory to accompany CS 420.

CS 421. Advanced Web Application Development. 3 Hours.
Introduction to web application design and development. Includes traditional web applications utilizing server-side scripting as well as client/server platforms. Covers responsive design for both mobile and desktop users, as well as hands on server provisioning and configuration. Other topics include web security problems and practices, authentication, database access, application deployment and Web API design, such as REpresentational State Transfer (REST).
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 421L. Advanced Web Application Development Laboratory. 0 Hours.
Laboratory to accompany CS 421.

CS 422. Mobile Application Development. 3 Hours.
Fundamental concepts of mobile application development. Focused on native application development for Android and iOS. Understand application architecture and lifecycle best practices. UX considerations for mobile devices. Interact with device sensors. Compare native vs hybrid frameworks. This course has a laboratory component.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 422L. Mobile Application Development Laboratory. 0 Hours.
Laboratory to accompany CS422.

CS 423. Fundamentals of Network Security. 3 Hours.
Conventional network security (symmetric and public-key cryptography). Message encryption and authentication. Secure communication between computers in a hostile environment, including E-mail (PGP), virtual private networks (IPSec), remote access (SSH), and E-commerce (SSL), firewalls, intrusion detection and prevention, security of IEEE 802.11 wireless networks (WEP, WPA). Mandatory weekly Linux-based lab.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 423L. Network Security Laboratory. 0 Hours.
Laboratory to accompany CS423.

CS 425. Metrics and Performance. 3 Hours.
Theory and practice of metrics for performance and scalability of software systems. The course will introduce students to the principles of queuing theory and statistical analysis relevant to analyzing the performance of software products. Students will use profiling frameworks to identify a range of performance problems in existing software. The course will enable students to improve the design of software and eliminate many common design oversights that hamper a system's performance and scalability.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 426. Secure Software Development. 3 Hours.
Why and how software fails, characteristics of secure and resilient software, life cycle of secure software development, metrics and models for secure software maturity, design methodology, best practices for secure programming, secure software for mobile computing, cloud computing and embedded systems, methodology for testing and validation.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 427. Software Design and Integration. 3 Hours.
This course provides hands-on experience in the design and integration of software systems. Component-based technology, model-driven technology, service-oriented technology, and cloud technology are all explored. Software design basics, including the decomposition of systems into recognizable patterns, the role of patterns in designing software and design refactoring, and attributes of good design. Agile culture, CASE tools, tools for continuous integration, build, testing, and version control.
Prerequisites: CS 420 [Min Grade: C]

CS 429. Software Engineering Research Project. 3 Hours.
This is a project-based research course in software engineering, involving significant implementation and experimentation under the supervision of a faculty member. A project proposal must be accepted before registering for this course.
Prerequisites: CS 420 [Min Grade: C]

CS 430. Computer Architecture. 3 Hours.
Introduction to computer architecture, including memory subsystems, direct-mapped and set-associative cache and multi-level cache subsystems, direct- access devices including RAID and SCSI disk drives, processor pipelining including super-scalar and vector machines, parallel architectures including SMP, NUMA and distributed memory systems, Interrupt mechanisms, and future microprocessor design issues.
Prerequisites: CS 330 [Min Grade: C] and CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 431. Distributed Systems. 3 Hours.
Introduction to distributed systems, distributed hardware and software concepts, communication, processes, naming, synchronization, consistency and replication, fault tolerance, security, client/server computing, web technologies, enterprise technologies.
Prerequisites: CS 303 [Min Grade: C] and CS 332 [Min Grade: C](Can be taken Concurrently) and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 432. Parallel Computing. 3 Hours.
Introduction to parallel computing architectures and programming paradigms. Theoretical and practical aspects of parallel programming and problem solving. Design, development, analysis, and evaluation of parallel algorithms.
Prerequisites: (CS 303 [Min Grade: C] and CS 330 [Min Grade: C]) and CS 332 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 433. Operating Systems. 3 Hours.
Introduction to operating systems. This course looks at the internal design and operation of a modern operating system. Topics include interrupt handling, process scheduling, memory management, virtual memory, demand paging, file space allocation, file and directory management, file/user security and file access methods. Several comparisons among current operating systems are used, with attention to Windows and Unix in particular.
Prerequisites: CS 330 [Min Grade: C] and CS 332 [Min Grade: C] and CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 433L. Operating Systems Laboratory. 0 Hours.
Laboratory to accompany CS 433.

CS 434. Virtualization. 3 Hours.
Theory and practice of virtualization. Origins, history, technical and economic motivations. Relationship to network operating systems and operating system architecture. Simulation, Emulation, Virtualization of CPUs, networks, storage, desktops, memory, devices, and combinations thereof. Different approaches to virtualization, including hardware assists and software-only techniques. Techniques, approaches, and methodologies for scale-out and scale-up computing, including security, performance and economic concerns.
Prerequisites: CS 433 [Min Grade: C] and CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 435. Network Programming. 3 Hours.
Remote procedure call and client-server mechanisms. Protocol definition and compilation; client and server stubs and application code; transport independence; multiple client and server systems. Applications, e.g., remote database query and update and image filtering and archiving; systems programming and file systems contexts.
Prerequisites: CS 334 [Min Grade: C] and CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 436. Fundamentals of Computer Security. 3 Hours.
Study of the breadth of major computer security topics including cyber threats, malware, information assurance, authorization, applied cryptography, web security, mobile and wireless security, network security, systems/software security, database and storage security, user-centered security, and best security practices and countermeasures.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 437. Digital Media Forensics. 3 Hours.
Digital media forensics addresses all stored digital evidence types faced by cyber security professionals and computer forensics examiners. Students will learn to analyze character encoding, file formats, and digital media, including hard drives, smartphones and other portable devices, and cloud-hosted evidence, as well as disk acquisition, duplication and evidence preservation techniques and how to apply these techniques in typical criminal investigation scenarios.
Prerequisites: CS 303 [Min Grade: C] and CS 330 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 437L. Digital Media Forensics Lab. 0 Hours.
Laboratory to accompany CS 437.

CS 438. Fundamentals of the Dark Web. 3 Hours.
The course provides an in-depth exploration of the technical architecture, tools, and analysis techniques used in the Dark Web. Students will gain a comprehensive understanding of the underlying network and computing infrastructure of the Dark Web, explore various tools and technologies used by threat actors, and learn techniques for analyzing activities and transactions on the Dark Web and gathering intelligence through artificial intelligence tools.
Prerequisites: CS 332 [Min Grade: C] and CS 334 [Min Grade: C]

CS 442. Mobile and Wireless Security. 3 Hours.
Mobile/wireless devices are ubiquitous, raising the potential for many cyber threats. This course examines security vulnerabilities inherent in many existing and emerging mobile and wireless systems, ranging from smartphones to wearables and RFID tags. In addition to exposing security vulnerabilities, defensive mechanisms to address these vulnerabilities drawn from existing deployments and research literature will be studied.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 443. Fundamentals of Cloud Security. 3 Hours.
Definition of cloud computing, cloud computing models, privacy, authenticity and integrity of outsourced data, proof of data possession / retrievability, cloud forensics, malware analysis as a service, remote verification of capability and reliability, proof of availability, economic attacks on clouds and outsourced computing, virtual machine security, trusted computing technology and clouds, verifiable resource accounting, cloud-centric regulatory compliance issues and mechanisms, business and security risk models, secure MapReduce, applications of secure cloud computing, private information retrieval and cloud cartography.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 444. Network Forensics. 3 Hours.
This course covers concepts and methods involved in unraveling network intrusions, DDOS, and other untoward network behavior.
Prerequisites: CS 303 [Min Grade: C] and CS 334 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 445. Modern Cryptography. 3 Hours.
Theory and practices of modern cryptographic techniques, algorithms and protocols, including formal analysis. Secret key encryption algorithms, public key encryption algorithms, stream ciphers, one-way hashing algorithms, authentication and identification, digital signatures, signcryption, key establishment and management, secret sharing and data recovery, zero-knowledge proofs, public key infrastructures, efficient implementation, cryptanalytic attacks and countermeasures, security models, assumptions and proofs.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 446. Blockchain and Cryptocurrency. 3 Hours.
Fundamental principles of blockchains and their applications in digital cash systems including Bitcoin, Ethereum and other notable cryptocurrencies. Topics to be covered include how a cryptocurrency works, blockchain and other decentralized consensus protocols, proof of work, proof of stake, smart contracts, security and privacy of cryptocurrencies, cryptographic techniques for digital currency, and applications of blockchain in peer-to-peer trust establishment, digital asset management, financial exchanges and distributed autonomous organization.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 447. Biomedical Modeling. 3 Hours.
Modeling and analysis of biomedical datasets. Aspects of image processing and shape modeling related to biomedical datasets, morphometry, alignment, surgical planning, case studies.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 452. Design and Analysis of Algorithms. 3 Hours.
This courses introduce students to the design and analysis of fundamental algorithms that underpin many fields of importance ranging from data science, business intelligence, finance and cyber security to bioinformatics. Algorithms to be covered include dynamic programming, greedy technique, linear programming, network flow, sequence matching, search and alignment, randomized algorithms, page ranking, data compression, and quantum algorithms. Both time and space complexity of the algorithms are analyzed.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 454. Malware Analysis. 3 Hours.
Hands-on course teaching static, dynamic and contextual analysis of malware. Malware analysis, and investigation is taught through interaction with both "classroom" and "wild" malware samples. Defensive and counter-measure techniques for both corporate and law enforcement environments are explored.
Prerequisites: CS 303 [Min Grade: C] and CS 330 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 454L. Malware Analysis Lab. 0 Hours.
Laboratory to accompany CS 454.

CS 456. Web Security. 3 Hours.
The web uses advanced applications that run on a large variety of browsers that may be built using programming languages such as JavaScript, AJAX, Google Web Toolkit and Apache Struts, to name a few. This course studies how core web technologies work, the common security vulnerabilities associated with them, and how to build secure web applications that are free from these vulnerabilities.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 457. Fundamentals of Penetration Testing. 3 Hours.
This course focuses on penetration testing and vulnerability analysis. It introduces methodologies, techniques and tools to analyze and identify vulnerabilities in stand-alone and networked applications. It also covers methodologies for legal and standards compliance.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 457 [Min Grade: C])

CS 458. Fundamentals of Quantum Computing. 3 Hours.
Mathematical foundations, architecture of quantum computer, quantum algorithms, quantum programming, quantum software application development environments and methodologies, and integration of quantum and classical computers.
Prerequisites: CS 303 [Min Grade: C] and (MA 260 [Min Grade: C] or MA 434 [Min Grade: C])

CS 460. Fundamentals of Artificial Intelligence. 3 Hours.
This course will provide an introduction to fundamental concepts in the field of artificial intelligence. Topics typically covered include agents, search, logic and knowledge representation, probabilistic models, machine learning, natural language processing and perception.
Prerequisites: CS 303 [Min Grade: C] and CS 350 [Min Grade: C]

CS 462. Fundamentals of Natural Language Processing. 3 Hours.
This course provides a broad introduction to Natural Language Processing (Computational Linguistics). Topics typically covered in this course include part-of-speech tagging, syntactic parsing, semantic analysis, speech recognition, machine translation, sequence labeling algorithms, n-gram language models, statistical parsing, grammar formalisms and treebanks.
Prerequisites: (CS 303 [Min Grade: C] and CS 350 [Min Grade: C] and CS 355 [Min Grade: C]) or CS 460 [Min Grade: C]

CS 463. Fundamentals of Data Mining. 3 Hours.
Techniques used in data mining (such as frequent sets and association rules, decision trees, Bayesian networks, classification, clustering), algorithms underlying these techniques, and applications.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 467. Fundamentals of Machine Learning. 3 Hours.
Introduction to machine learning, the design of algorithms that can make predictions about the future based on past experience. Emphasizes practical considerations for developing efficient and accurate machine learning models, and theoretical underpinnings of different learning algorithms.
Prerequisites: CS 303 [Min Grade: C] and CS 355 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 468. AI Assisted Software Development. 3 Hours.
Techniques for the accelerated development of better and more robust software using emerging artificial intelligence (AI) tools such as OpenAI Codex, IntelliCode and others. Covers AI assisted key software development stages from requirements gathering, designing, coding, code review, debugging, testing and deployment to maintenance.
Prerequisites: CS 303 [Min Grade: C]

CS 469. Introduction to the Internet of Things. 3 Hours.
Definition of the Internet of Things (IoT), history, IoT components, device specifications and examples, architectures, protocols, applications, security and privacy issues, programming and development environments for IoT, interoperability, interfacing IoT devices via web and mobile applications.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 470. Fundamentals of Computer Graphics. 3 Hours.
Computer graphics is the study of the creation, manipulation, and rendering of shape models and images, for visualization, modeling, shape analysis, and animation. Topics include matrix transforms for motion and viewing, shading, viewing and camera modeling, shape modeling including meshes and smooth parametric curves and surfaces, visibility analysis, sampling, nonphotorealistic rendering, shape analysis, and texture mapping.. Topics are explored through code, including OpenGL and GLSL.
Prerequisites: CS 303 [Min Grade: C] and CS 332 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 473. Fundamentals of Computer Vision. 3 Hours.
Computer vision, the study of the interpretation of images, is central to many areas of computer science, including data science and machine learning, biomedical computing, social media, and security. Recent algorithms for vision also leverage deep learning, such as for object recognition. Topics in this course include linear filters, calculus on the image, convolution, edge and corner detection, segmentation, projective geometry, structure from motion, rectification, two-view geometry, reconstruction in 3D, Hough transform, object recognition.
Prerequisites: CS 332 [Min Grade: C] and (MA 260 [Min Grade: C] or MA 434 [Min Grade: C])

CS 475. Fundamentals of Data Visualization. 3 Hours.
The amount and complexity of data produced everyday is increasing at a staggering rate. Visualization presents an intuitive way to explore and interpret data. This course will be an introduction to the principles, and methods for effective visual analysis of data. Techniques to facilitate information visualization for non-spatial data (eg. graphs, text, high-dimensional data) and scientific visualization for spatial data (eg. gridded data from simulations and scanners and sensors) will be covered. Emphasis will be given to interactive approaches, especially while dealing with massive volumes of data. Topics in the domain of data analytics tightly coupled with visualization will also be covered. Students will learn fundamentals of perception, visualization techniques and methods for a broad range of data types, good practices for visualization, and will ultimately be able to develop their own visualization system.
Prerequisites: CS 303 [Min Grade: C] and CS 332 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 476. Introduction to Game Development. 3 Hours.
A course in game development and game design that considers the theory and practice of developing computer games from both a technical and aesthetic perspective. Technical components include shaders and materials, meshes, procedural generation, game physics, collision detection, game AI, pathfinding, animation, and lighting. Aesthetic components include game loop design, level design, gameplay, and sound.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 226 [Min Grade: C])

CS 478. Fundamentals of Digital Image Processing. 3 Hours.
Human visual system, image acquisition, binary image processing, image transformation, Fourier Transform, segmentation, edge detection, medical imaging modalities, and image reconstruction from projections.
Prerequisites: CS 303 [Min Grade: C] and MA 125 [Min Grade: C]

CS 483. Open Source Security Systems. 3 Hours.
An introduction to the design, implementation, evaluation and maintenance of secure software systems and applications using open source technologies, with an emphasis on hands-on experience. Topics include: open source ecosystems, open source security methodologies and models, notable open source software systems and projects, quality and security assurance through open source, open source supply chain security, major open source cryptographic packages; designing, implementing and maintaining security systems using open source technologies; assessment and regulatory compliance using open source tools, and open source hardware.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 484. Robot Motion. 3 Hours.
Path planning algorithms. Configuration space, potential functions, roadmaps, cell decomposition, probabilistic motion planning, compliant motion.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 485. Foundations of Data Science. 3 Hours.
This introductory course in data science teaches fundamental concepts and techniques in statistical inference and big data analytics. Topics include high-dimensional space, singular value decomposition, random graphs, random walks and Markov chains, data streaming and sketching, and basics of data mining and machine learning.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 486. Software-Defined Networking. 3 Hours.
Software defined networking (SDN) allows a logically centralized software component to manage and control the behavior of an entire network. Topics to be covered include abstractions and layered architecture of SDN, data, control and management planes, network virtualization, programming SDN, network functions (e.g. routing, load balancing and security), comparison of OpenFlow and proprietary SDN technologies, and network optimization with SDN.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 487. Complex Networks. 3 Hours.
Introduction to complex network theory and real-world applications in biology, physics, sociology, national security and cyber enabled technology systems such as social networks. Essential network models including small world networks, scale free networks, spatial and hierarchical networks together with methods to generate them with a computer will be discussed. In addition, various techniques for the analysis of networks including network modeling and evolution, community structure, dynamic network analysis, and network visualization will be explored.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 489. Fundamentals of Cyber Risk Management. 3 Hours.
This course develops knowledge and skills in risk based information security management geared toward preventive management and assurance of security of information and information systems in technology-enabled environments. It focuses on risk assessments, risk mitigation strategies, risk profiling and sensitivity, quantitative and qualitative models of calculating risk exposures, security controls and services, threat and vulnerability management, financing the cost of security risks, and return on investment for information security initiatives. The course presents several risk assessment models with an ultimate goal of identifying and realizing the unique and acceptable level of information risk for an organization.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 491. Special Topics. 3 Hours.
Special Topics in Computer Science.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 492. Special Topics. 3 Hours.
Special Topics in Computer Science.
Prerequisites: CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 496. Research Seminar. 1 Hour.
Participation in research seminar directed by a faculty member.

CS 497. Competitive Programming Techniques. 1 Hour.
This course will help students become more competitive in a programming competition such as the ACM programming contest by exploring numerous problem solving techniques and algorithms not covered in the traditional curriculum.

CS 498. Research Methods in Computer Science. 3 Hours.
This course is designed to provide future computer science teachers with the tools that computer science uses to develop new knowledge. Students will design, implement, and document independent research inquiry. Students will learn how scientists communicate through peer-reviewed publications and evaluate conflicting scientific claims. Work is closely coordinated with the work of students from other content disciplines so that students see the similarity and differences of research methods in their own field as compared with those of other science disciplines.
Prerequisites: EHS 126 [Min Grade: D]

CS 499. Senior BS Capstone. 3 Hours.
This capstone course consolidates key concepts in the undergraduate BS curriculum and prepares students for their professional careers. Teamwork and writing are key themes of the course. Students discuss and write about topics in ethics, professional practice, entrepreneurship, intellectual property, licensing (e.g., GPL, MIT), privacy, continuing professional development, professional networking tools, compliance, tolerance, inclusion, appreciation of diversity, and contemporary issues. In a software engineering project, students work in a team to put to practice principles and techniques that they have acquired throughout the undergraduate curriculum. Students take the Major Field Test in Computer Science as a requirement for completing this course. Students should be CS BS majors in their last year of undergraduate study.
Prerequisites: (CMST 101 [Min Grade: C] or CM 101 [Min Grade: C]) and PHL 115 [Min Grade: C] and CS 303 [Min Grade: C] and (MA 125 [Min Grade: C] or MA 225 [Min Grade: C])

CS 499L. Senior Capstone Laboratory. 0 Hours.
Laboratory to accompany CS 499.