CS 1100. Freshman Leap Seminar. 1 Credit Hour.
Small group discussions with first year students are led by one or more faculty members and include a variety of foundational, motivational, and topical subjects for computationalist.

CS 1171. Introductory Computing in MATLAB. 1 Credit Hour.
For students with a solid introductory computing background needing to demonstrate proficiency in the MATLAB language.

CS 1301. Introduction to Computing. 3 Credit Hours.
Introduction to computing principles and programming practices with an emphasis on the design, construction and implementation of problem solutions use of software tools.

CS 1315. Introduction to Media Computation. 3 Credit Hours.

CS 1316. Representing Structure and Behavior. 3 Credit Hours.

CS 1331. Introduction to Object Oriented Programming. 3 Credit Hours.
Introduction to techniques and methods of object-oriented programming such as an emphasis on the design, construction and implementation of problem solutions use of software tools.

CS 1332. Data Structures and Algorithms for Applications. 3 Credit Hours.
Computer data structures and algorithms in the context of object-oriented programming. Focus on software development towards applications.

CS 1371. Computing for Engineers. 3 Credit Hours.

CS 1372. Structured Program Design for Engineers. 3 Credit Hours.

CS 1801. Special Topics. 1 Credit Hour.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 1802. Special Topics. 2 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 1803. Special Topics. 3 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 1804. Special Topics. 4 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 1805. Special Topics. 5 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 1XXX. Computer Sci Elective. 1-21 Credit Hours.

CS 2050. Introduction to Discrete Mathematics for Computer Science. 3 Credit Hours.

CS 2051. Honors - Induction to Discrete Mathematics for Computer Science. 3 Credit Hours.

CS 2110. Computer Organization and Programming. 4 Credit Hours.
An introduction to basic computer hardware, machine language, assembly language, and C programming.

CS 2200. Computer Systems and Networks. 4 Credit Hours.
A broad exposure to computer system structure and networking including software abstractions in operating systems for orchestrating the usage of the computing resources.

CS 2261. Media Device Architectures. 4 Credit Hours.
Controlling the interface between hardware and software in media devices. Machine-level programming (e.g., in C) to create graphics, generate sound, and support user interaction.

CS 2316. Data Manipulation for Science and Industry. 3 Credit Hours.
Reading, manipulating, and exporting data for engineering, business, and scientific applications. Covers GUIs, File I/O, basic SQL, and web scraping. Emphasis on software development.

CS 2335. Software Practicum. 3 Credit Hours.
Methods for solving large programming problems. Techniques for quality assurance, managing programs, working in teams, analyzing problems, and producing effective solutions.

CS 2340. Objects and Design. 3 Credit Hours.
Object-oriented programming methods for dealing with large programs. Focus on quality processes, effective debugging techniques, and testing to assure a quality product.

CS 2345. Advanced Practical Object-Oriented Programming. 4 Credit Hours.
This course presents important programming principles that should be considered when using a non-automatic memory management complex language (such as C++). Templating, generic programming, resource acquisition is initialization (RAII), and smart pointers are a few examples. Credit not awarded for both CS 2345 and ECE 2036.

CS 2600. Knowledge Representation and Processing. 4 Credit Hours.
Introduction to the representation and manipulation of complex symbolic and sub-symbolic information.

CS 2698. Undergraduate Research Assistantship. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

CS 2699. Undergraduate Research. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

CS 2701. Startup Lab: Introduction to Technology Ventures. 3 Credit Hours.
Elements of technology venture creation including opportunity identification and validation, ideation, customer discovery, market analysis, minimum viable product development, business models, intellectual property, and capital raises. Cross-listed with COE 2701.

CS 2801. Special Topics. 1 Credit Hour.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 2802. Special Topics. 2 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.
CS 2803. Special Topics. 3 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 2804. Special Topics. 4 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 2805. Special Topics. 5 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 2XXX. Computer Sci Elective. 1-21 Credit Hours.

CS 3101. Computer Science Ventures. 3 Credit Hours.
Students will learn how computer-science-based ventures are developed. The course is project-based. Students propose, analyze, pitch, design, implement, package and market web-2.0 and virtual-world-based products and services.

CS 3210. Design of Operating Systems. 3 Credit Hours.
Operating systems concepts, including multi-threading, scheduling, synchronization, communication, and access control. Projects will cover design and implementation of several operating systems components.

CS 3220. Computer Structures: Hardware/Software Codesign of a Processor. 3 Credit Hours.
Principles in pipelined processor design, with emphasis on the need for a close interaction between code generation and architecture.

CS 3240. Languages and Computation. 3 Credit Hours.
Interpreters as abstract machines and the tools used to construct them, such as scanners and parsers. An introduction to models of computation as embodied by different programming languages. Limits of and relationships between these models.

CS 3251. Computer Networking I. 3 Credit Hours.
Introduction to problems in computer networking, including error recovery, medium access, routing, flow control, and transport. Emphasis on current best practice. Includes programming of networked applications.

CS 3300. Introduction to Software Engineering. 3 Credit Hours.
Team-based project class to introduce and apply software engineering principles and practices.

CS 3311. Part 1 of a 2 semester project design and implementation sequence conjoined with Tech Communications. 1 Credit Hour.
Part 1 of a 2 semester project design and implementation sequence conjoined with Technical Communications. Prepare requirements, design and project plans. Develop a basic prototype of the desired system. Project is completed in CS 3312-Project Implementation. Credit will not be awarded for CS 3311 and CS 4911.

CS 3312. Part 2 of a 2 semester project design and implementation sequence conjoined with Tech Communications. 2 Credit Hours.
The second part of a 2 semester project design and implementation sequence conjoined with Technical Communications. Implement a project designed in CS 3311. Credit will not be awarded for CS 3312 and CS 4911.

CS 3451. Computer Graphics. 3 Credit Hours.
Geometric constructions; transformations; perception; reflection models; photorealistic; non-photorealistic, and image-based rendering; rendering software and APIs; triangle-mesh processing; graphic acceleration; user-interaction, design and animation.

CS 3510. Design and Analysis of Algorithms. 3 Credit Hours.

CS 3511. Design and Analysis of Algorithms, Honors. 3 Credit Hours.
Techniques of design and analysis of efficient algorithms for standard computational problems. NP-Completeness Project. Credit not allowed for both CS 3511 and CS 3510.

CS 3600. Introduction to Artificial Intelligence. 3 Credit Hours.
An introduction to artificial intelligence and machine learning. Topics include intelligent system design methodologies, search and problem solving, supervised and reinforced learning.

CS 3630. Introduction to Perception and Robotics. 3 Credit Hours.
Covers fundamental problems and leading solutions for computer and robot perception and action from the point of view of autonomous robot navigation.

CS 3651. Prototyping Intelligence Appliances. 4 Credit Hours.
Hands-on course teaching the fundamentals of electronics of electrical and mechanical prototyping.

CS 3743. Analysis of Emerging Technologies. 3 Credit Hours.
Analysis of emerging technologies and their impacts for firm practice, market practice, policy, and society. Credit not allowed for both CS 3743 and MGT 3743 or ME 3743.

CS 3750. Human Computer Interface Design and Evaluation. 3 Credit Hours.
Human computer interface is considered in terms of user-system compatibility. Concepts in human factors and interface design are covered in relation to capabilities of both humans and computers. Crosslisted with PSYC 3750.

CS 3790. Introduction to Cognitive Science. 3 Credit Hours.
Multidisciplinary perspectives on cognitive science. Interdisciplinary approaches to issues in cognition, including memory, language, problem solving, learning, perception, and action. Crosslisted with PST, PSYC, and ISYE 3790.

CS 3801. Special Topics. 1 Credit Hour.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 3802. Special Topics. 2 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 3803. Special Topics. 3 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 3804. Special Topics. 4 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 3805. Special Topics. 5 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 3XXX. Computer Sci. 1-21 Credit Hours.

CS 4001. Computing, Society, and Professionalism. 3 Credit Hours.

CS 4002. Robots and Society. 3 Credit Hours.

CS 4005. Next-Generation Computing Technologies. 3 Credit Hours.
Students will explore new paradigms in how content is created, distributed, and consumed, with hands-on demos of next-generation computing technologies.
CS 4010. Introduction to Computer Law. 3 Credit Hours.
Provides an introduction to copyrights, patents, trade secrets, trademarks, and commercial law pertaining to computer software and hardware.

CS 4052. Systems Analysis and Design. 3 Credit Hours.
An introductory course on the development life cycle of business information systems. It covers analysis and design tools and methodology. Credit not allowed for both CS 4052 and MGT 4045.

CS 4057. Business Process Analysis and Design. 3 Credit Hours.
Business processes are the mechanisms by which work is organized and performed. This course covers the analysis of business technology. Credit will not be awarded for both CS 4057 and MGT 4057.

CS 4210. Advanced Operating Systems. 3 Credit Hours.
Operating system abstractions and their implementations, multi-threading, efficient inter-address communication, high-level synchronization, introduction to multi-processor and distributed operating systems, real-time systems.

CS 4220. Programming Embedded Systems. 3 Credit Hours.
Design principles, programming techniques, and case studies of embedded real-time systems. Interface techniques and devices. Representations and reasoning about physical processes.

CS 4233. Parallel Computer Architecture. 3 Credit Hours.
The objective of this course is to develop an in-depth understanding of the design, implementation, and evaluation of modern parallel computers. Credit not allowed for both CS 4233 and CS 7110.

CS 4235. Introduction to Information Security. 3 Credit Hours.
CS 4237. Computer and Network Security. 3 Credit Hours.
Fundamental concepts and principles of computer security, operating system and database security, secret key and public key cryptographic algorithms, hash functions, authentication, firewalls and intrusion detection systems, IPSec ad VPN, and wireless security.

CS 4240. Compilers, Interpreters, and Program Analyzers. 3 Credit Hours.
Study of techniques for the design and implementation of compilers, interpreters, and program analyzers, with consideration of the particular characteristics of widely used programming languages.

CS 4245. Introduction to Data Mining and Analysis. 3 Credit Hours.
Computational techniques for analysis of large, complex datasets, covering fundamental aspects as well as modern data mining and analysis techniques. Cross-listed with ISYE 4245.

CS 4251. Computer Networking II. 3 Credit Hours.
Principles of computer networks, including medium access, ARQ protocols, routing, congestion avoidance, and control. Emphasis on design options and tradeoffs. Includes significant network application programming.

CS 4255. Introduction to Network Management. 3 Credit Hours.
Introduction to SNMP-based network management. Practical application to network and system management including hands-on lab practice.

CS 4260. Telecommunications Systems. 3 Credit Hours.
Study of telecommunication systems emphasizing functional roles of the various portions of the system and how various functional components support and interact with one another.

CS 4261. Mobile Applications and Services for Converged Networks. 3 Credit Hours.
This course provides an introduction to mobile applications and services with an emphasis on voice and data service integration in modern commercial networks.

CS 4270. Data Communications Laboratory. 3 Credit Hours.
Detailed study of the principles of data transmission systems and their performance, reinforced by laboratory exercises.

CS 4280. Survey of Telecommunications and the Law. 3 Credit Hours.
Overview of telecommunication regulation at the federal, state, and judicial levels; review of FCC policies and restrictions on Bell operating companies under the AT&T Consent Agreement.

CS 4290. Advanced Computer Organization. 3 Credit Hours.
CS 4320. Introduction to Software Processes. 3 Credit Hours.
The course will provide students with an overall context in which software systems are developed from the viewpoint of processes that support development. Software engineering is described as the set of activities developers engage in to create high-quality products within schedule and budget constraints.

CS 4330. Software Engineering Applications. 3 Credit Hours.
Software engineering methods specific to classes of applications or systems, including information systems and embedded, real-time systems.

CS 4342. Software Generation, Testing, and Maintenance. 3 Credit Hours.
Methods and principles for program generation, testing, and managing the evolution of software systems.

CS 4400. Introduction to Database Systems. 3 Credit Hours.
The course will cover current developments including distributed, object-oriented, temporal-spatial, Web-based, mobile, and active database technologies, and data warehousing and mining applications.

CS 4455. Video Game Design and Programming. 3 Credit Hours.
Introduction to programming and human-centered principles of computing based on a communications and media computation context. Introduces user interface programming.

CS 4457. Emerging Database Technologies and Applications. 3 Credit Hours.
The course will cover current developments including distributed, object-oriented, temporal-spatial, Web-based, mobile, and active database technologies, and data warehousing and mining applications.

CS 4458. Human-Centered Computing Concepts. 3 Credit Hours.
Introduction to programming and human-centered principles of computing based on a communications and media computation context. Introduces user interface programming.

CS 4460. Introduction to Information Visualization. 3 Credit Hours.
Introduction to principles and techniques of information visualization, the presentation of primarily abstract data to help people understand, analyze and make sense of data.

CS 4464. Computational Journalism. 3 Credit Hours.
CS 4470. Introduction to User Interface Software. 3 Credit Hours.
Concepts, techniques, structures, and strategies for implementation of interactive software.

CS 4472. Design of Online Communities. 3 Credit Hours.
Introduction to the design of online communities. Students study an existing community in depth. Credit not allowed for both CS 4472 and CS 6470.
CS 4475. Computational Photography. 3 Credit Hours.
An introductory course on the scientific, technical, perceptual, and aesthetic principles of pictures. Emphasis is on the techniques of image formation, analysis, merging, modification and their use for depiction of reality on a 2D medium of photographs.

CS 4476. Introduction to Computer Vision. 3 Credit Hours.
Introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. Credit will not be awarded for both CS 4476 and CS 4495 or CS 6476.

CS 4480. Digital Video Special Effects. 3 Credit Hours.
A study of digital multimedia and the analysis and synthesis of digital video. Special attention paid to techniques for generating video special effects.

CS 4495. Computer Vision. 3 Credit Hours.

CS 4496. Computer Animation. 3 Credit Hours.
Motion techniques for computer animation and interactive games (keyframing, procedural methods, motion capture, and simulation) and principles for storytelling, composition, lighting, and interactivity.

CS 4510. Automata and Complexity Theory. 3 Credit Hours.
Computational machine models and their language classes. Undecidability. Resource-bounded computations. Central complexity-theoretic concepts such as complexity classes, reducibility and completeness.

CS 4520. Approximation Algorithms. 3 Credit Hours.
Approximation algorithms for NP-hard optimization problems, design and analysis techniques for such algorithms. Credit not allowed for both CS 4520 and CS 7520.

CS 4530. Randomized Algorithms. 3 Credit Hours.
Efficient randomized algorithms with improved performance over deterministic algorithms, or for NP-hard optimization problems, design and analysis techniques for such algorithms. Credit not allowed for both CS 4530 and CS 7530.

CS 4540. Advanced Algorithms. 3 Credit Hours.
Advanced techniques for designing and analyzing efficient algorithms for combinatorial, algebraic, and number theoretic problems. Credit not allowed for both CS 4540 and CS 6550.

CS 4550. Scientific Data Processing and Visualization. 3 Credit Hours.
Foundations and algorithms underlying the development and application of tools for the efficient transmission, analysis, filtering, and visualization of large scientific data sets.

CS 4560. Verification of Systems. 3 Credit Hours.
Technique for verifying, validating and testing software and hardware systems. Topics covered will include modeling, abstraction methods, evaluation and certification, and computer-aided verification methods.

CS 4590. Principles and Applications of Computer Audio. 3 Credit Hours.
A well-rounded exploration of digital audio and its importance in current research and applications. Exposes students to the principles, technology, and current research of computer audio.

CS 4605. Mobile and Ubiquitous Computing. 3 Credit Hours.
Investigates the infrastructure required to develop mobile and ubiquitous computing applications and establishes major research themes and experimental practices.

CS 4611. Artificial Intelligence Problem Solving. 3 Credit Hours.
Basic concepts and methods of AI problem solving, knowledge representation, reasoning, and learning.

CS 4613. Knowledge Systems Engineering. 3 Credit Hours.
Techniques for constructing large knowledge-based systems. Advanced symbolic AI techniques. Constraint systems.

CS 4615. Knowledge-Based Modeling and Design. 3 Credit Hours.
Information-processing theories of modeling and design; topics include design decision-making, problem-solving and learning, and knowledge-based modeling and design.

CS 4616. Pattern Recognition. 3 Credit Hours.
An introductory course on pattern classification and decision problems with applications to character recognition, image analysis, and speech recognition.

CS 4622. Case-Based Reasoning. 3 Credit Hours.
Based on human problem-solving, CBR has had many successes in industry and research. Topics include case representation, indexing and retrieval, similarity assessment, adaptation, learning. Credit not allowed for both CS 4622 and CS 7620.

CS 4625. Intelligent and Interactive Systems. 3 Credit Hours.
Explores how human-computer interaction and machine learning can interact to create personalized information environments. Emphasis on current research efforts from both fields.

CS 4632. Advanced Intelligent Robotics. 3 Credit Hours.
Hands-on course in which students program autonomous mobile robots and solve complex tasks for robot teams.

CS 4635. Knowledge-Based Artificial Intelligence. 3 Credit Hours.
Structured knowledge representation; knowledge-based methods of reasoning and learning; problem-solving, modeling and design.

CS 4641. Machine Learning. 3 Credit Hours.
Machine learning techniques and applications. Topics include foundational issues; inductive, analytical, numerical, and theoretical approaches; and real-world applications.

CS 4649. Robot Intelli Planning. 3 Credit Hours.
We investigate algorithms for robots and complex systems that make intelligent decisions. Emphasis on the theoretical and empirical properties of classical, geometric, stochastic/dynamic planning.

CS 4650. Natural Language Understanding. 3 Credit Hours.

CS 4660. Introduction to Educational Technology. 3 Credit Hours.
Introduction to the theory and practice of educational technology. Covers learning theory applicable to educational technology, explains major research findings.

CS 4665. Educational Technology: Design and Evaluation. 3 Credit Hours.
Intensive project class in which students design, implement, and evaluate a piece of educational technology, applying the theory learned in Introduction to Educational Technology.

CS 4670. Computer-Supported Collaborative Learning. 3 Credit Hours.
Research and practice in computer-supported collaborative learning. Review of existing systems and research, as well as evaluation and design methods.

CS 4675. Internet Computing Systems, Services and Applications. 3 Credit Hours.

CS 4685. Pervasive Systems and Networking. 3 Credit Hours.
In-depth study of systems and wireless networking issues in enabling pervasive computing environments and applications using a hand-on approach.
CS 4690. Empirical Methods for User Interface Design and Evaluation. 3 Credit Hours.
Introduction to empirical methods for gathering requirements and evaluating the end-user and usability of software systems.

CS 4698. Undergraduate Research Assistantship. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

CS 4699. Undergraduate Research. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

CS 4710. Introduction to Computing Concepts for Bioinformatics. 4 Credit Hours.
Introduction to programming concepts and computing tools such as formal models and algorithms with applications from conceptual biology. May not be used by computer science majors for degree credit.

CS 4725. Information Security Strategies and Policies. 3 Credit Hours.
Information security vulnerabilities and risks; legal, cost, privacy, and technology constraints; derivation of strategies; technical and procedural means of achieving desired results. Credit will not be awarded for both CS 4725 and CS 6725 or MGT 4725 or MGT 6725.

CS 4726. Privacy, Technology, Policy, and Law. 3 Credit Hours.
This course takes a multi-disciplinary approach to privacy, a topic of great interest in the technology, policy, ethics, law, and business realms. Credit will not be awarded for both CS 4726 and MGT 4726 or MGT 6726 or CS 6726.

CS 4731. Game AI. 3 Credit Hours.
Examines the expressive possibilities of artificial intelligence techniques in computer games. Students learn AI programming techniques, and how they strongly interface with game design.

CS 4741. Integrative Management Development-Project Preparation. 3 Credit Hours.
Individual and group-based experiential learning activities to develop integrated human system management skills that prepare students for more successful capstone collaboration and learning. Credit not allowed for both CS 4741 and MGT 4741 or ME 4741.

CS 4742. Integrated Computing and Management Capstone Project. 4 Credit Hours.
Project-based course for students in Computing and Management minor to work in interdisciplinary teams on projects provided by corporate affiliates. Credit not allowed for both CS 4742 and MGT 4742 or ME 4742.

CS 4752. Philosophical Issues in Computation. 3 Credit Hours.
Metaphysical and epistemological issues in the foundations, methods, and implications of computing. Issues include: minds, brains, and machines; representation and language; simulating nature. Crosslisted with PST 4752.

CS 4770. Mixed Reality Experience Design. 3 Credit Hours.
Focuses on informal design, integration of media theory, HCI and technology issues. Significant group design projects.

CS 4791. Integrative Project in Cognitive Science. 3 Credit Hours.
An integrative course in cognitive science focusing on the integration and use of concepts and skills from cognitive science. A different integrative project or set of projects will be taken on each semester; students will contribute on the basis of their background and skill. Crosslisted with PST, PSYC, and ISYE 4791.

CS 4792. Design Project in Cognitive Science. 3 Credit Hours.
Individual project with a cognitive science faculty member, designed as a supplement to the student's senior design project or thesis in their major area. Crosslisted with PST, PSYC, and ISYE 4792.

CS 4793. Integrative Perspectives in Cognitive Science. 3 Credit Hours.
An integrative course in cognitive science which uses a focus topic to deepen interdisciplinary perspective and develop cognitive science knowledge and skills.

CS 4801. Special Topics. 1 Credit Hour.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 4802. Special Topics. 2 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 4803. Special Topics. 3 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 4804. Special Topics. 4 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 4805. Special Topics. 5 Credit Hours.
Courses of timely interest to the profession, conducted by resident or visiting faculty.

CS 4901. Special Problems. 1-21 Credit Hours.
An investigation of significant areas of information in computer science. Guided study and research.

CS 4902. Special Problems. 1-21 Credit Hours.
An investigation of significant areas of information and computer science. Guided study and research.

CS 4903. Special Problems. 1-21 Credit Hours.
An investigation of significant areas of information and computer science. Guided study and research.

CS 4911. Design Capstone Project. 1-21 Credit Hours.
Team-based capstone experience allowing students to analyze a problem for a customer and manage the solution development through the full project life cycle.

CS 4980. Research Capstone Project. 1-21 Credit Hours.

CS 4XXX. Computer Sci Elective. 1-21 Credit Hours.