201 Fundamentals of Information Technology  
Fall, Spring. 3(3-0) P: (CSE 101 or CSE 131) and (MTH 103 or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LB 118) RB: high school algebra; literacy in web and computer tools, such as editor and browser. SA: CSE 240  
Digital representation of objects such as numbers, signals, and 3-dimensional shapes. Algorithms that operate on digital objects. Computer communications and the Internet. Computer security and web services.

220 Programming in C  
Fall, Spring. 3(2-2) P: (EGR 100 or ECE 101) and (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) or (MTH 124 or concurrently) R: Open to undergraduate students. Not open to students with credit in CSE 251.  
Basics of programming in C. Data types, operators, control, functions, arrays, pointers, file processing, testing and debugging.

231 Introduction to Programming I  
Fall, Summer. 3(2-2) P: (LB 118 or concurrently) or (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) SA: CSE 230  
Introduction to programming using Python. Design, implementation and testing of programs to solve problems such as those in engineering, mathematics and science. Programming fundamentals, functions, objects, and use of libraries of functions.

232 Introduction to Programming II  
Fall, Spring. 4(3-2) P: CSE 231 and (LB 118 or MTH 124 or MTH 132 or MTH 152H) SA: CSE 330  
Continuation of object-centered design and implementation in C++. Building programs from modules. Data abstraction and classes to implement abstract data types. Static and dynamic memory allocation. Data structure implementation and algorithm efficiency. Lists, tables, stacks, and queues. Templates and generic programming.

251 Programming in C  
Fall, Spring. 1(0-2) P: CSE 231 or CSE 131 or EGR 102 RB: Students are expected to have experience in programming in some language other than C R: Open to undergraduate students or graduate students. Programming in the C language. Data and control. Compiling and linking.

260 Discrete Structures in Computer Science  
Fall, Spring. 4(4-0) P: MTH 133 or MTH 126 or MTH 153H or LB 119 SA: CSE 260  

290 Independent Study in Computer Science  
Fall, Spring. 1 credit. A student may earn a maximum of 3 credits in all enrollments for this course. R: Approval of department, application required. SA: CPS 290  
Supervised individual study in an area of computer science.

291 Selected Topics in Computer Science  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Approval of department. SA: CPS 291  
Topics selected to supplement and enrich existing courses and lead to the development of new courses.

300 Operating Systems  
Fall, Spring. 3(3-0) P: (CSE 232 and CSE 260) and (CSE 320 or ECE 331) R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Disciplinary Teaching Minor. SA: CPS 420  
Organization and architecture of computer systems. Arithmetic Logic Unit and control unit implementation. Process and processor management. Concurrent processes and threads. Primary and secondary storage management. Case studies of modern operating systems.

320 Computer Organization and Architecture  
Fall, Spring. 3(3-0) P: CSE 232 and CSE 260 R: Open to students in the Department of Computer Science and Engineering or in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Disciplinary Teaching Minor. SA: CPS 320  
Not open to students with credit in ECE 331. Boolean algebra and digital logic. Combinational and sequential circuits. Representations of data and instructions. Architecture and major components of computer systems. Assembly language programming and interfacing to high level languages. Assembler and linker processing.

331 Algorithms and Data Structures  
Fall, Spring. 3(3-0) P: CSE 232 and CSE 260 R: Open to students in the Department of Computer Science and Engineering or in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Disciplinary Teaching Minor. SA: CPS 331  
Linear data structures, trees, graphs and algorithms which operate on them. Fundamental algorithms for searching, sorting, string matching, graph problems. Design and analysis of algorithms.

335 Object-oriented Software Design  
Fall, Spring. 4(4-0) P: CSE 232 and CSE 260 R: Open to students in the Department of Computer Science and Engineering or in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CSE 370  
29 Interdisciplinary Topics in CyberSecurity
Fall. 3(3-0) Interdepartmental with Criminal Justice. Administered by Computer Science and Engineering. P: CSE 101 or CSE 131 or CSE 231 R: Open to juniors or seniors or graduate students.
Technical, legal, criminal, medical business, and communication aspects of CyberSecurity.

435 Software Engineering
Fall. 3(3-0) P: (CSE 331 and CSE 335) and completion of Tier I writing requirement. R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CSE 470
Software lifecycle including specification, design, coding, testing, and verification of a software product. Stepwise refinement and traceability. Software maintenance and documentation.

440 Introduction to Artificial Intelligence
Fall. 3(3-0) P: CSE 331 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CPS 440

444 Information Technology Project Management
Spring. 3(3-0) Interdepartmental with Information Technology Management and Telecommunication. Administered by Information Technology Management. P: ITM 311 R: Open to students in the Information Technology Specialization. Practical training and experiences in design, testing, and launch of new information technologies and systems.

450 Translation of Programming Languages
Spring. 3(3-0) P: CSE 331 and (CSE 320 or ECE 331) R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CPS 450

460 Formality and Formal Language Theory
Fall, Spring. 3(3-0) P: CSE 331 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CSE 360
Formal models of computation such as finite state automata, pushdown automata and Turing machines. Formal definitions of languages, problems, and language classes including recursive, recursively enumerable, regular, and context free languages. The relationships among various models of computation, language classes, and problems. Church's thesis and the limits of computability. Proofs of program properties including correctness.

471 Media Processing and Multimedia Computing
Fall. 3(3-0) P: CSE 320 or CSE 331 or CSE 335 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor.

472 Computer Graphics
Spring. 3(3-0) P: CSE 331 or CSE 335 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CPS 472

473 Fundamentals of 3D Game Development
Fall. 3(3-0) P: CSE 331 or CSE 335 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. Further development and techniques for the 3D game development. Includes geometric transformations, procedual and keyframe animation, models and scene graphs, skeletal animation and skinned characters, illuminations and shading, collision detection, and level of detail.

476 Mobile Application Development
Spring. 3(3-0) P: CSE 320 or CSE 331 or CSE 335 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor.
Software development techniques for mobile devices such as smart phones and tablet computers.

477 Web Application Architecture and Development
Spring. 3(3-0) P: CSE 331 R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor.
Fundamentals of World Wide Web (WWW) programming, including protocols, client-server interaction, markup languages, client- and server-side programming, databases, and remote procedure calls. Development of a WWW server and WWW sites with browser-based interfaces to remote databases. Students will incorporate scaling, throughput, and latency considerations in the development of widely-distributed systems.

480 Database Systems
Spring. 3(3-0) P: CSE 331 R: Open to students in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CPS 480
Storage of and access to physical databases including indexing, hashing, and range accesses. Relations, data models, design principles, query languages, query optimization, transaction processing and recovery techniques. Object-oriented and distributed databases.

484 Information Retrieval
Fall. 3(3-0) P: CSE 331 RB: STT 351 R: Open to students in the Computer Engineering Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CPS 484

490 Independent Study in Computer Science
Fall, Spring. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. P: Open to students in the Computer Engineering Major or in the Computer Science Major. Approval of department; application required. SA: CPS 490
Supervised individual study in an area of computer science.

491 Selected Topics in Computer Science
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to students in the Computer Engineering Major or in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. Approval of department. SA: CPS 491
Topics selected to supplement and enrich existing courses and lead to the development of new courses.
498 Collaborative Design (W)
Fall, Spring, 4(2-4) P: ((CSE 420 or CSE 422 or CSE 425 or CSE 435 or CSE 440 or CSE 450) or (CSE 460 or CSE 471 or CSE 472 or CSE 473 or CSE 480 or CSE 484)) and ((CSE 335 and CSE 410) and completion of Tier I writing requirement) R: Open to students in the Computer Science Major or in the Lyman Briggs Computer Science Co-ordinate Major. SA: CSE 449; CSE 479; CSE 479
Development of a comprehensive software and/or hardware solution to a problem in a team setting with emphasis on working with a client. Participation in a design cycle including specification, design, implementation, testing, maintenance, and documentation. Issues of professionalism, ethics, and communication.

801 Introduction to Computational Science for Evolutionary Biologists
Fall. 3(3-0) R: A strong background in molecular biology, evolution, or ecology. R: Not open to graduate students in the College of Engineering or in the Department of Computer Science and Engineering. Approval of department.
Introductory and intermediate programming and scripting for data analysis and modeling. Algorithmic considerations. Scientific controls, workflows, and reproducibility.

802 Pattern Recognition and Analysis
Spring. 3(3-0) R: CSE 331 and MTH 314 and STT 441 or CSE 331 and MTH 314 and STT 441 R: Open to graduate students in the Department of Computer Science and Engineering or in the Department of Electrical and Computer Engineering. Algorithms for classifying and understanding data. Statistical and syntactic methods, supervised and unsupervised machine learning. Cluster analysis and ordination. Experiential data analysis. Methodology for design of classifiers.

803 Computer Vision
Fall. 3(3-0) R: CSE 331 and MTH 314 and STT 351 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 803

812 Distributed Systems
Spring. 3(3-0) R: CSE 410 R: Open to students in the Electrical Engineering Major or in the Computer Science Major. SA: CPS 812
Principles, paradigms, techniques used in distributed systems. Assurance techniques for distributed systems. Fault-tolerance and security issues in distributed systems. Research issues in the design and implementation of distributed systems.

813 Advanced VLSI Design
Spring. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Electrical and Computer Engineering. P: ECE 410 SA: EE 813

814 Formal Methods in Software Development
Fall of odd years. 3(3-0) R: MTH 472 R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 814
Formal specification languages, integrating verification with design. Development and the implementation of term project.

820 Advanced Computer Architecture
Fall, Spring. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Computer Science and Engineering. R: CSE 410 and CSE 420 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 820
Instruction set architecture, Pipelining, vector processors, cache memory, high bandwidth memory design, virtual memory, input and output. Benchmarking techniques. New developments related to single CPU systems.

824 Advanced Computer Networks and Communications
Fall. 3(3-0) R: CSE 422 R: Open only to graduate students in the Department of Computer Science and Engineering. SA: CPS 824
Advanced topics in emerging computer networking technologies, including high-speed wide area networks and local area networks, wireless and mobile computing networks, optical networks, and multimedia networking.

825 Computer and Network Security
Spring. 3(3-0) R: CSE 410 and CSE 422 R: Secure software, intrusions and intrusion detection.

830 Design and Theory of Algorithms
Fall, Spring. 3(3-0) R: CSE 460 R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 830
Analysis of algorithms. Algorithm design techniques. Efficient algorithms for classical problems. Intractable problems and techniques to handle them.

835 Algorithmic Graph Theory
Spring. 3(3-0) R: CSE 232 and CSE 460 and (MTH 309 or MTH 314) R: Open to students in the Department of Computer Science and Engineering or approval of department. SA: CPS 835
Classical concepts in Graph Theory. Algorithmic aspects of graphs such as finding paths, network flow, spanning trees and matching.

836 Probabilistic Models and Algorithms in Computational Biology
Spring. 3(3-0) R: CSE 331 RB: Basic understanding of data structures; probabilities; programming experiences (no restriction to programming language)
Canonical probabilistic models and algorithms used in important bioinformatics tools.

841 Artificial Intelligence
Fall. 3(3-0) R: CSE 440 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 841
Types of intelligence, knowledge representation, cognitive models. Goal-based systems, heuristic search and planning, expert systems. Language understanding, robotics and computer vision, theorem proving and deductive systems, and learning.

842 Natural Language Processing
Spring of odd years. 3(3-0) R: Programming skills, basic probability and statistics knowledge.
Models and algorithms for natural language processing including syntax, semantics, pragmatics, and discourse. Knowledge-based and statistical approaches to a variety of language related applications.

843 Language and Interaction
Spring of even years. 3(3-0) R: CSE 440 R: Programming skills. Basic probability and statistical knowledge.
Introduction to foundations and the state-of-the-art technology enabling natural language communication with artificial agents. Speech recognition, acoustics modeling and language modeling, dialogue and discourse modeling, psycholinguistic studies on situated human language processing, and their applications in situated human robot dialogue.

845 Multi-disciplinary Research Methods for the Study of Evolution
Spring. 3(3-0) Interdepartmental with Microbiology and Molecular Genetics and Zoology. Administered by Computer Science and Engineering.
Techniques for engaging in multi-disciplinary research collaborations, including biology, computer science, and engineering. Students engage in group projects to answer fundamental questions about the dynamics of actively evolving systems including both natural and computational. Multi-disciplinary teams will learn to overcome discipline-specific language and conceptual issues. Experimental design, statistical analysis, data visualization, and paper and grant writing for multi-disciplinary audiences.

847 Machine Learning
Spring. 3(3-0) R: CSE 841 R: Algorithms, programming in C or equivalent, probability and statistics, artificial intelligence. R: Open only to students in the Department of Computer Science and Engineering or approval of department.
Computational study of learning and data mining. Strengths and limitations of various learning paradigms, including supervised learning, learning from scalar reward, unsupervised learning, and learning with domain knowledge.

848 Evolutionary Computation
Fall of even years. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Computer Science and Engineering. R: CSE 841 and CSE 440 R: Open to graduate students in the Department of Computer Science and Engineering and open to graduate students in the Department of Electrical and Computer Engineering or approval of department.
Investigation of evolutionary computation from a historical, theoretical and application viewpoint. Readings from the present literature, experiments with provided software on the application of evolutionary computation principles.

860 Foundations of Computing
Spring of even years. 3(3-0) R: CSE 460 R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 860
867 Nature and Practice of Cognitive Science  
Spring. 3(3-0) Interdepartmental with Linguistics and Philosophy and Psychology and Zoology. Administered by Zoology. RB: Undergraduate course work in behavioral biology, cognitive psychology, linguistics, or artificial intelligence. Survey of how different disciplines explore the cognitive processes underlying intelligent behavior.

870 Advanced Software Engineering  
Spring. 3(3-0) RB: (CSE 470) or undergraduate software engineering course R: Open only to students in the Department of Computer Science and Engineering. Methods and techniques supporting later lifecycle activities, including software testing and maintenance, reuse, and reverse engineering. Domain-specific software engineering methods. Human-computer interfaces, distributed systems, and visualization techniques.

872 Advanced Computer Graphics  
Fall. 3(3-0) RB: CSE 472  
Advanced aspects of digital image generation, geometric modeling, computer animation and rendering methods.

880 Advanced Database Systems  
Fall. 3(3-0) RB: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 880  
Distributed and object-oriented databases and knowledgebase systems. Design theory, query optimization, and transaction processing.

881 Data Mining  
Fall. 3(3-0) RB: Programming skills in C, C++, Java and Matlab. Basic knowledge in calculus, probability and statistics. Techniques and algorithms for knowledge discovery in databases, from data preprocessing and transformation to model validation and post-processing. Core concepts include association analysis, sequential pattern discovery, anomaly detection, predictive modeling, and cluster analysis. Application of data mining to various application domains.

885 Artificial Neural Networks  
Spring. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Electrical and Computer Engineering. SA: EE 885  

890 Independent Study  
Fall. Spring. Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to Computer Science or Electrical Engineering majors. Approval of department. SA: CPS 890  
Independent study of some topic, system, or language not covered in a regular course.

891 Selected Topics  
Fall, Spring. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 891  
Selected topics in computer science of current interest and importance but not covered in a regular course.

898 Master’s Project  
Spring. 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to students in the Department of Computer Science and Engineering. Approval of department. In depth student project where the student performs original research, research replication, or survey and reporting on a topic such as system design and development, or system conversion or installation.

899 Master’s Thesis Research  
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 24 credits in all enrollments for this course. R: Open only to Computer Science majors. Approval of department. SA: CPS 899  
Master’s thesis research.

902 Selected Topics in Recognition by Machine  
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. RB: CSE 802 and CSE 803 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 902  
Advanced topics in pattern recognition and computer vision such as Markov random fields, modeling and recognition of three dimensional objects, and integration of visual modules.

910 Selected Topics in Computer Networks and Distributed Systems  
Spring of even years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. RB: CSE 422 and CSE 812 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 910  
Advanced topics and developments in high-bandwidth computer networks, protocol engineering, and distributed computer systems.

912 Advanced Topics in Distributed Computing Systems  
Spring of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. RB: CSE 410 and CSE 812  
Advanced topics and developments in Internet computing, distributed algorithm and operating systems, distributed middleware, high-performance distributed computing, peer-to-peer computing, security and fault tolerance of distributed systems, mobile computing, ubiquitous and pervasive computing, and distributed-data management.

914 Formal Methods in Software Development  
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. R: CSE 814 RB: Undergraduate courses in software engineering and in logic. R: Open to graduate students in the Department of Computer Science and Engineering. Current research in selected areas of software engineering such as: approaches for the incorporation of formal methods in software development; current projects using formal methods in software engineering; object-oriented analysis and development techniques; and approaches for the incorporation of user-interface analysis and design in software development.

920 Selected Topics in High Performance Computer Systems  
Spring of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. Interdepartmental with Electrical and Computer Engineering. Administered by Computer Science and Engineering. R: Open to students in the Computer Science Major or approval of department. SA: CPS 920  
Design of high performance computer systems. Seminar format.

921 Advanced Topics in Digital Circuits and Systems  
Fall, Spring. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course. Interdepartmental with Electrical and Computer Engineering. Administered by Electrical and Computer Engineering. SA: EE 921  
Topics vary each semester.

941 Selected Topics in Artificial Intelligence  
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. RB: CSE 841 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 941  
Topic such as second generation expert systems, human factors, natural language processing, speech understanding, neural networks, genetic algorithms and opportunistic planning.

960 Selected Topics in Algorithms and Complexity  
Spring of odd years. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. RB: CSE 830 and CSE 860 R: Open only to graduate students in the Department of Computer Science and Engineering. Approval of department. SA: CPS 960  
Current research in the general theory of algorithms and computational complexity.

980 Selected Topics in Database Systems  
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. RB: CSE 880 R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 980  
Recent developments in areas such as distributed and parallel database systems, object oriented database systems, knowledgebase and expert database systems.

999 Doctoral Dissertation Research  
Fall, Spring, Summer. 1 to 36 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to graduate students in the Computer Science major. Approval of department. SA: CPS 999  
Doctoral dissertation research.