COMPUTER SCIENCE AND ENGINEERING

Department of Computer Science and Engineering
College of Engineering

100 Computer Science as a Profession
Fall, Spring. 1(1-0) RB: High school algebra; ability to use a computer for browsing, email, and report preparation. The computing and programming profession. Professionalism and ethics. Industry practice. Experiments with programming.

101 Computing Concepts and Competencies
Fall, Spring, Summer. 3(2-2) SA: CPS 100, CPS 130
Core concepts in computing including information storage, retrieval, management, and representation. Applications from specific disciplines. Applying core concepts to design and implement solutions to various focal problems, using hardware, multimedia software, communication and networks.

102 Algorithmic Thinking and Programming
Fall, Spring, Summer. 3(2-2) P: (MTH 103 or MTH 103B or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LB 118) or designated score on Mathmatics Placement test Not open to students with credit in CSE 231.
Fundamentals of computing, algorithms and programming, using a high-level language such as Python.

201 Fundamentals of Information Technology
Fall, Spring. 3(3-0) P: (CSE 102 or CSE 220 or CSE 231) and (MTH 103 or MTH 103B or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LB 118) or concurrently) R: Open to undergraduates. Not open to students with credit in CSE 240.
Fundamentals of applied computing and computational thinking.

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) R: Open to undergraduates. 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, Spring. 4(3-2) 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 or CMSE 202) 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.

260 Discrete Structures in Computer Science
Fall, Spring. 4(5-0) P: MTH 133 or MTH 126 or MTH 153H or LB 119 SA: CPS 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 Social, Ethical, and Professional Issues in Computer Science
Fall, Spring. 1(1-0) R: Open to undergraduates in the Department of Computer Science Major or in the Computer Science and Engineering. P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) R: Open to juniors or seniors in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major in or the Lyman Briggs Computer Science Major or in the Computer Science Disciplinary Teaching Minor. SA: CSE 370

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 Major.

331 Algorithms and Data Structures
Fall, Spring. 3(3-0) P: (CSE 232) and (CSE 260 or CMSE 202) 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 Data Science Major and open to juniors or seniors in the College of Engineering.
Design, analysis, and application of fundamental algorithms and data structures in computer science.

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
Object-oriented techniques used for feature extraction and pattern matching focusing on face, fingerprint and iris recognition.

402 Biometrics and Pattern Recognition
Fall, Spring. 3(3-0) P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) R: Open to juniors or seniors in the College of Engineering or in the Computer Science Minor or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Automated techniques used for feature extraction and pattern matching focusing on face, fingerprint and iris recognition.

404 Introduction to Machine Learning
Fall, Spring. 3(3-0) Interdepartmental with Computational Mathematics, Science, and Engineering and Statistics and Probability. Administered by Computer Science and Engineering. P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) R: Basic linear algebra R: Open to juniors or seniors in the College of Engineering or in the Computer Science Minor or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Core principles and techniques of all machine learning including model design and programming algorithms.
Computer Science and Engineering—CSE

410 Operating Systems
Fall. 3(3-0) P: (CSE 232 and CSE 260) and CSE 325 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major. SA: CPS 410 Theory and application of modern computer operating systems.

415 Introduction to Parallel Computing
Spring. 3(3-0) P: CSE 320 and CSE 331 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major. Not open to students with credit in CMSE 401.
Core principles and techniques of parallel computing including architectures, programming models, and algorithm design. Performance analysis and optimization. Use of parallel computers.

420 Computer Architecture
Spring of odd years. 3(3-0) P: (CSE 232 and CSE 260) and CSE 325 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Lyman Briggs Computer Science Major. Not open to students with credit in CMSE 401.
Fundamental organization and architecture of computer systems.

422 Computer Networks
Fall, Spring. 3(3-0) P: (STT 351 or ECE 280 or STT 430 or STT 441) and CSE 325 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major. SA: CPS 422
Computer network architectures and protocols.

425 Introduction to Computer Security
Spring. 3(3-0) P: (CSE 422 or concurrently) or (ECE 442 or concurrently) R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Theory and practice of computer security engineering.

429 Interdisciplinary Topics in CyberSecurity
Spring. 3(3-0) Interdepartmental with Criminal Justice. Administered by Computer Science and Engineering. P: CSE 102 or CSE 231 R: Open to juniors or seniors or graduate students.
Technical, legal, criminal, medical business, and communication aspects of CyberSecurity.

431 Algorithm Engineering
Fall, Spring. 3(3-0) P: CSE 331 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Algorithm analysis, design, implementation, and optimization for a broad range of problem categories including techniques to recognize and cope with intractable problems.

435 Software Engineering
Fall. 3(3-0) P: (CSE 331 and CSE 335) and completion of Tier I writing requirement R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Software engineering methods for reliable, reusable, and dependable software.

440 Introduction to Artificial Intelligence
Fall. 3(3-0) P: CSE 331 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major or in the Lyman Briggs Computer Science Major. SA: CPS 440

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

450 Translation of Programming Languages
Fall. 3(3-0) P: CSE 331 and (CSE 320 or ECE 331) R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major. SA: CPS 450
Theory and practice of programming language translation from languages and grammars to optimization and generation.

460 Computability and Formal Language Theory
Fall. 3(3-0) P: CSE 331 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
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.

461 Machine Processing and Multimedia Computing
Spring. 3(3-0) P: CSE 320 or CSE 331 or CSE 335 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.

472 Computer Graphics
Spring. 3(3-0) P: CSE 331 or CSE 335 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major. SA: CPS 472

476 Mobile Application Development
Spring. 3(3-0) P: CSE 320 or CSE 331 or CSE 335 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Software development techniques for mobile devices such as smartphones and tablet computers.

477 Web Application Architecture and Development
Spring. 3(3-0) P: CSE 320 or CSE 331 or CSE 335 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
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 or CSE 335 R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Principles and technologies for database systems, algorithms, languages, and applications.

482 Big Data Analysis
Spring. 3(3-0) P: (CSE 331) and (STT 351 or STT 380 or STT 430 or STT 441) R: Open to juniors or seniors in the College of Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science Major.
Data collection, storage, and preprocessing, and analysis techniques. Programming for large-scale data analysis. Case studies and applications.
CSE—Computer Science and Engineering

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. R: Open to students in the Computer Engineering Major or in the Computer Science Major. Approval of department; application required. SA: CPS 490

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

492 Selected Topics in Data Science
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. Interdepartmental with Computational Mathematics, Science, & Engineering and Statistics and Probability. Administered by Computational Mathematics, Science, & Engineering. R: Approval of department. Topics selected to supplement and enrich existing courses in Data Science.

495 Experiential Learning in Data Science (W)
Fall, Spring. 4(2-4) Interdepartmental with Computational Mathematics, Science, & Engineering and Statistics and Probability. Administered by Computational Mathematics, Science, & Engineering. P: (CSE 232 and CMSE 382) and completion of Tier I writing requirement. R: Open to seniors. Team-based data science projects on realistic, large-scale data.

498 Collaborative Design (W)
Fall, Spring. 4(2-4) F: (CSE 402 or CSE 415 or CSE 422 or CSE 431 or CSE 440 or CSE 450 or CSE 471 or CSE 476 or CSE 477 or CSE 482) and (CSE 402 or CSE 420 or CSE 425 or CSE 435 or CSE 440 or CSE 460 or CSE 472 or CSE 477 or CSE 480 or CSE 482) and (CSE 355 and completion of Tier I writing requirement) and (CSE 325 or CSE 410) R: Open to students in the Computer Science Major or in the Lyman Briggs Computer Science Coordinate Major. SA: CPS 449, CSE 476, CSE 479

499 Undergraduate Research
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course. 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 Coordinator Major or in the Lyman Briggs Computer Science Major. Approval of department. Independent undergraduate research in contemporary areas of computer science.

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

820 Advanced Computer Architecture
Fall of even years. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Computer Science and Engineering. RB: CSE 325 and CSE 420 R: Open to graduate students in the Department of Computer Science and Engineering or in the Department of Electrical and Computer Engineering. SA: CPS 820

822 Parallel Computing

824 Advanced Computer Networks and Communications
Fall. 3(3-0) RB: CSE 422 R: Open only to graduate students in the Department of Computer Science and Engineering. SA: CPS 824

830 Design and Theory of Algorithms
Fall, Spring. 3(3-0) RB: CSE 232 and CSE 460 R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 830

835 Algorithmic Graph Theory
Spring. 3(3-0) RB: (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

836 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.
Probabilistic Models and Algorithms in Computational Biology
Fall. 3(3-0) P: 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.

Artificial Intelligence
Fall. 3(3-0) RB: 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 games, expert systems. Language understanding, robotics and computer vision, theorem proving and deductive systems, and learning.

Natural Language Processing
Spring of odd years. 3(3-0) RB: 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.

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

Multi-disciplinary Research Methods for the Study of Evolution
Spring. 3(3-0) Interdepartmental with Integrative Biology and Microbiology and Molecular Genetics. 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.

Machine Learning
Spring. 3(3-0) P: CSE 841 RB: 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.

Evolutionary Computation
Fall of even years. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Computer Science and Engineering. RB: 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.

Foundations of Computing
Spring of even years. 3(3-0) RB: CSE 460 R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 860

Nature and Practice of Cognitive Science
Spring. 3(3-0) Interdepartmental with Integrative Biology and Linguistics and Philosophy and Psychology. Administered by Psychology. RB: Undergraduate course work in behavioral biology, cognitive psychology, philosophy, linguistics, or artificial intelligence. SA: ZOL 867
Survey of how different disciplines explore the cognitive processes underlying intelligent behavior.

Advanced Software Engineering
Spring. 3(3-0) RB: CSE 470 or under-graduate 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, reverse engineering. Domain-specific software engineering methods. Human-computer interfaces, distributed systems, and visualization techniques.

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

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.

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

Independent Study
Fall, Spring. 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.

Selected Topics
Fall. Spring. 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. SA: CPS 891
Selected topics in computer science of current interest and importance but not covered in a regular course.

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.

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.

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.

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.
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. P: 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.

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.