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.

131 Technical Computing and Problem Solving
Fall, Spring. 3(1-3) P: (MTH 124 or concurrently) or (MTH 132 or concurrently) or (LBS 118 or concurrently) SA: CPS 131
Use of computing systems for technical problem solving in engineering and science.

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 LBS 117) 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.

231 Introduction to Programming I
Fall, Spring, Summer. 4(3-2) P: (LBS 118 or concurrently) or (MTH 124 or concurrently) or (MTH 132 or concurrently) or (LBS 118 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 (LBS 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 LBS 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.

320 Computer Organization and Architecture
Fall, Spring. 3(3-0) P: CSE 232 and CSE 260 R: Open to undergraduate students in the Department of Computer Science and Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science major. SA: CPS 320
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 undergraduate students in the Department of Computer Science and Engineering or Computer Engineering majors or the LBS Computer Science coordinate major or the Computer Science disciplinary teaching minor.
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. 3(3-0) P: CSE 232 and CSE 260 R: Open only to students in Computer Science or Computer Engineering or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary minor. SA: CPS 370

410 Operating Systems
Fall, Spring. 3(3-0) P: (CSE 232 and CSE 260) and (CSE 320 or ECE 331) R: Open only to students in the Department of Computer Science and Engineering or the Computer Engineering major or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary teaching minor. SA: CPS 410

420 Computer Architecture
Fall, Spring, 3(3-0) P: (CSE 232 and CSE 260) and (CSE 320 or ECE 331) 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: CPS 420
Organization and architecture of computer systems. Arithmetic Logic Unit and control unit implementations. Hardware and microprogrammed control. Pipelined processors; data and branch hazards. Memory hierarchy and storage devices. Input-output and peripheral devices. Advanced architectures.

422 Computer Networks
Fall, Spring. 3(3-0) P: (STT 351 or ECE 280) and (CSE 320 or ECE 331) and (CSE 410 or concurrently) R: Open only to students in the Department of Computer Science or the Computer Engineering or LBS Computer Science major or the LBS Computer Science coordinate major or the Computer Science disciplinary teaching minor. SA: CPS 422

425 Introduction to Computer Security
Spring. 3(3-0) P: CSE 422 R: Open to students in Computer Engineering major or in Computer Science major.

429 Interdisciplinary Topics in CyberSecurity
Fall, Spring. 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.
Software Engineering  
Fall. (3-0) P CSE 330 and CSE 331 and CSE 335 R: Open only to students in the Department of Computer Science or the Computer Engineering or LBS Computer Science major or the LBS Computer Science coordinate major or 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.

Introduction to Artificial Intelligence  
Fall. (3-0) P: CSE 331 or CSE 335 R: Open only to students in the Department of Computer Science and Engineering or the Computer Engineering major or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary teaching minor. SA: CPS 440

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

Translation of Programming Languages  
Spring. (3-0) P: (CSE 331 or CSE 335) and (CSE 320 or CSE 335) R: Open only to students in the Department of Computer Science and Engineering or the Computer Engineering major or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary teaching minor. SA: CPS 450

Organization of Programming Languages  
Fall. (3-0) P: (CSE 331 or CSE 335) and (CSE 320 or ECE 331) R: Open only to students in the Department of Computer Science and Engineering or the Computer Engineering major or the LBS Computer Science field of concentration or the Computer Science disciplinary teaching minor. SA: CPS 452

Computability and Formal Language Theory  
Fall, Spring. (3-0) P: CSE 331 R: Open only to students in the Department of Computer Science and Engineering or Computer Engineering major or LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the LBS Computer Science field of concentration or 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, recursive 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.

Media Processing and Multimedia Computing  
Fall. (3-0) P: CSE 320 or CSE 331 or CSE 335 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.

Computer Graphics  
Spring. (3-0) P: (MTH 234 or LB 220) and (CSE 331 or CSE 335) R: Open to juniors or seniors in the Department of Computer Science and Engineering or in the Lyman Briggs Computer Science Coordinate Major or in the Lyman Briggs Computer Science major. SA: CPS 472

Fundamentals of 3D Game Development  
Fall. (3-0) P: MTH 234 and (CSE 320 or CSE 331 or CSE 335) R: Open to juniors or seniors 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.
Fundamental algorithms and techniques for 3D computer game development including geometric transformations, procedural and keyframe animation, models and scene graphs, skeletal animation and skinned characters, illuminations and shading, collision detection, and level of detail.

Introduction to Computational Linguistics  
Fall. (3-0) Interdepartmental with Linguistics. Administered by Linguistics. P: CSE 232 and LIN 401
Computer science of linguistic theories and their application in natural language processing systems. Stochastic and categorical automata for morphological analysis. Rule grammars. Parsing algorithms for syntactic and semantic analysis, with implications for cognitive models of human sentence processing. Probabilistic models of linguistic events.

Database Systems  
Spring. (3-0) P: CSE 331 and (CSE 320 or ECE 331) R: Open only to students in the Department of Computer Science and Engineering or the Computer Engineering major or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary teaching minor. SA: CPS 480
Storage of and access to physical databases including indexing, hashing, and range accesses. Relational data models, database design principles, query languages, query optimization, transaction processing and recovery techniques. Object-oriented and distributed databases.

Information Retrieval  
Fall. (3-0) P: CSE 331 RB: STT 351 R: Open only to students in Computer Science or Computer Engineering or Lyman Briggs Computer Science major.

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

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: Open only to students in the Department of Computer Science or the Computer Engineering major. Approval of department. SA: CPS 491
Topics selected to supplement and enrich existing courses and lead to the development of new courses.

Collaborative Design (W)  
Fall, Spring. 4(2-4) P: (CSE 335 and CSE 410) and computer science major requirement and (CSE 420 or CSE 422 or CSE 435 or CSE 440 or CSE 450 or CSE 452 or CSE 460 or CSE 471 or CSE 472 or CSE 480) R: Open only to students in the Department of Computer Science and Engineering. SA: CSE 449, CSE 478, 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.

Pattern Recognition and Analysis  
Spring. (3-0) RB: (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.
803  Computer Vision
Fall. 3(3-0) RB: CSE 331 and MTH 314 and
STT 351 R: Open only to Computer Science or Elec-
trical Engineering majors. SA: CPS 803
Visual information processing problems. Human and
machine vision systems. Image formation and trans-
forms. Encoding, enhancement, edge detection,
segmentation, 2D and 3D object description and

812  Advanced Operating Systems
Spring. 3(3-0) RB: CSE 410 and CSE 420 R:
Open only to Computer Science or Elec-
trical Engineering majors. SA: CPS 812
Parallel and distributed operating systems. Load
sharing, scheduling, reliability, recovery, memory
management. Distributed file systems, distributed
agreement, and object-oriented operating systems.

813  Advanced VLSI Design
Spring. 3(3-0) Interdepartmental with Elec-
trical and Computer Engineering. Adminis-
tered by Electrical and Computer Engineer-
ing. P: ECE 410 SA: EE 813
Advanced computer architecture. Design specify-
s: functionality, performance, reliability, manufactur-
ability, testability, cost. Standard.
cells. Design-rule checking. Circuit extraction,
simulation, verification. Team-based design.

814  Formal Methods in Software Development
Fall of odd years. 3(3-0) RB: MTH 472 R:
Open only to majors in the Department of Com-
puter Science and Engineering or app-
roval of department. SA: CPS 814
Formal specification languages, integrating verifica-
tion with development. Design and the implementa-
tion of term project.

820  Advanced Computer Architecture
Fall. Spring. 3(3-0) Interdepartmental with Elec-
trical and Computer Engineering. Ad-
ministered by Computer Science and Engi-
neering. RB: CSE 410 and CSE 420 R:
Open only to Computer Science or Electrical
Engineering majors. SA: CPS 820
Instruction set architecture. Pipelining, vector pro-
cessors, cache memory, high bandwidth memory
design, virtual memory, input and output. Bench-
marking techniques. New developments related to
single CPU systems.

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

825  Computer and Network Security
Spring. 3(3-0) RB: CSE 410 and CSE 422
Threat assessments, secure software, intrusions
and intrusion detection.

830  Design and Theory of Algorithms
Fall. Spring. 3(3-0) RB: CSE 232 and CSE
460 R: Open only to majors in the Depart-
ment of Computer Science and Engineering
or approval of department. SA: CPS 830
Analysis of algorithms. Algorithm design tech-
niques. Efficient algorithms for classical problems. Intracta-
ble problems and techniques to handle them.

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 de-
partment. SA: CSE 835
Classical concepts in Graph Theory. Algorithmic
aspects of graphs such as finding paths, network
flow, spanning trees and matching.

841  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, theo-
rem proving and deductive systems, and learning.

842  Natural Language Processing
Spring of odd years. 3(3-0) RB: Program-
ming skills, basic probability and statistics
knowledge.
Models and algorithms for natural language pro-
cessing including syntax, semantics, pragmatics,
and discourse. Knowledge-based and statistical
approaches to a variety of language related applica-
tions.

847  Machine Learning
Spring. 3(3-0) P: CSE 841 R: Algorithms:
programming in C or equivalent. Probability and
statistics, artificial intelligence, R: Open
only to students in the Department of Com-
puter Science and Engineering or approval of
department.
Computational studies of learning and data mining.
Strengths and limitations of various learning para-
digms, 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 Elec-
trical and Computer Engineering. Adminis-
tered by Computer Science and Engineering.
RB: CSE 841 and CSE 440 R:
Open to graduates and in the Depart-
ment of Computer Science and Engineering
and open to graduate students in the De-
partment of Electrical and Computer Engi-
neering 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 evolu-
tionary computation principles.

860  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
Models of computation: partial recursive functions,
Turing machines, alternative models of computing.
Basic theory and limitations of computability. Unde-
cidability. Resource-bounded computational com-
plexity, non-determinism, NP-completeness.

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

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

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

875  Advanced Studies in Computational Linguistics
Spring. 3(3-0) A student may earn a maxi-
mum of 9 credits in all enrollments for this course.
Interdepartmental with Linguistics. Administered by Linguistics (PL 475)
Cutting-edge research in computational linguistics.
Expressive formalisms such as tree-adjoining, type-
logical and multi-component string grammars, and
their associated parsing and learning problems.
Robustness for spoken language understanding.
Mathematical theories of language learnability.
Logic and probability of finite state techniques.

880  Advanced Database Systems
Fall. 3(3-0) RB: CSE 480 R: Open only to
majors in the Department of Computer Sci-
ence and Engineering or approval of de-
partment. 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 trans-
formation to model validation and post-processing.
Core concepts include association analysis, sequen-
tial 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 Elec-
trical and Computer Engineering. Adminis-
tered by Electrical and Computer Engineer-
ing. SA: EE 885
Overview of neuro-engineering technology. Basic
neural network architectures. Feedbackforward and
feedback networks. Temporal modeling. Supervised
and unsupervised learning. Implementation. Basic
applications to pattern recognition.

890  Independent Study
Fall. Spring. 1 to 3 credits. A stu-
dent 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 lan-
guage 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.

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) 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. 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. P: CSE 822 R: Open only to students in the Computer Science and Engineering 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 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to Computer Science majors. Approval of department. SA: CPS 999
Doctoral dissertation research.