Computer Science and Engineering (CSE)

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For major requirements, see the School of Engineering section of this Catalog.

1000. Computers in Modern Society
Three credits. Two class periods and one 1-hour program design periods. Not open for credit to students who have passed CSE 110C or 1010 or 1100. Students who anticipate extensive study or use of computers in their future work should take CSE 1100-1102 rather than this course.

Introduction to computer applications in the humanities, social sciences, business, and other fields. Influence of the computer on modern society and technology. Elements of computer usage in the solution of numeric and non-numeric problems including introduction to programming methods.

1010. Introduction to Computing for Engineers
Three credits. Two 1-hour lectures and one 2-hour laboratory. Not open for credit to students who have passed CSE 110 or 1100 or 1102.

Introduction to computing logic, algorithmic thinking, computing processes, a programming language and computing environment. Knowledge obtained in this course enables use of the computer as an instrument to solve computing problems. Representative problems from science, mathematics, and engineering will be solved.

1100. Introduction to Computing
Two credits. Two class periods of lecture and one 1-hour laboratory period per week. No previous programming experience required. Not open for credit to students who have passed CSE 110C.

Problem solving with the computer, basics of data representation and computer organization, procedural and object-oriented programming in a modern language including control structures, functions and parameter passing, one and two dimensional arrays, numerical error and basic numerical methods. Examples taken from various disciplines. Programming projects required. Intellectual property issues discussed.

1102. Object Oriented Design and Programming
Three credits. Three class periods of lecture and one 75-minute laboratory period per week. Prerequisite: CSE 1100 or 1010 or 1102.


1401. Honors Core: Computational Molecular Biology
(Also offered as BME 1401, MCB 1401, and PNB 1401.) Three credits.

Introduction to research in computational biology through lectures, computer lab exercises, and mentored research projects. Topics include gene and genome structure, gene regulation, mechanisms of inheritance, biological databases, sequence alignment, motif finding, human genetics, forensic genetics, stem cell development, comparative genomics, early evolution, and modeling complex systems. CA 3.

1729. Introduction to Principles of Programming
Three credits. Two 1-hour lectures and one 2-hour laboratory. Prerequisite: CSE 1010. Not open for credit to students who have passed CSE 110, 123, 1100, or 1010. CSE 1729 may be used in place of CSE 1010 to fulfill any requirement fulfilled by CSE 1010.

An introduction to computer programming in a structured programming language including fundamental elements of program design and analysis. Data and functional abstraction as tools for constructing correct, efficient, and intelligible programs for a variety of common computing problems. While this course covers the material in CSE 1010, its focus on abstraction makes it appropriate for students seeking a deeper understanding of computing fundamentals as well as those

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planning on continued study in computing.

2050. Data Structures and Object-Oriented Design
Three credits. Three class periods of lecture and one 75-minute laboratory period per week. Prerequisite: CSE 1729. Not open to students who have passed CSE 2100.
Introduction to fundamental data structures and algorithms. The emphasis is on understanding how to efficiently implement different data structures, communicate clearly about design decisions, and understand the relationships among implementations, design decisions, and the four pillars of object-oriented programming: abstraction, encapsulation, inheritance, and polymorphism.

2100. Data Structures and Introduction to Algorithms
Three credits. Three class periods of lecture. Prerequisite: CSE 1102. Students who have passed CSE 124C will receive only 2 credits for this course.
Fundamental concepts of data structures and the algorithms that proceed from them. Implementation and use of linked lists, stacks, queues, trees, priority queues, heaps and graphs. Emphasis on recursion, abstract data types, object oriented design, and associated algorithms and complexity issues. Design using specifications and requirements. Basic computer organizations, including memory organizations and allocations issues. Programming assignments.

2102. Introduction to Software Engineering
Three credits. Three class periods and one problem session. Prerequisite: CSE 2050 or 2100 and 2500; CSE 2500 may be taken concurrently.
Software engineering concepts including the software life cycle and other software-development process models. Specification techniques, design methodologies, performance analysis, and verification techniques. Team-oriented software design and development, and project management techniques. Use of appropriate design and debugging tools for a modern programming language. Homework and laboratory projects that emphasize design and the use/features of a modern programming language.

2300W. Digital Logic Design
Four credits. Three class periods and one 2-hour laboratory period. Prerequisite: CSE 1010 or 1100 or 1102 or 1729 and secondary school physics or PHYS 1010 or 1501; ENGL 1010 or 1011 or 2011. Not open to students who have passed CSE 207.
Representation of digital information. Analysis, design, and evaluation of combinational and sequential logic circuits. Debugging techniques. Use of computer facilities for circuit simulation, CAD, and report preparation and presentation. Introduction to structure and operation of digital computers. Design projects. Written reports with revisions are required for each project.

2304. Computer Architecture
Three credits. Prerequisite: CSE 2050 or 2100 and 2500. Not open to students who have credit for CSE 207 or CSE 241 or CSE 2300W.
Structure and operation of digital systems and computers. Fundamentals of digital logic. Machine organization, control and data paths, instruction sets, and addressing modes. Hardwired and microprogrammed control. Memory systems organization. Discussion of alternative architectures such as RISC, CICS, and various parallel architectures.

2500. Introduction to Discrete Systems
Three credits. Prerequisite: CSE 1102 or 1729.
Mathematical methods for characterizing and analyzing discrete systems. Modern algebraic concepts, logic theory, set theory, grammars and formal languages, and graph theory. Application to the analysis of computer systems and computational structures.

3000. Contemporary Issues in Computer Science and Engineering
One credit. Prerequisite: CSE 2102 and either CSE 2304 or 3666; open only to Computer Science and Engineering and Computer Science majors.
The global and societal impact of computer science and engineering decisions, professional and ethical responsibility.

3002. Social, Ethical and Professional Issues in Computer Science and Engineering
Three credits. Prerequisite: CSE 2102; open only to Computer Science and Engineering and Computer Science majors.
Study of areas in which computer science interacts with ethical issues, and issues of public policy. Topics of professional growth, development, and responsibility. Practice in the analysis of complex issues brought about by modern technology.

3100. Systems Programming
Three credits. Two 1-hour lectures and one 2-hour laboratory per week. Prerequisite: CSE 2050 or 2100.
Introduction to system-level programming with an emphasis on C programming, process management, and small scale concurrency with multi-threaded programming. Special attention will be devoted to proficiency with memory management and debugging facilities both in a sequential and parallel setting.

3300. Computer Networks and Data Communication
Three credits. Prerequisite: CSE 2304 or 3666.
Introduction to computer networks and data communications. Network types, components and topology, protocol architecture, routing algorithms, and performance. Case studies including LAN and other architectures.

3302. Digital Systems Design
(Also offered as ECE 3401.) Three credits. Prerequisite: CSE 2300W; open only to students in the School of Engineering.
Design and evaluation of control and data structures for digital systems. Hardware design languages are used to describe and design alternative register transfer level architectures and control units with a micro-programming emphasis. Consideration of computer architecture, memories, digital interfacing timing and synchronization, and microprocessor systems.

3350. Digital Design Laboratory
(Also offered as ECE 4401.) Three credits. Four hours of laboratory. Prerequisite: Open only to students in the School of Engineering. Prerequisite or corequisite: CSE 3302/ECE 3401.
Digital designing with PLA and FPGA, A/D and D/A conversion, floating point processing, ALU design, synchronous and asynchronous controllers, control path; bus master; bus slave; memory interface; I/O interface; logic circuits analysis, testing, and troubleshooting; PCB; design and manufacturing.

3500. Algorithms and Complexity
Three credits. Three class periods. Prerequisite: CSE 2050 or 2100 and 2500.

3502. Theory of Computation
Three credits. Prerequisite: CSE 2050 or 2100 and 2500.
Formal models of computation, such as finite state automata, pushdown automata, and Turing machines, and their corresponding elements in formal languages (regular, context-free, recursively enumerable). The complexity hierarchy. Church’s thesis and undecidability. NP completeness. Theoretical basis of design and compiler construction.

3504. Probabilistic Performance Analysis of Computer Systems
Three credits. Prerequisite: CSE 2050 or 2100 and 2500; and one of STAT 3025Q or 3345Q or 3375Q or MATH 3160.
Introduction to the probabilistic techniques which can be used to represent random processes in computer systems. Markov processes, generating functions and their application to performance analysis. Models which can be used to describe the probabilistic performance of digital systems.

3666. Introduction to Computer Architecture
Three credits. Three 1-hour lectures and one 1-hour laboratory period. Prerequisite: CSE 2050 or 2100 and 2300W.
Structure and operation of digital systems and computers. Machine organization, control and data paths, instruction sets, and addressing modes. Integer and floating-point arithmetic, the memory hierarchy, the I/O subsystem. Assembly language and basic program organization, interrupts, I/O, and memory allocation.
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3800. Bioinformatics
(Also offered as BME 4800.) Three credits. Prerequisite: BIOL 1107, CSE 1010 or 1100 or 1729 and either STAT 3025Q or STAT 3345Q.

Fundamental mathematical models and computational techniques in bioinformatics. Exact and approximate string matching, suffix trees, pairwise and multiple sequence alignment, Markov chains and hidden Markov models. Applications to sequence analysis, gene finding, database search, phylogenetic tree reconstruction.

(Also offered as ECE 3431.) Three credits. Prerequisite: CSE 1010 or 1100 or 1729 and MATH 2110Q and 2410Q; open only to students in the School of Engineering. Prerequisite or corequisite: MATH 2210Q.

Introduction to the numerical algorithms fundamental to scientific computation. Equation solving, function approximation, integration, difference and differential equations, special computer techniques. Emphasis is placed on efficient use of computers to optimize speed and accuracy in numerical computations. Extensive digital computer usage for algorithm verification.

3810. Computational Genomics
(Also offered as BME 3810.) Three credits. Prerequisite: BIOL 1107, CSE 1010 or 1100 or 1729, and either STAT 3025Q or 3345Q.

Computational methods for genomic data analysis. Topics covered include statistical modeling of biological sequences, probabilistic models of DNA and protein evolution, expectation maximization and Gibbs sampling algorithms, genomic sequence variation, and applications in genomics and genetic epidemiology.

4095. Special Topics in Computer Science and Engineering
Credits by arrangement. Prerequisites and recommended preparation vary. Open only to students in the School of Engineering. With a change in content, this course may be repeated for credit.

Classroom course in special topics as announced in advance for each semester.

4099. Independent Study in Computer Science and Engineering
Credits by arrangement, not to exceed 4 in any semester. Prerequisite: Consent of instructor and department head; open only to students in the School of Engineering.

Exposes the student to management principles and practices and the knowledge and skills necessary to develop an education project and to perform a research project.

4100. Programming Language Translation
Three credits. Prerequisite: CSE 2102 and 3502 and either CSE 2304 or 3666; open only to students in the School of Engineering.

Introduction to the formal definition of programming language syntax and semantics. Design and realization of programming language processing systems such as assemblers, compilers, and interpreters.

4102. Programming Languages
Three credits. Prerequisite: CSE 3502; open only to students in the School of Engineering.

The study of programming language features and programming paradigms. Data types, control, run-time environments, and semantics. Examples of procedural, functional, logical, and object-oriented programming. Features used for parallel and distributed processing. Classic and current programming languages and environments.

4300. Operating Systems
Three credits. Prerequisite: CSE 2102 or 3100; CSE 2304 or 3666; open only to students in the School of Engineering.

Introduction to the theory, design, and implementation of software systems to support the management of computing resources. Topics include the synchronization of concurrent processes, memory management, processor management, scheduling, device management, file systems, and protection.

4302. Computer Organization and Architecture
Three credits. Three 1-hour lectures. Prerequisite: CSE 2300W; CSE 2304 or 3666; open only to students in the School of Engineering. This course and CSE 243 may not both be taken for credit. Cannot be taken after CSE 4901.

Organization and architecture of modern computer systems. Emphasis is on alternatives and advances to the basic Von Neumann architecture: topics such as pipelining, memory hierarchy and management, multiprocessor and
alternative architectures, reconfigurable hardware, and other techniques for performance enhancement.

4500. Parallel Systems
Three credits. Prerequisite: CSE 2304 or 3666, and CSE 3500; open only to students in the School of Engineering.

4701. Principles of Data Bases
Three credits. Prerequisite: CSE 3500; open only to students in the School of Engineering.
Fundamentals of data base design and data indexing techniques. Hierarchical, network, and relational data models. Data base design theory. Query languages, their implementation and optimization. Data base security and concurrent data base operations.

4702. Introduction to Modern Cryptography
Three credits. Prerequisites: CSE 3500 and CSE 3502; open only to students in the School of Engineering.
An introduction to the fundamentals of modern cryptography focusing on development of secure cryptographic tools based on hard computational problems. Topics include one-way functions, pseudorandom generators, encryption, digital signatures, and protocols.

4703. Principles of Computer Graphics
Three credits. Prerequisite: CSE 3500 and MATH 2110Q and either MATH 2210Q or 3210Q; open only to students in the School of Engineering.
Representation of two- and three-dimensional data, internal representation of data structures, transformations, mapping of data to graphics screen, graphics hardware. Programming projects are assigned.

4704. Computational Geometry
Three credits. Prerequisite: CSE 3500; open only to students in the School of Engineering.
An extension of sorting, searching, selection, and graph algorithms to geometric problems. This includes algorithms and data structures for constructing geometric objects, computing geometric properties, and answering geometric queries as well as techniques for the analysis of their correctness and complexity.

4705. Artificial Intelligence
Three credits. Prerequisite: CSE 3500; open only to students in the School of Engineering.
Design and implementation of intelligent systems, in areas such as natural language processing, expert reasoning, planning, robotics, problem solving and learning. Students will design their own versions of “classic” AI problems, and complete one substantial design project. Programming will be done primarily in Lisp, which will be covered briefly at the beginning of the course.

4707. Computer Security
Three credits. Prerequisite: CSE 2102 and either 2304 or 3666; and 3300 or equivalent with permission of the instructor; open only to students in the School of Engineering.

4709. Networked Embedded Systems
Three credits. Prerequisite: CSE 2300W, 2304 or 3666, and 3300 or equivalent with permission of the instructor; open only to students in the School of Engineering.
Introduction to the basic concepts, challenges, and methods for designing networked embedded systems. Examines related hardware, software, and system-level design. Hardware topics include various design alternatives (such as microcontrollers, digital signal processors (DSP), and field-programmable gate array (FPGA)) in resource-constrained environments. Software issues include operating systems, programming languages, program verification and analysis. System-level topics include autonomous wireless sensor network design, power and resource management, security and privacy.

4900. Independent Design Laboratory
Three credits. Prerequisite: CSE 2102; instructor and department head consent; open only to students in the School of Engineering. May be taken twice for credit.

Experimental design project undertaken by the student by special arrangement with a faculty member of the Department of Computer Science and Engineering.

4901. Digital Hardware Laboratory
(Also offered as ECE 4402.) Three credits. One 4-hour laboratory period. Prerequisite: CSE 4302; CSE 3401 or CSE 3302; open only to students in the School of Engineering.

Advanced combinational and sequential circuit design and implementation using random logic and microprocessor based system. Hardware and software interface to the basic system. Serial communication, user program loading and execution. Microcontrollers — familiarization and inclusion in design.

4902. Software Engineering Laboratory
Three credits. Four program design periods. Prerequisite: CSE 2102; open only to students in the School of Engineering.

A major software design project addresses specification through delivery phases of the lifecycle. The major focus of the course is utilization and application of concepts from CSE 2102 to a straightforward semester long project. This allows the student to explore programming in the large with an emphasis on techniques for teamwork, walk through, design, documentation, implementation, and debugging. Data structures and algorithm alternatives for the design and implementation phases of the lifecycle are also stressed. Formal design presentations are required by all students.

4903. Microprocessor Laboratory
Three credits. One lecture and one 3-hour laboratory period. Prerequisite: CSE 2304 or 3666; open only to students in the School of Engineering.

The design of microcomputer systems, including both hardware and software, for solving application problems. Hardware and software design and implementation techniques for interfacing microcomputers to other systems. Use of modern microcomputer software/hardware development facilities. Projects to design and apply microcomputer systems.

4904. Computer Science Design Laboratory
Three credits. One 4-hour laboratory period. Prerequisites and recommended preparation vary; open only to students in the School of Engineering. With a change in content this course may be repeated for credit.

Design and implementation of complex software and/or hardware systems to solve problems posed by either student groups or the instructor.

4905. Networking and Distributed Systems Laboratory
Three credits. Four hour laboratory. Prerequisite: CSE 3300; CSE 2304 or 3666; open only to students in the School of Engineering.

Software laboratory that explores selected issues in networking and distributed systems. Topics include: Berkeley sockets; TCP and IP; atm apis; latency and bandwidth; performance models; performance evaluation of different network fabrics; MPI; simple CORBA; performance characteristics of MPI, Java, RMI, and CORBA; implementation and evaluation of a client-server system.

4939W. Computer Science and Engineering Design Project I
Three credits. Prerequisite: One of CSE 4100, 4102, or 4300, which may be taken concurrently; ·ENGLE 1010 or 1011 or 2011; open only to Computer Science and Engineering and Computer Science majors.

The first semester of the required two-semester major design experience. Working on a team, students will propose, design, produce, and evaluate a software and/or hardware system. Will culminate in the delivery of the design, analysis, and initial working system, to be used as a basis for CSE 4940, formal public presentation, and written documentation. Oral and written progress reports are required.

4940. Computer Science and Engineering Design Project II
Three credits. Prerequisite: CSE 4939W; open only to Computer Science and Engineering and Computer Science majors.

The second semester of the required year-long major design experience. The semester will be spent developing, testing, and evaluating the software and/or hardware system begun in CSE 4939W. The project will culminate in the delivery of a working system and will include a formal, public presentation, and written documentation. Oral and written progress reports are required.
4950. Electrical and Computer Engineering Design I
(Also offered as ECE 4901.) Two credits. Prerequisite: ECE 3101, 3201 and a grade of C+ or better in both ECE 2001 and ECE/ENGR 3101; senior standing: open only to students in the School of Engineering.
Discussion of the design process; project statement, specification, project planning scheduling and division of responsibility, ethics in engineering design, safety, environmental considerations, economic constraints, liability, manufacturing, and marketing. Projects are carried out using a team-based approach. Selection and analysis of a design project to be undertaken in CSE 4951/ECE 4902 is carried out. Written progress reports, a proposal, an interim report, a final report, and oral presentations are required.

4951. Electrical and Computer Engineering Design II
(Also offered as ECE 4902.) Three credits. Hours by arrangement. Prerequisite: ECE 4901: open only to students in the School of Engineering.
Design of a device, circuit, system, process, or algorithm. Team solution to an engineering design problem as formulated in CSE 4950/ECE 4901, from first concepts through evaluation and documentation. Written progress reports, a final report, and oral presentations are required.

4997. Senior Thesis in Computer Science and Engineering
Three credits. Hours by arrangement. Prerequisite: Senior standing in Computer Science, Computer Science and Engineering, or Computer Engineering. Requires consent of instructor and Department Head. Not limited to honors students.
Students are expected to choose an advisor and seek approval of a thesis topic by the time of registration. Students will author a formal thesis based on independent research conducted under the advisor supervision. Thesis proposal and final thesis must follow the guidelines developed by the department.