

Course Catalog - Fall 2006

Computer Science

100 **Freshman Orientation in CS** Credit: 1 hours.

Introduction to Computer Science as a field and career for computer science majors. Overview of the field is presented along with specific examples of problem areas and methods of solution. Recommended for all freshman Computer Science majors.

101 **Intro to Computing, Eng & Sci** Credit: 3 hours.

Fundamental principles, concepts, and methods of computing, with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; fundamental algorithms and data structures; use of computers in solving engineering and scientific problems. Credit is not given for both CS 101 and either CS 105 or CS 110 section C. Prerequisite: MATH 220 or MATH 221.

This course satisfies the General Education Criteria for a Quant Reasoning II course.

105 **Intro to Computing, Non-Tech** Credit: 3 hours.

Introduction to computing as an essential tool of academic and professional activities in disciplines other than science and engineering. Functions and interrelationships of computer system components: hardware, systems and applications software, and networks. Widely used application packages such as spreadsheets and databases. Concepts and practice of programming for the solution of simple problems in different application areas. Students interested in scientific and engineering applications of computing should take CS 101 instead of this course.

Prerequisite: MATH 012 or equivalent. Credit is not given for both CS 105 and CS 101.

This course satisfies the General Education Criteria for a Quant Reasoning I course.

110 **Programming Laboratory** Credit: 1 hours.

Practical laboratory course in the methods used and skills required for writing and maintaining well-structured software. Extensive practice with a programming language is provided. Different sections use different programming languages. An existing knowledge of fundamental computing principles is assumed. Three laboratory hours per week. Credit is not given for studying any given language more than once. (That is, a given section may be taken only once.) Credit is not given for both CS 110 section C and CS 101, both CS 110 section J and CS 125, or both CS 110 section CP and CS 225. Prerequisite: One of CS 101, CS 105, or CS 125; or consent of instructor. It is recommended that students enrolling in CS 110 section CP have prior C programming experience or credit for CS 110 section C.

125 **Intro to Computer Science** Credit: 4 hours.

First course for computer science majors and other students with a deep interest in computing. The course introduces students to basic concepts in computing and fundamental techniques for solving computational problems. Prerequisite: Three years of high school mathematics or MATH 012.

This course satisfies the General Education Criteria for a Quant Reasoning I course.

173 **Discrete Structures** Credit: 3 hours.

Studies discrete mathematical structures frequently encountered in the study of Computer Science. Topics will include sets, propositions, boolean algebra, induction, recursion, relations, functions, and graphs. Credit is not given for both CS 173 and MATH 213.

196 **Freshman Honors Course in CS** Credit: 1 hours.

Course is offered for honors credit in conjunction with other 100-level computer science courses, in which concurrent registration is required. Enrollment is strictly limited to beginning students with superior talents in computer science. A special examination may be required for admission to this course. May be repeated.

Prerequisite: Concurrent registration in another 100-level computer science course (see Schedule); or consent of instructor.

199 **Undergraduate Open Seminar** Credit: 1 to 5 hours.

May be repeated.

210 Ethical & Prof'l Issues in CS Credit: 2 hours.

Ethics for the computing profession. Ethical decision-making; licensing; intellectual property, freedom of information, and privacy. Students will be required to make oral presentations. Credit is not given for both CS 210 and ECE 316. Prerequisite: CS 225 and junior standing.

225 Data Structure & Softw Prin Credit: 4 hours.

Data abstractions: elementary data structures: lists, stacks, queues, trees; searching and sorting techniques. Introduction to the principles of software engineering including term programming project. Prerequisite: CS 125 or ECE 190; CS 173 or MATH 213; or consent of instructor.

This course satisfies the General Education Criteria for a Quant Reasoning II course.

231 Computer Architecture I Credit: 3 hours.

Introduction to computer architecture, working up from the logic gate level: combinational and sequential networks; computer arithmetic; arithmetic/logic units; memory organization; control unit design. Credit is not given for both CS 231 and ECE 290. Prerequisite: CS 125.

This course satisfies the General Education Criteria for a Quant Reasoning II course.

232 Computer Architecture II Credit: 3 hours.

Second-level course in computer architecture: machine-level programming, instruction sets, data representations; subroutines; input/output hardware and software; linking and loading; relation to high-level languages. Credit is not given for both CS 232 and ECE 390. (Counts for advanced hours in LAS.) Prerequisite: CS 231.

241 System Programming Credit: 3 hours.

Introduction to systems programming: This course will cover the basics of system programming, including POSIX processes, process control, inter-process communication, synchronization, signals, simple memory management, file I/O and directories, shell programming, socket network programming, RPC programming in distributed systems, basic security mechanisms, and standard tools for systems programming such as debugging tools. Prerequisite: CS 225; CS 232 or ECE 390.

242 Programming Studio Credit: 3 hours.

Intensive programming lab intended to strengthen skills in programming. Prerequisite: CS 241.

257 Numerical Methods Credit: 3 hours.

Introduction to numerical methods for students in science and engineering; topics include floating-point computation, systems of linear equations, approximation of functions and integrals, the single nonlinear equation, and the numerical solution of ordinary differential equations; discusses various applications in science and engineering; includes some programming as well as the use of high quality mathematical library routines. Same as MATH 257. Students with earned credit in CS 450 may not receive additional credit for CS 257 or MATH 257. (Counts for advanced hours in LAS.) Prerequisite: A 100-level computer science course; MATH 225 or MATH 415; MATH 241 (formerly MATH 243) or MATH 242.

This course satisfies the General Education Criteria for a Quant Reasoning II course.

273 Intro to Theory of Computation Credit: 3 hours.

Finite automata and regular languages; pushdown automata and context-free languages; Turing machines and recursively enumerable sets; computability and the halting problem; undecidable problems. Prerequisite: CS 125 and either CS 173 or MATH 213.

This course satisfies the General Education Criteria for a Quant Reasoning II course.

296 Honors Course in CS Credit: 1 hours.

Group projects for honors work in computer science. Sections of this course are offered in conjunction with other 200-level computer science courses, in which concurrent registration is required. A special examination may be required for admission to this course. May be repeated. Prerequisite: Concurrent registration in another 200-level computer science course (see Schedule); or consent of instructor.

397 Individual Study Credit: 1 to 3 hours.

May be repeated. Prerequisite: 100-level computer science course; consent of instructor.

398 Special Topics in CS Credit: 2 to 4 hours.

Lecture course in topics of current interest. See Schedule for current topics. May be repeated. Prerequisite: As specified for each topic offering; see Schedule or departmental course description.

400 Data Structures, Non-CS Majors Credit: 4 hours.

Course integrates software engineering principles with data structures implemented in C++. While prior experience with either C, C++ or Java is assumed, C++ will be taught in the first three weeks of the course. Software engineering will be covered in three stages: personal software process (checkpoints, project plans, defects, and code reviews), prior to coding (process models, requirements, and design) and after coding (testing and quality assurance techniques). The concepts, principles, and use of data structures will include pointers, lists, arrays, sets, stacks, trees, hashing, graphs, priority queues, and sorting. Special emphasis will be placed on the implementations of these structures in real-world applications. Same as CSE 400. Credit is not given for both CS 400 and CS 225. Computer Science and Computer Engineering majors may not receive credit for CS 400. Prerequisite: CS 101 or consent of instructor.

410 Intro to Text Info Systems Credit: 3 or 4 hours.

Introduction to the theory, design, and implementation of text-based information systems. Text analysis, retrieval models (e.g., Boolean, vector space, probabilistic), text categorization, text filtering, clustering, retrieval system design and implementation, and applications to web information management. Same as LIS 410. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or CS 400 or consent of instructor.

411 Database Systems Credit: 3 or 4 hours.

Examines the logical organization of databases: the entity-relationship model; the hierarchical, network, and relational data models and their languages. Functional dependencies and normal forms. Design, implementation, and optimization of query languages; security and integrity; concurrency control, and distributed database systems. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or CS 400 or consent of instructor.

412 Intro Data Mining Credit: 3 or 4 hours.

Introduction to the concepts, techniques, and systems of data warehousing and data mining, including (1) design and implementation of data warehouse and on-line analytical processing (OLAP) systems; and (2) data mining concepts, methods, systems, implementations, and applications. 3 undergraduate or graduate hours. 4 graduate hours. Prerequisite: CS 225 or CS 500; or consent of instructor.

413 Intro to Combinatorics Credit: 3 or 4 hours.

Same as MATH 413. See MATH 413.

This course satisfies the General Education Criteria for a Quant Reasoning II course.

414 Multimedia Systems Credit: 3 or 4 hours.

Organization and structure of modern multimedia systems; audio and video encoding; quality of service concepts; scheduling algorithms for multimedia within OS and networks multimedia protocols over high-speed networks; synchronization schemes, user-interface design; multimedia teleservices. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or CS 423.

417 Computer-Assisted Instruction Credit: 4 hours.

Same as CI 435. See CI 435.

418 Computer Graphics Credit: 3 or 4 hours.

Introduction to basic mathematical tools and computational techniques for modeling, rendering, and animating 3-D scenes. Same as CSE 427. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or CS 400; MATH 225 or MATH 241 (formerly MATH 243) or MATH 242.

419 Advanced Comp Graphics Credit: 3 or 4 hours.

Advanced methods for representing, displaying, and rendering two-, three-, and four-dimensional scenes. General algebraic curves and surfaces, splines, Gaussian and bump-function representation, fractals, particle systems, constructive solid geometry methods, lighting models, radiosity, advanced ray-tracing methods, surface texturing animation techniques, data visualization methods. Same as CSE 428. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 418.

420 Intro to Parallel Programming Credit: 3 or 4 hours.

Introduction to fundamental issues in design and development of parallel programs for various types of parallel computers. Various programming models according to both machine type and application area. Cost models, debugging, and performance evaluation of parallel programs with actual application examples. Same as CSE 402, and ECE 492. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 400 or CS 225; or advanced programming experience.

421 Programming Lang and Compilers Credit: 3 or 4 hours.

Introduction to the structure of programming languages and their implementation. Basic language design principles; abstract data types; functional languages; type systems; object-oriented languages. Basics of lexing, parsing, syntax-directed translation, semantic analysis, and code generation. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225; CS 232 or ECE 390.

422 Programming Language Design Credit: 3 or 4 hours.

Advanced course in principles of language design. Using imperative and functional programming as unifying themes, major language design paradigms will be explored. Tools in this study will include both practical language processor construction and theoretical models. Emphasis will be on reasoning about programs and languages. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 421.

423 Operating Systems Design Credit: 3 or 4 hours.

The organization and structure of modern operating systems and concurrent programming concepts. Deadlock, virtual memory, processor scheduling, and disk systems. Performance, security, and protection. Same as CSE 423. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241.

424 Real-Time Systems Credit: 3 or 4 hours.

Examples of real-time computing systems; real-time scheduling and resource management algorithms; analytical and efficient validation methods; examples of real-time operating systems; temporal consistency of real-time data; formal methods for specification of and reasoning about timing constraints. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 431.

425 Distributed Systems Credit: 3 hours.

Covers topics needed for a basic understanding of distributed computer systems: Protocols, specification techniques, global states and their determination, reliable broadcast, transactions and commitment, security, and real-time systems. Same as CSE 424 and ECE 428. Prerequisite: CS 241.

426 Compiler Construction Credit: 3 or 4 hours.

Compiler structure, syntax analysis, syntax-directed translation, automatically constructed recognizers, semantic analysis, code generation, intermediate language, optimization techniques. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 421.

427 Software Engineering, I Credit: 3 or 4 hours.

Software process, analysis and design. Topics include: software development paradigms, system engineering, function-based analysis and design, and object-oriented analysis and design. Course will use team-projects for hands-on exercises. Same as CSE 426. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 and CS 273; or consent of instructor.

This course satisfies the General Education Criteria for a Advanced Composition course.

428 Software Engineering, II Credit: 3 or 4 hours.

Software development, management, and maintenance. Topics include project and configuration management, collaborative development models, software quality assurance, interoperability domain engineering and software reuse, and software re-engineering. Same as CSE 429. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 427.

This course satisfies the General Education Criteria for a Advanced Composition course.

429 Software Engineering II, ACP Credit: 3 hours.

Course is identical to CS 428 except for the additional writing component. See CS 428. Prerequisite: CS 427

431 *Embedded Sys Arch and Software* Credit: 0 to 4 hours.

Survey of sampled data systems and embedded architecture; overview of the key concepts in common embedded system applications; signal processing and control; embedded microprocessor and device interface; time-critical I/O handling; data communications; real-time operating systems and techniques for the development and analysis of embedded real-time software; hands-on laboratory projects. 3 undergraduate hours only. 3 or 4 graduate hours only. Prerequisite: CS 241 or CS 423.

433 *Computer System Organization* Credit: 3 or 4 hours.

Computer system analysis and design. Organizational dependence on computations to be performed. Speed and cost of parts and overall machines. Instruction set design. Pipeline and vector machines. Memory hierarchy design. Same as CSE 422. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 232 or ECE 390.

435 *Intro VLSI System Design* Credit: 3 hours.

Same as CSE 433 and ECE 425. See ECE 425.

437 *VLSI System and Logic Design* Credit: 3 or 4 hours.

Computer system design of VLSI chips with emphasis on logic design. Overview of VLSI technology; detailed discussion of recent integrated circuit logic families; types of memories and contemporary logic design methods based on them, including various custom design approaches; automated logic synthesizers; Binary Decision Diagrams; Field Programmable Gate Arrays; hardware/software realization of algorithms; and hardware/software tradeoffs for improving system performance and lowering costs. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 231 or ECE 290 or consent of instructor.

438 *Communication Networks* Credit: 3 hours.

Layered architectures and the OSI Reference Model; design issues and protocols in the transport, network, and data link layers; architectures and control algorithms of local-area, point-to-point, and satellite networks; standards in networks access protocols; models of network interconnection; overview of networking and communication software. Same as CSE 425 and ECE 438. Prerequisite: CS 241; one of MATH 461, MATH 463, ECE 413.

440 *Intro Artificial Intelligence* Credit: 3 or 4 hours.

Introductory description of the major subjects and directions of research in artificial intelligence; topics include AI languages (LISP and PROLOG), basic problem solving techniques, knowledge representation and computer inference, machine learning, natural language understanding, computer vision, robotics, and societal impacts. Same as ECE 448. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or ECE 390; or consent of instructor.

443 *Introduction to Robotics* Credit: 4 hours.

Same as ECE 470, GE 421, and ME 445. See ECE 470.

446 *Machine Learning & Pattern Rec* Credit: 3 or 4 hours.

Organized review of basic theoretical concepts and methods of machine learning and recognition; decision space and linguistic and relational representation of objects; statistical and deterministic recognition algorithms; various types of learning, including adaptive, procedural, and inductive; selected applications; and medical consulting, determination of cost-optimal classification rules, inferential information systems, and computer vision. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 273 and CS 440.

450 *Intro to Numerical Analysis* Credit: 3 or 4 hours.

Introduction to numerical analysis, including linear system solvers, optimization techniques, interpolation and approximation of functions, solving systems of nonlinear equations, eigenvalue problems, least squares, and quadrature; numerical handling of ordinary and partial differential equations. Same as CSE 401, ECE 491, and MATH 450. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 101 or CS 125; CS 257 or MATH 415; one of MATH 385, MATH 386, MATH 441; or consent of instructor.

455 *Numerical Methods for PDEs* Credit: 3 or 4 hours.

Introduction to numerical techniques for initial and boundary value problems in partial differential equations; includes finite difference and finite element discretization techniques, direct and iterative solution methods for discrete problems, and programming techniques and usage of FORTRAN packages. Same as CSE 411, and MATH 455. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 257; one of MATH 241 (formerly MATH 243), MATH 380, MATH 385, MATH 386, MATH 441.

458 Numerical Linear Algebra Credit: 3 or 4 hours.

Direct and iterative methods for systems of linear equations; over determined systems of equations; eigenvalue problems; nonlinear systems of equations. Same as CSE 412 and MATH 458. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 257 or consent of instructor.

459 Numerical Approx and ODEs Credit: 3 or 4 hours.

Polynomial and spline interpolation; least squares and uniform approximation; numerical differentiation and integration; initial-value and boundary-value problems in ordinary differential equations. Same as CSE 413, and MATH 459. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 257; one of MATH 385, MATH 386, MATH 441; or consent of instructor.

462 Logic Design Credit: 3 hours.

Same as ECE 462 and MATH 491. See ECE 462.

465 Princ of User Interface Design Credit: 3 or 4 hours.

This is a project-focused course that covers fundamental principles of user interface design, implementation, and evaluation. Students work in small teams on a semester-long project that includes: analysis of the problem domain, user skills, and tasks; iterative prototyping of interfaces to address user needs; conducting several forms of evaluation such as cognitive walkthroughs and usability tests; and implementation of the final prototype. Students from non-technical disciplines may enroll in the course as non-programmers who participate in all aspects of the projects with the possible exception of implementation. Same as LIS 465. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or CS 400; or consent of instructor.

473 Algorithms Credit: 3 or 4 hours.

Advanced data structures, graph algorithms, arithmetic algorithms, geometric algorithms, string problems, parallel algorithms, NP-completeness. Same as CSE 414 and MATH 473. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 and CS 273; or consent of instructor.

475 Formal Models of Computation Credit: 3 or 4 hours.

Finite automata and regular languages; pushdown automata and context-free languages; Turing machines and recursively enumerable sets; linear-bounded automata and context-sensitive languages; computability and the halting problem; undecidable problems; recursive functions; Chomsky hierarchy; computational complexity. Same as MATH 475. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 273 or consent of instructor.

476 Program Verification Credit: 3 or 4 hours.

Examines formal methods for demonstrating correctness and other properties of programs; includes an overview of predicate calculus. Topics include: invariant assertions, Hoare axiomatics, well-founded orderings for proving termination, structural induction, computational induction, data structures, and parallel programs. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225; CS 273 or MATH 414.

477 Formal Software Dev Methods Credit: 3 or 4 hours.

Mathematical models, languages, and methods for software specification, development, and verification. Same as ECE 478. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 225 or CS 400; CS 273 or MATH 414.

484 Computer Data Acquisition Sys Credit: 3 or 4 hours.

Theory, operation, and design of computer data acquisition systems; analog and digital aspects, conversions between representations, interfacing and systems considerations. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 231 or ECE 290; ECE 205 or ECE 440.

491 Seminar in Computer Science Credit: 0 to 4 hours.

Seminar course for advanced undergraduate and graduate students. Topics will vary. Approved for S/U grading

only. May be repeated to a maximum of 4 hours. May be repeated if topics vary. Prerequisite: Varies with course topic; consent of instructor.

492 Senior Project in CS, I Credit: 3 hours.

First part of a project course in computer science. Students work in teams to solve typical commercial or industrial problems. Work involves planning, design, and implementation. Extensive oral and written work is required both on-campus and possibly off-campus at sponsors' locations. Students must enroll for a two term sequence, CS 492 and either CS 493 or CS 494. 3 undergraduate hours. Credit is not given for both CS 492 and a project course in another engineering department for the same project. Prerequisite: Senior standing in CS or consent of instructor. *This course satisfies the General Education Criteria for a* Advanced Composition course.

493 Senior Project in CS II, ACP Credit: 3 hours.

Course is identical to CS 494 except for the additional writing component. See CS 494. 3 undergraduate hours. Students must enroll for a two term sequence, CS 492 and CS 493. Credit is not given for both CS 493 and a project course in another engineering department for the same project. Prerequisite: CS 492. *This course satisfies the General Education Criteria for a* Advanced Composition course.

494 Senior Project in CS II Credit: 3 hours.

Continuation of a project course in computer science. Students work in teams to solve typical commercial or industrial problems. Work involves planning, design, and implementation. Extensive oral and written work is required both on-campus and possibly off-campus at sponsors' locations. 3 undergraduate hours. Students must enroll for a two term sequence, CS 492 and either CS 493 or CS 494. Credit is not given for both CS 494 and a project course in another engineering department for the same project. Prerequisite: CS 492.

498 Special Topics in CS Credit: 0 to 4 hours.

Lectures in topics of current interest. See Schedule for current topics. Approved for both letter and S/U grading. May be repeated. Prerequisite: As specified for each topic offering, see Schedule or departmental course description.

499 Senior Thesis in CS Credit: 3 hours.

Research and thesis development experience in computer science. A student works with a faculty member on a mutually agreed upon thesis topic and completes a written thesis. Work involves literature search, oral presentation, analysis and/or implementation, paper preparation, and a written thesis. 3 undergraduate hours. May be repeated to a maximum of 6 hours. Prerequisite: Senior standing in CS and consent of instructor. *This course satisfies the General Education Criteria for a* Advanced Composition course.

505 Numerical Fluid Dynamics Credit: 4 hours.

Same as ATMS 502 and CSE 566. See ATMS 502.

511 Adv Database Mgt Systems Credit: 4 hours.

Advanced concepts in database management system design and implementation, and an introduction to the major recent developments in the field. Topics include the relational roots, distributed and parallel databases, object databases and extensibility, semistructured data and XML, web research, benchmarks, and current directions in the field. Prerequisite: CS 411.

512 Data Mining Principles Credit: 4 hours.

Advanced course on principles and algorithms of data mining. Topics include data cleaning and integration; descriptive and predictive mining; mining frequent, sequential, and structured patterns; clustering, outlier analysis and fraud detection; stream data, web, text, and biomedical data mining; security and privacy in data mining; and research frontiers. Prerequisite: CS 412 or consent of instructor.

519 Scientific Visualization Credit: 4 hours.

Detailed study of visualization techniques useful in analysis of engineering and scientific data. Topics include study of physical models; methods of computational science; two- and three-dimensional data types; visual representation schemes for scalar, vector, and tensor data; isosurface and volume visualization methods; visual monitoring; and interactive steering. Same as CSE 527. Prerequisite: CS 418.

522 Programming Language Semantics Credit: 4 hours.

Topics in the theory of programming languages including: functional programming, meta-circular interpreters, typed, untyped and polymorphic lambda-calculi, and denotational semantics. Prerequisite: CS 422 and CS 426.

523 Advanced Operating Systems Credit: 4 hours.

Advanced concepts in operating system design and coverage of recent research directions. Resource management for parallel and distributed systems. Interaction between operating system design and computer architectures. Topics include: process management, virtual memory, interprocess communication, context switching, parallel and distributed file system designs, persistent objects, process and data migration, load balancing, security, protection. Term projects. Same as CSE 523. Prerequisite: CS 423, CS 425, and CS 433; or consent of instructor.

524 Concurrent Prog Lang and Sys Credit: 4 hours.

Introduction to the theory of concurrency and concurrent programming languages. Topics include formal models of concurrent computation such as process algebras, nets and actors; high level concurrent programming languages and their operational semantics; and methods for reasoning about correctness and complexity of concurrent programs. Prerequisite: CS 422; CS 475 or CS 476.

526 Adv Topics in Compiler Constr Credit: 4 hours.

Advanced topics in compiler construction, including incremental and interactive compiling, error correction, code optimization, models of code generators, etc. Same as CSE 526. Prerequisite: CS 426.

527 Adv Topics in Software Eng Credit: 4 hours.

Advanced topics in software engineering, including fault-tolerant software, software architecture, software patterns, multi-media software, and knowledge-based approaches to software engineering. Course also includes a number of case studies. Same as CSE 529. Prerequisite: CS 428 or CS 429 or consent of instructor.

533 Parallel Computer Architecture Credit: 4 hours.

Theoretical aspects of parallel and pipeline computation; time and processor bounds on classes of computations; data alignment network speed and cost bounds; conflict-free access memories; and overall computer system ideas. Same as CSE 522 and ECE 533. Prerequisite: Consent of instructor.

536 Design Fault-Tolerant Dig Syst Credit: 4 hours.

Same as ECE 542. See ECE 542.

541 Computer Systems Analysis Credit: 4 hours.

Same as CSE 524 and ECE 541. See ECE 541.

542 Artificial Neural Networks Credit: 4 hours.

Comprehensive treatment of neural network architectures and learning algorithms balanced with theory and application examples. Prerequisite: CS 440; one of MATH 385, MATH 386, MATH 441; MATH 415; or consent of instructor.

543 Computer Vision Credit: 4 hours.

Same as ECE 549. See ECE 549.

545 Systems Modeling & Simulation Credit: 4 hours.

Same as BADM 575. See BADM 575.

546 Machine Learning in NLP Credit: 4 hours.

An introduction to the central learning frameworks and techniques that have emerged in the field of natural language processing and found applications in several areas in text and speech processing: from information retrieval and extraction, through speech recognition to syntax, semantics and language understanding related tasks. Presents the theoretical paradigms -- learning theoretic, probabilistic, and information theoretic -- and the relations among them, as well as the main algorithmic techniques developed within these and in key natural language applications. Prerequisite: CS 446 and CS 473.

548 *Comp Models of Cognitive Proc* Credit: 4 hours.

Formal models and concepts in vision and language; detailed analysis of computer vision, language, and learning problems; relevant psychological results and linguistic systems; and survey of the state-of-the-art in artificial intelligence. Same as ECE 548. Prerequisite: CS 440.

549 *Seminar in Cognitive Science* Credit: 2 or 4 hours.

Same as PSYC 514, ANTH 514, EPSY 551, LING 570, and PHIL 514. See PSYC 514.

550 *Iterative & Multigrid Solvrs* Credit: 4 hours.

A comprehensive treatment of algebraic and multigrid iterative solvers for systems of equations, primarily linear equations arising from discretization of partial differential equations. Same as CSE 511. Prerequisite: CS 450 or consent of instructor.

554 *Parallel Numerical Algorithms* Credit: 4 hours.

Introduction to numerical algorithms for parallel computers: parallel algorithms in numerical linear algebra (dense and sparse solvers for linear systems and the algebraic eigenvalue problem), numerical handling of ordinary and partial differential equations, and numerical optimization techniques. Same as CSE 512. Prerequisite: One of CS 450, CS 455, CS 458, or CS 459; or consent of instructor.

558 *Topics in Numerical Analysis* Credit: 4 hours.

Same as CSE 513. May be repeated. Prerequisite: Consent of instructor.

565 *Topics in Human-comp Interact* Credit: 4 hours.

This course provides in-depth coverage of advanced topics in human-computer interaction (HCI). Topics include applied models of human performance and attention, design tools for creative design tasks, interruptions and peripheral displays, gestures and bimannual input, and usability evaluation techniques. The class meetings will consist of traditional classroom lectures along with group discussions. In the course, students will complete a research-oriented semester project of their choosing. Prerequisite: CS 465 or consent of instructor.

570 *Mesh Generation* Credit: 4 hours.

Design of geometric algorithms for grids and triangulations. Development of geometric and topological prerequisites (no prior course in these subjects is assumed). Topics include complexes, subdivisions, Delaunay triangulations, randomized algorithms, homology groups, splines and surfaces. Same as CSE 514. Prerequisite: CS 473 or consent of instructor.

571 *Combinatorial Mathematics* Credit: 4 hours.

Same as MATH 580. See MATH 580.

572 *Extremal Graph Theory* Credit: 4 hours.

Same as MATH 581. See MATH 581.

573 *Topics in Algorithms* Credit: 4 hours.

Theoretical analysis of various algorithms; topics include sorting, searching, selection, polynomial evaluation, matrix multiplication, and multiplication of real numbers. Same as CSE 515. May be repeated. Prerequisite: CS 473 or consent of instructor.

575 *Methods of Combinatorics* Credit: 4 hours.

Same as MATH 584. See MATH 584.

576 *Topics in Automated Deduction* Credit: 2 to 4 hours.

Advanced topics in computer-aided methods for formal deduction, selected from areas of current research, such as: resolution theorem proving strategies, special relations, equational reasoning, unification theory, rewrite systems, mathematical induction, program derivation, hybrid inference systems, and programming with logic. Prerequisite: Consent of instructor.

577 *Coding Theory* Credit: 4 hours.

Same as ECE 556 and MATH 579. See ECE 556.

578 Information Theory Credit: 4 hours.

Same as ECE 563 and STAT 563. See ECE 563.

579 Computational Complexity Credit: 4 hours.

Turing machines; determinism and non-determinism; time and space hierarchy theorems; speed-up and tape compression; Blum axioms; structure of complexity classes NP, P, NL, L, and PSPACE; complete problems; randomness and complexity classes RP, RL, and BPP; alternation, polynomial-time hierarchy; circuit complexity, parallel complexity, NC, and RNC; relativized computational complexity; time-space trade-offs. Same as ECE 579 and MATH 578. Prerequisite: CS 473 or CS 475 or consent of instructor.

591 Advanced Seminar in CS Credit: 0 to 4 hours.

Seminar on topics of current interest. Subjects will be announced in the Schedule. Approved for both letter and S/U grading. May be repeated in the same or subsequent terms as topics vary. Prerequisite: Consent of instructor.

597 Individual Study Credit: 2 to 16 hours.

Individual study or reading in a subject not covered in normal course offerings. May be repeated. Prerequisite: Consent of instructor.

598 Special Topics in CS Credit: 2 to 4 hours.

Lecture course in topics of current interest. See Schedule for current topics. May be repeated. Prerequisite: As specified for each topic offering, see Schedule or departmental course description.

599 Thesis Research Credit: 0 to 16 hours.

May be repeated. Approved for S/U grading only. Prerequisite: Consent of instructor.