Independent Study
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in Communication. Approval of department. Individualized study under faculty direction.

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 Ph.D. students in Communication. Doctoral dissertation research.

COMMUNICATION ARTS AND SCIENCES CAS

College of Communication Arts and Sciences

Environmental Issues Seminar
Fall, Spring. 1(1-0) A student may earn a maximum of 4 credits in all enrollments for this course. Interdepartmental with Natural Science; Agriculture and Natural Resources; Engineering; Social Science. Administered by Natural Science. R: Open only to students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science or College of Communication Arts and Sciences or College of Social Science. Approval of college. Environmental issues and problems explored from a variety of perspectives, including legal, scientific, historical, political, socio-economic, and technical points of view.

Special Topics
Fall, Spring, Summer. 1 to 8 credits. A student may earn a maximum of 16 credits in all enrollments for this course. R: Approval of college. Varied topics pertaining to the study of communication processes.

Mass Communication and Public Health
Fall, Spring. 3(3-0) RB: Academic or professional background in mass communication and/or health.
Health communication campaigns in domestic and international contexts. Focus on principles of effective communication.

Health Communication for Diverse Populations
Spring, 3(3-0) RB: Academic or professional background in mass communication and/or health.
Theory, research, and practice of communicating with specialized populations in clinical and public health contexts. Emphasis on interpersonal and small-group strategies.

Special Topics
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 16 credits in all enrollments for this course. R: Open only to graduate students in the College of Communication Arts and Sciences or approval of college. Varied topics pertaining to advanced study of communication processes.

Doctoral Seminar
Fall, Spring, Summer. 3(3-0) A student may earn a maximum of 15 credits in all enrollments for this course. R: Open only to Ph.D. students in Mass Media and Communication or approval of college. Topics on theoretical and research issues in communication and mass media.

Research Internship
Fall, Spring, Summer. 1 credit. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to Ph.D. students in Mass Media. Participation in faculty research projects.

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 Ph.D. students in Mass Media. Doctoral dissertation research.

COMPUTER SCIENCE AND ENGINEERING CSE

Department of Computer Science and Engineering

College of Engineering

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 local problems, using hardware, multimedia software, communication and networks.

Introduction to Technical Computing
Fall, Spring, 3(2-2) P:M: (MTH 103 or MTH 110 or MTH 116 or LBS 117 or MTH 124 or concurrently or MTH 132 or concurrently or LBS 118 or concurrently) SA: CPS 131
Use of computing systems for technical communications and problem solving in engineering, mathematics, and science. Development and use of mathematical models suitable for computer representation, solution, graphical display, and animation.

Introduction to Programming I
Fall, Spring. 4(3-2) P:M: (LBS 118 or MTH 124 or MTH 132 or MTH 152H) RB: (CSE 131) SA: CSE 230
Introduction to object-oriented programming using C++. Design, implementation and testing of programs to solve problems in engineering, mathematics and science. Programming fundamentals, functions, classes, arrays, and pointers.

Introduction to Programming II
Fall, Spring. 4(3-2) P:M: (CSE 231) SA: CSE 330
Continuation of object-oriented programming using C++. Development of classes and reliable software. Data structures and their encapsulation; stacks, queues, lists, trees, and hash tables. Algorithms operating on data structures. Object-oriented design and programming.
420  Computer Architecture
Fall, Spring. 4(3-2) 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 minor. SA: CPS 420
Digital logic and sequential machine design. Computer organization, control unit and arithmetic logic unit implementation. Input-output, memory organization, parallel operations. Digital system simulation.

422  Computer Networks
Fall, Spring. 4(3-2) P: (STT 351) 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 field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary minor. SA: CPS 422
Computer network architectures and models. Medium access control. Physical, data link, network, transport, and session layers. Local-area and wide-area networks.

440  Artificial Intelligence and Symbolic Programming
Fall. 4(3-2) P: (CSE 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 minor. SA: CPS 440
Machine intelligence. Heuristic programming. Representation and control in LISP and PROLOG. Applications to search, rule-based diagnosis, and planning.

450  Translation of Programming Languages
Spring. 4(3-2) 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 minor. SA: CPS 450

452  Organization of Programming Languages
Fall. 4(3-2) 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 Computer Science disciplinary minor. SA: CPS 452
Organization of programming languages including language processors, syntax, data types, sequence control, storage management. Comparison of language features from the functional, imperative, logical and object-oriented paradigms.

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

470  Software Engineering
Fall, Spring. 4(3-2) 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 minor. SA: CPS 470
Software life cycle including specification, design, coding, testing, and verification of a software product. Stepwise refinement and rapid prototyping. Software portability, reusability and maintenance.

471  Media Processing and Multimedia Computing
Fall. 4(3-2) P: (CSE 320 and CSE 331) R: Open only to students in the Department of Computer Science and Engineering or Computer Engineering major or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary minor.
Basic operations for processing images, video, and audio; devices for input and output; data formats and compression; tools for processing images and sound; multimedia authoring tools; applications

472  Computer Graphics
Spring. 4(3-2) P: (MTH 314 and CSE 331) R: Open only to juniors or seniors or graduate students in the Department of Computer Science and Engineering or to juniors or seniors in the Computer Engineering major or the LBS Computer Science field of concentration or the LBS Computer Science coordinate major or the Computer Science disciplinary minor. SA: CPS 472
Graphics hardware. Fundamental algorithms. Two- and three-dimensional imaging geometry and transformations. Curve and surface design, rendering, shading, color, and animation.

480  Database Systems
Spring. 4(3-2) 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 minor. SA: CPS 480
Storage of and access to physical databases including indexing, hashing, and range accesses. Data models, query languages, transaction processing, recovery techniques, Object-oriented and distributed database systems. Database design.

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 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.

491  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.

498  Collaborative Design (W)
Fall, Spring. 4(2-4) P: (CSE 470) P:NM: and two additional CSE 400-level courses. 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.

802  Pattern Recognition and Analysis
Spring. 4(4-0) P:NM: (CSE 330 and MTH 314 and STT 441) R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 802

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

807  Computer System Performance and Measurement
Spring of odd years. 3(3-0) Interdepartmental with Electrical and Computer Engineering. P:NM: (CSE 410 and STT 441) R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 807

808  Modelling and Discrete Simulation
Fall of odd years. 3(3-0) P:NM: (CSE 232 and STT 441) R: Open only to majors in Computer Science and Engineering or approval of Department. SA: CPS 808
Computer Science and Engineering–CSE

809 Algorithms and Hardware Implementation
Fall. 3(3-0) Interdepartmental with Electrical and Computer Engineering. Administered by Department of Electrical and Computer Engineering. P:NM: (CSE 420) and CSE 420) R: Open only to Computer Science and Electrical 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.

810 Advanced Operating Systems
Spring. 3(3-0) P:NM: (CSE 420) and CSE 420) R: Open only to Computer Science or Electrical 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

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

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

822 Parallel Processing Computer Systems
Spring. 3(3-0) Interdepartmental with Electrical and Computer Engineering. P:NM: (CSE 820) R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 822 Massively parallel SIMD processors, multiprocessor architectures, interconnection networks, synchronization and communication. Memory and address space management, process management and scheduling. Parallel compilers, languages, performance evaluation.

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

830 Design and Theory of Algorithms
Fall, Spring. 3(3-0) P:NM: (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 Analysis of algorithms. Algorithm design techniques. Efficient algorithms for classical problems. Intractable problems and techniques to handle them.

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

838 Design of Parallel Algorithms
Spring. 3(3-0) P:NM: (CSE 420 and CSE 830) R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 838 Current research topics and issues. Models of parallel computation. Implementation of algorithms on SIMD and MIMD machines. Relationship to VLSI.

841 Artificial Intelligence
Fall. 3(3-0) P:NM: (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.

845 Introduction and Laboratory in Knowledge-Based Systems
Spring. 4(3-2) P:NM: (CSE841) or equivalent. R: Open only to students in the Department of Computer Science and Engineering. Approval of department needed for non-majors. SA: CPS 845 Principled development and deployment of knowledge-based systems. Extensive reading in the historical literature of rule-based systems and approaches to task specific architectures for problem solving. Issues in knowledge acquisition, design problem solving, and qualitative modeling.

847 Machine Learning
Spring. 3(3-0) P:NM: (CSE 841 and CSE 440) R: Open only to students in the Department of Computer Science and Engineering or approval of department. Computational study of learning and data mining. Strengths and limitations of various learning paradigms, including supervised learning, learning from scalar reward, unsupervised learning, and learning with domain knowledge.

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

860 Foundations of Computing
Fall. 3(3-0) P:NM: (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. Undecidability. Resource-bounded computational complexity, non-determinism, NP-completeness.

870 Advanced Software Engineering
Spring. 3(3-0) P:NM: (CSE470) R: Undergraduate software engineering course R: Open only to students in the Department of Computer Science and Engineering. Methods and techniques supporting later lifecycle activities, including software testing and maintenance, reuse, and reverse engineering. Domain-specific software engineering methods. Human-computer interfaces, distributed systems, and visualization techniques.

880 Advanced Database Systems
Fall. 3(3-0) P:NM: (CSE 480) R: Open only to majors in the Department of Computer Science and Engineering or approval of department. SA: CPS 880 Distributed and object-oriented databases and knowledgebase systems. Design theory, query optimization, and transaction processing.

885 Artificial Neural Networks

890 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.

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 majors. Approval of department. SA: CPS 891 Selected topics in computer science of current interest and importance but not covered in a regular course.

898 Master’s Project
Fall, Spring. Summer. 1 to 4 credits. A student may earn a maximum of 12 credits in all enrollments for this course. R: Open only to Computer Science majors. Approval of department. SA: CPS 898 Master's degree Plan B individual student project: original research, research replication, or survey and reporting on a topic such as system design and development, or system conversion or installation.
Topics vary each semester. Topics such as testable and fault-tolerant digital systems, embedded architectures.

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. P:NM: (CSE 841) R: Open only to Computer Science or Electrical Engineering majors. SA: CPS 841
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. P:NM: (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. P:NM: (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 72 credits in all enrollments for this course. R: Open only to Computer Science majors. Approval of department. SA: CPS 999
Doctoral dissertation research.

COUNSELING, EDUCATIONAL PSYCHOLOGY AND SPECIAL EDUCATION CEP

Department of Counseling, Educational Psychology, and Special Education

150 Reflections on Learning
Fall, Spring, Summer. 3(3-0) Interdepartmental with Teacher Education. Administered by Department of Teacher Education. Students’ experiences as learners in comparison to psychological, sociological, and anthropological theories and assumptions about learning and teaching in and out of school.

240 Diverse Learners in Multicultural Perspective
Fall, Spring, Summer. 3(2-2) Interdepartmental with Teacher Education. Not open to students with credit in TE 250.
Communicative, linguistic, physical, sensory, behavioral, affective, and cognitive differences in learning in multicultural classrooms. Factors that mediate access to knowledge.

260 Dynamics of Personal Adjustment
Fall, Spring, Summer. 3(3-0) Psychological theories of human adjustment. Implications for effective learning, self-development, and adaptation.

341 American Sign Language and the Deaf Community
Fall, Spring, Summer. 2(2-0) Orientation to deaf culture. Essential signifying for those expecting to have intermittent contact with deaf adults.

416 Teaching and Learning With Technology
Fall, Spring, Summer. 3(3-0) R: Open only to juniors or senior graduate in the College of Education.
Uses of technology in teaching and learning. Major emphasis on developing plans for implementing and evaluating uses of technology in the classroom setting.

441A American Sign Language I
Fall, Spring, Summer. 3(3-0) P:M: Completion of Tier I writing requirement. R: Open only to students admitted to the teacher certification program in deaf education or to master’s students in the special education major. SA: CEP 840
Political, social, methodological, historical, philosophical, and legal issues in educating deaf children and youth.

441B American Sign Language II
Fall, Spring, Summer. 3(3-0) P:M: Completion of Tier I writing requirement. R: Open only to students admitted to the teacher certification program in deaf education or to master’s students in the special education major. SA: CEP 840

441C American Sign Language III
Fall, Spring, Summer. 3(3-0) P:M: (CEP 441B) R: Not open to freshmen. Production, conversation, and grammatical analysis of American Sign Language.

441D American Sign Language IV
Fall, Spring, Summer. 3(3-0) P:M: (CEP 441C) R: More advanced lexical and syntactic structures of American Sign Language. Sentence types, verb inflections, aspect marking, and story telling. Translations between American Sign Language and English.

442A American Sign Language V
Fall, Spring, Summer. 3(3-0) P:M: (CEP 441D) R: Use of space for multiple-person discourse. Formal register. Colloquial and idiomatic language. Applications to teaching in American Sign Language.

442B American Sign Language VI
Spring, 3(3-0) P:M: (CEP 442A) R: Use of space for creative interpretation of literature, science, mathematics, socio-historical concepts. Formal register. Colloquial and idiomatic language.