

COMPUTER SCIENCE AND SOFTWARE ENGINEERING

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Academic Programs

Program name	Program type
Computer Engineering	BS
Computer Science	BS, MS, Minor
Cross Disciplinary Studies Minor in Bioinformatics	Minor
Cross Disciplinary Studies Minor in Computing for Interactive Arts	Minor
Cross Disciplinary Studies Minor in Data Science	Minor
Software Engineering	BS

The Computer Science and Software Engineering Department educates students in the discipline of computer science and teaches them to apply their education to solve practical problems in a socially responsible way. To support the department's educational mission, faculty engage in research and professional development.

Department programs are designed to be flexible. Although freshmen choose their major when they apply for admission, students can easily switch among software engineering, computer engineering and computer science since the lower division curricula are similar.

In all of the department's programs, laboratory experiences ensure that students have both a theoretical and practical understanding of computer science. Individual and team projects, culminating in a capstone experience or a senior project, reinforce concepts and provide students the opportunity to apply and communicate their knowledge.

The department has active student chapters of the Association for Computing Machinery, IEEE Computer Society and Upsilon Pi Epsilon (the national computer honor society). Student teams compete in national competitions and student organizations sponsor industry/student events.

The department, with industry support, provides a modern computing environment that includes the most current software tools running on a variety of workstations and servers. Projects in advanced courses are supported by specialized laboratories for databases, computer architecture, operating systems, software engineering, computer networks, computer graphics, and human/computer interaction.

Undergraduate Programs

BS Computer Science

The BS Computer Science program provides in-depth study of computer science fundamentals and practice, including programming concepts

and languages, software engineering, operating systems and computer architecture.

In addition, the major offers a wide choice of technical electives that allows students to focus on particular areas of computer science and their application. Typical areas of emphasis include databases, distributed computing, software engineering, programming languages, graphical user interfaces, operating systems, computer networks, computer graphics, and artificial intelligence.

The curriculum is project-oriented and develops students' ability to solve problems using modern computing concepts. Students can expect to complete many projects in a variety of programming languages and on a variety of computer systems. During their last year of study, students complete a senior project, either individually or as members of a team, spanning two academic quarters.

Graduates of the computer science program are well prepared to become successful professionals and to pursue graduate study. They are sought by the computer industry for positions as software developers, quality assurance and test engineers, and other technical positions in computer-related industries.

The Computer Science program has four broad program educational objectives (PEOs) that graduates are expected to attain within five years of graduation:

- **Technical Competence.** Graduates have applied current technical knowledge and skills to develop effective computer solutions, using state-of-the art technologies.
- **Interpersonal Skills.** Graduates have communicated effectively and worked collaboratively in a team environment.
- **Professional Awareness.** Graduates have maintained a positive and ethical attitude concerning the computing profession and its impact on individuals, organizations and society.
- **Intellectual Growth.** Graduates have continued to grow intellectually and professionally in their chosen field, including successful pursuit of graduate study if such study was a desired goal.

The BS Computer Science program is accredited by the Computing Accreditation Commission of ABET, <http://www.ABET.org>.

Concentration

Interactive Entertainment

The Interactive Entertainment concentration focuses on providing the preparation necessary to succeed in technical-oriented careers relating to computer graphics, digital animation, video games and interactive experiences. Students will take part in multiple project-based courses involving significant programming and design work, and will employ relevant industry practices.

BS Software Engineering

The BS in Software Engineering prepares students to become software professionals who develop software products on time, within budget, and that meet customer requirements. Building on the fundamentals of computer science, the program focuses on practical aspects of building and deploying software systems in a socially responsible way. The program's educational mission supports the faculty in research and professional development that keeps them current in their field and in touch with current industry practices and trends.

The hallmark of the program is “hands on” experience where students follow a curriculum that builds on traditional computer science but differs from the BS in Computer Science in the following ways:

1. Classes emphasize the team approach to building software and provide leadership opportunities for every student.
2. Classes place an emphasis on software processes and lifecycles.
3. Classes include significant learning in engineering and management areas such as quality assurance, testing, metrics, maintenance, configuration management and interpersonal management skills.
4. The curriculum has a stronger emphasis on mathematics and the use of engineering methods in software design.

The software engineering curriculum culminates in a year-long capstone sequence where the students work in teams to build a large software system.

The software industry increasingly requires both a software and an engineering background for their cutting edge projects. Graduates with a BS in Software Engineering can expect to find significant opportunities in software development and management, software engineering and marketing.

The Software Engineering program has four broad program educational objectives (PEOs) that graduates are expected to attain within five years of graduation:

- **Technical Competence.** Graduates have applied the software engineering body of knowledge and other technical skills to specify, design, and implement complex software systems, doing so with state-of-the art technologies.
- **Interpersonal Skills.** Graduates have communicated effectively and worked collaboratively in a multi-disciplinary team environment.
- **Professional Awareness.** Graduates have maintained a positive and ethical attitude concerning the computing profession and its impact on individuals, organizations and society.
- **Intellectual Growth.** Graduates have continued to grow intellectually and professionally in their chosen field, including successful pursuit of graduate study if such study was a desired goal.

The BS Software Engineering program is accredited by the Engineering Accreditation Commission of ABET, <http://www.ABET.org>.

BS Computer Engineering

This program is jointly administered by the Computer Science Department and the Electrical Engineering Department. For information regarding this program, please refer to Computer Engineering (<http://catalog.calpoly.edu/collegesandprograms/collegeofengineering/computerengineering/>).

Computer Science Minor

Nearly all disciplines use the capabilities of computers. The Computer Science minor consists of a core and upper-division courses selected in consultation with an advisor. The core provides common knowledge and skills needed by anyone who wishes to advance further in computer science. The remaining courses enable students to specialize in areas relevant to their goals.

Admission to the minor is limited and selection is based upon the applicant’s performance in:

CSC/CPE 101	Fundamentals of Computer Science	4
CSC/CPE 202	Data Structures	4
CSC/CPE 203	Project-Based Object-Oriented Programming and Design	4

Students who intend to minor in computer science should consult the College of Engineering Advising Center website for GPA and course grade requirements for admission to the minor. In addition, they should contact the Advising Center for further information *before* planning to enter the minor.

Before formally applying, students must make an appointment at the College of Engineering Advising Center. The Computer Science minor is not open to CSC, CPE or SE major students, or to students in the Computing for Interactive Arts Minor or the Cross Disciplinary Studies Minor in Data Science. Questions concerning the minor should be directed to the Advising Center.

Cross Disciplinary Studies Minor in Bioinformatics

For information regarding the Cross Disciplinary Studies Minor in Bioinformatics, please see the Biological Sciences (<http://catalog.calpoly.edu/collegesandprograms/collegeofsciencemathematics/biologicalsciences/>) section of the catalog.

Cross Disciplinary Studies Minor in Computing for Interactive Arts

The minor in Computing for Interactive Arts (CIA) is a Cross Disciplinary Studies Minor jointly offered by the Department of Art and Design and the Computer Science Department. The CIA minor fosters a collaborative, cross-disciplinary environment in which Art and Design students integrate coding and algorithmic thinking in creative works and Computer Science students apply the principles and methodology of design thinking to visual applications. The minor enables students from different disciplines to collaborate on projects requiring both a technical and a creative perspective. The Computing for Interactive Arts minor is not open to students in the Computer Science minor or the Cross Disciplinary Studies Minor in Data Science.

Cross Disciplinary Studies Minor in Data Science

An interdisciplinary minor sponsored by the departments of Statistics and Computer Science. For more information, see the Statistics (<http://catalog.calpoly.edu/collegesandprograms/collegeofsciencemathematics/statistics/>) section. The Cross Disciplinary Studies Minor in Data Science is not open to students in the Computer Science minor or the Computing for Interactive Arts minor.

Graduate Program MS Computer Science

The MS program in Computer Science offers students the opportunity to prepare for careers in several areas of emphasis including software engineering, computer architecture, programming languages, theory of computing, operating systems, database systems, distributed computing,

computer networks, artificial intelligence, computer graphics, and human computer interaction. The program is designed for maximum flexibility to allow students to concentrate in one or more areas of study.

Eligibility for admission to the program requires a baccalaureate degree from an accredited institution and good standing at the last college attended. Admission can be granted in either classified or conditionally classified status. Classified admission can be granted to domestic and overseas applicants who satisfy the following conditions: applicants with a bachelor's degree in computer science, software engineering, or computer engineering are required to have a minimum 3.0 grade point average, including a minimum 3.0 grade point average in major courses; applicants with a bachelor's degree in a different field must have completed the required preliminary coursework listed in the table below and have a minimum grade point average of 3.25 for all undergraduate coursework. Conditionally classified admission can be granted to domestic applicants who satisfy the following conditions: The applicant must hold a Computer Science minor obtained as part of their undergraduate study, or they must have successfully completed introductory and upper-division Computer Science coursework in the amount equivalent to the Computer Science minor (an equivalent of about 28-32 quarter units). Specifically, applicants are expected to have completed the equivalent of 24 units of coursework (6 courses) from the below list, prior to starting their MS in Computer Science study.

All applicants must satisfy the following. A satisfactory score on the General Graduate Record Exam (GRE) is required; applicants are expected to achieve the following minimum scores: 425 verbal, 650 quantitative, 4.0 analytical writing on the old GRE test, or their matching equivalents on the revised GRE test (currently standing at 148 verbal, 158 quantitative and 4.0 analytical writing). A satisfactory score on the TOEFL is required for applicants with degrees from institutions from countries where English is not a native language; expected minimum scores are: 80 for internet-based test with a minimum 20 on each portion; 213 for computer-based test; 550 for paper-based test, plus 4.5 on TWE. All applicants must provide three letters of recommendation. Women and underrepresented minorities are strongly encouraged to apply for admission.

Students admitted as conditionally classified must complete the necessary undergraduate coursework to advance to candidacy. While fulfilling the undergraduate requirements, conditionally classified students retain official status as graduate students in the university. Conditionally classified students may advance to candidacy by completing coursework selected by the graduate coordinator from the following list of courses:

CSC 300	Professional Responsibilities	4
CSC 307 or CSC 308	Introduction to Software Engineering Software Engineering I	4
CPE 315	Computer Architecture	4
CSC 349	Design and Analysis of Algorithms	4
CSC/CPE 357	Systems Programming	4
CSC 430	Programming Languages	4
CSC 445	Theory of Computation I	4
CSC/CPE 453	Introduction to Operating Systems	4

Each course must be completed with a grade of "B" or better. These courses do not count toward the graduate degree.

The department may offer several graduate teaching assistantships. Preference is given to continuing graduate students and experienced

teachers. Other grant, fellowship, scholarship and loan information can be obtained from the Financial Aid office.

Degree Requirements

Students must file a Formal Study Plan with the Computer Science Department office no later than the end of the quarter in which they complete the twelfth unit of coursework to be counted toward the degree. The formal study plan identifies specific courses to be taken to fulfill requirements of the MS degree. The formal study plan may be amended with approval of the graduate coordinator.

Blended BS + MS Computer Science Program

A blended program provides an accelerated route to a graduate professional degree, with simultaneous conferring of both Bachelor's and Master's degrees. Students in the blended program are provided with a seamless process whereby they can progress from undergraduate to graduate status. Students are required to complete all requirements for both degrees, including senior project for the Bachelor's degree.

A blended program is available for MS Computer Science.

Eligibility

Majors that are eligible for the blended program are:

- BS Computer Science
- BS Computer Engineering
- BS Software Engineering

Participation in a blended program is based upon prior academic performance and other measures of professional promise. Refer to [Graduate Education \(http://catalog.calpoly.edu/graduateeducation/#graduateandpostbaccalaureateadmissionrequirements/\)](http://catalog.calpoly.edu/graduateeducation/#graduateandpostbaccalaureateadmissionrequirements/) for more information and for the minimum criteria required to be eligible for a blended program at Cal Poly. Contact the Graduate Program Coordinator in the Computer Science and Software Engineering department for any additional eligibility criteria.

Program of Study

Senior project requirements for the eligible undergraduate majors are satisfied as follows:

- BS Computer Engineering students may complete either CPE 461 and CPE 462 or CSC 497 and CSC 498. Those that complete CPE 461 and CPE 462 to satisfy the senior project requirement must take CSC 596 and CSC 597 as prerequisites to CSC 599 to complete the MS degree requirements. Those that complete CSC 497 and CSC 498 to satisfy both the senior project requirement and the CSC 599 prerequisites must take an additional 500-level course to satisfy the MS degree requirements.
- BS Computer Science students may complete either CSC 491 and CSC 492 or CSC 497 and CSC 498 to satisfy the undergraduate senior project requirement. Those that complete CSC 491 and CSC 492 to satisfy the senior project requirement must take CSC 596 and CSC 597 as prerequisites to CSC 599 to complete the MS degree requirements. Those that complete CSC 497 and CSC 498 to satisfy both the senior project requirement and the CSC 599 prerequisites must take an additional 500-level course to satisfy the MS degree requirements.

- BS Software Engineering students must complete the senior project requirement as satisfied by the software engineering capstone sequence culminating in CSC 406. BS Software Engineering students must complete CSC 596 and CSC 597 to satisfy the MS degree requirements.

In all cases, the master's culminating experience (CSC 599) must be completed to satisfy the MS degree requirements.

CSC Courses

CSC 101. Fundamentals of Computer Science. 4 units

Prerequisite: Appropriate Math Placement Level; or MATH 117 with a grade of C- or better; or MATH 118 with a grade of C- or better; or consent of instructor.

Basic principles of algorithmic problem solving and programming using methods of top-down design, stepwise refinement and procedural abstraction. Basic control structures, data types, and input/output. Introduction to the software development process: design, implementation, testing and documentation. The syntax and semantics of a modern programming language. Credit not available for students who have taken CSC/CPE 108. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 101.

CSC 105. Fundamentals of Computer Science I Supplemental Instruction. 1 unit

CR/NC
Concurrent: CPE/CSC 101.

Facilitated study and discussion of fundamental concepts of computer science and familiarization with programming environments. Credit/No Credit grading only. 1 laboratory. Crosslisted as CPE/CSC 105.

CSC 108. Accelerated Introduction to Computer Science. 4 units

Prerequisite: MATH 118 (or equivalent) with a grade of C- or better, significant experience in computer programming, and consent of instructor.

Accelerated introduction to basic principles of algorithmic and object-oriented problem solving and programming. Introduction to programming language concepts including control structures, data types, classes, and inheritance. Program design principles. Use and implementation of algorithms (searching, sorting, recursion) and data structures (lists, stacks, and queues). Intended for students with experience in algorithmic problem solving and using basic control structures and data types in a modern programming language (CPE/CSC 101), but who are not ready for CPE/CSC 202. Not open to students with credit in CPE/CSC 102 or CPE/CSC 202. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 108.

CSC 121. Computing for All I. 4 units

2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 115; or appropriate Math Placement Level.

Fundamentals of computational thinking in the study of non-computing disciplines. Ethical and social considerations of computing. Data gathering and representation. Logic and computational reasoning. Data and procedural abstraction. Problem decomposition. Code patterns for algorithmic problem-solving. 3 lectures, 1 activity. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE Area.

CSC 122. Computing for All II. 4 units

2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: CSC 121.

Fundamentals of computational thinking in the study of non-computing disciplines. Ethical and social considerations of computing. Reading code and identifying patterns. Problem Decomposition. Algorithms and automation. Software Engineering. Creative Computing. 3 lectures, 1 laboratory. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE Area.

CSC 123. Introduction to Computing. 4 units

Prerequisite: Basic computer literacy.

Use of a supportive software development environment to design, develop, and test applications in a selected topic domain that demonstrates the potential of careers in computing. An introduction to computing and to the selected topic domain. The Class Schedule will list topic selected. No programming experience required. Not for students with credit in CPE/CSC 103 or CPE/CSC 203. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 123.

CSC 171. Introduction to Interactive Entertainment. 4 units

Use of click-and-drag software application to create an entertaining or informative, socially responsible application, such as a game. Team collaboration to design, develop, and test applications. Focus on design, teamwork, and using an iterative development process. An enjoyable introduction to both computer science and interactive entertainment. No computer science experience required. 3 lectures, 1 laboratory.

CSC 200. Special Problems for Undergraduates. 1-2 units

Prerequisite: Consent of instructor.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CSC 202. Data Structures. 4 units

Prerequisite: CPE/CSC 101 with a grade of C- or better; MATH 141 or MATH 221 with a grade of C- or better; or consent of instructor.

Introduction to data structures and analysis of algorithms. Abstract datatypes. Specification and implementation of advanced data structures. Theoretical and empirical analysis of recursive and iterative algorithms. Software performance evaluation and testing techniques. Not open to students with credit in CSC/CPE 108. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 202.

CSC 203. Project-Based Object-Oriented Programming and Design. 4 units

Prerequisite: CPE/CSC 202 with a grade of C- or better or consent of instructor.

Object-oriented programming and design with applications to project construction. Introduction to class design, interfaces, inheritance, generics, exceptions, streams, and testing. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 203.

CSC 209. Problem Solving with Computers. 1 unit

CR/NC

Prerequisite: CSC/CPE 101 or CSC/CPE 108 with a grade of C- or better, or consent of instructor.

Reinforcement of computer science fundamentals. Review of important algorithms, language features, design, syntax, and testing techniques. Repeated application of techniques to solve problems in a constrained amount of time. Primarily intended to support students preparing for the Association for Computing Machinery's International Collegiate Programming Contest. Credit/No Credit grading only. Total credit limited to 15 units. 1 laboratory.

CSC 225. Introduction to Computer Organization. 4 units

Prerequisite: CSC/CPE 202.

Introduction to computer systems. Simple instruction set architecture and the computer hardware needed to implement that architecture. Machine and assembly language programming. 3 lectures, 1 laboratory.

CSC 231. Programming for Engineering Students. 2 units

Prerequisite: MATH 142; PHYS 121 or PHYS 131 or PHYS 141.

Programming techniques and procedures with applications to engineering problems. Introduction to numerical methods and simulation. Credit not allowed for CSC, Software Engineering or CPE majors. 2 activities.

CSC 232. Computer Programming for Scientists and Engineers. 3 units

Prerequisite: MATH 118 or equivalent.

Computer programming, with an emphasis on procedural programming, taught using a language hosted by applications commonly used in science and engineering. Credit not allowed for CSC, CPE or Software Engineering majors. 2 lectures, 1 activity.

CSC 234. C and Unix. 3 units

Prerequisite: MATH 142.

The C programming language and the UNIX programming environment. Operators, standard I/O functions, strings, pointers and arrays, data types and storage classes. Unix shell programming and basic I/O system calls. Credit not allowed for CSC, Software Engineering or CPE majors. 3 lectures.

CSC 235. Fundamentals of Computer Science for Scientists and Engineers I. 4 units

Prerequisite: MATH 141 or MATH 161 with a grade of C- or better, or consent of instructor.

Introduction to the fundamentals of computer programming with an emphasis on mathematical, scientific and engineering applications: principles of algorithmic problem solving and procedural programming using a modern programming language, data types, elementary data structures, input/output and control structures. Not a substitute for CSC/CPE 101 for CSC/CPE majors or minors. 3 lectures, 1 laboratory.

CSC 236. Fundamentals of Computer Science for Scientists and Engineers II. 4 units

Prerequisite: CSC 235 with a grade of C- or better, or consent of instructor.

Further study of computer program development with an emphasis on mathematical, scientific and engineering applications. Introduction to more complicated data types and structures. Practice of more complicated techniques of procedural programming. Introduction to the principles of object-oriented programming using a modern programming language. Detailed discussion of lists and classic list algorithms, algorithm analysis, multidimensional arrays, records, dynamic data structures, file input/output, classes. Not a substitute for CSC/CPE 202 for CSC/CPE/SE majors or minors. 3 lectures, 1 laboratory.

CSC 290. Selected Topics. 1-4 units

Prerequisite: Open to undergraduate students and consent of instructor.

Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

CSC 300. Professional Responsibilities. 4 units

Prerequisite: CSC/CPE 357 and junior standing.

The responsibilities of the computer science professional. The ethics of science and the IEEE/ACM Software Engineering Code of Ethics. Quality tradeoffs, software system safety, intellectual property, history of computing and the social implications of computers in the modern world. Applications to ethical dilemmas in computing. Technical presentation methods and practice. 3 lectures, 1 laboratory.

CSC 301. Personal Software Process. 4 units

Prerequisite: CSC/CPE 102 and CSC/CPE 103, or CSC/CPE 202 and CSC/CPE 203.

Principles and practices for defining and applying software processes to individual software development tasks. Quantitative methods for the measurement and analysis of software development cost and quality. Interpretation and evaluation of process metrics for creation of improvement plans. Adaptation of processes to individual styles. 3 lectures, 1 laboratory.

CSC 302. Computers and Society. 4 units

2020-21 or later: Upper-Div GE Area B

2019-20 catalog: GE Area B7

2017-19 or earlier catalog: GE Area F

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).

Social, ethical, political and technological implications and effects of computers in the modern world. Examination of the benefits and side-effects of computer applications and automation. Case study review and analysis. 4 lectures. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

CSC 303. Teaching Computer Science. 2 units

Prerequisite: CSC/CPE 102 and CSC/CPE 103, with a grade of C- or better or consent of instructor, or CSC/CPE 202 and CSC/CPE 203, with a grade of C- or better or consent of instructor.

Practical coverage of educational techniques appropriate for tutoring in CSC/CPE undergraduate courses, including Socratic methods for tutoring of technical topics, design of test questions and grading rubrics, and lecture presentation. Intended for CSC/CPE/SE students interested in tutoring, grading, or a career in teaching computer science. 1 lecture, 1 laboratory. Not available for technical elective credit.

CSC 305. Individual Software Design and Development. 4 units

Prerequisite: CSC/CPE 357.

Practical software development skills needed for construction of mid-sized production-quality software modules, using the CSC upper division programming language. Topics include inheritance, exceptions, and memory and disk-based dynamic data structures. Students must complete an individual programming project of mid-level complexity. 3 lectures, 1 laboratory.

CSC 307. Introduction to Software Engineering. 4 units

Prerequisite: CSC 141 or CSC 348; and CPE/CSC 357.

Requirements, specification, design, implementation, testing and verification of large software systems. Study and use of the software process and software engineering methodologies; working in project teams. Not open to students with credit in CSC 308. 3 lectures, 1 laboratory.

CSC 308. Software Engineering I. 4 units

Prerequisite: CSC 141 or CSC 348.

Principles for engineering requirements analysis and design of large complex software systems. Software process models. Methods of project planning, tracking, documentation, communication, and quality assurance. Analysis of engineering tradeoffs. Group laboratory project. Technical oral and written presentations. 3 lectures, 1 laboratory.

CSC 309. Software Engineering II. 4 units

Prerequisite: CSC 308 and CSC/CPE 357.

Continuation of the software lifecycle. Methods and tools for the implementation, integration, testing and maintenance of large software systems. Software development and test environments. Software quality assurance. Group laboratory project. Technical presentation methods and practice. 3 lectures, 1 laboratory.

CSC 310. Computers for Poets. 4 units

2020-21 or later: Upper-Div GE Area B

2019-20 catalog: GE Area B7

2017-19 or earlier catalog: GE Area F

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).

How computers and computer devices work. Introduction to software systems and applications. How computers connect with various media including images, speech and data. How information is encoded and transmitted across networks. Relationship between the computer and human information processing. 4 lectures. Crosslisted as CSC 310/HNRS 311. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

CSC 311. Computational Art. 4 units

2020-21 or later: Upper-Div GE Area B

2019-20 catalog: GE Area B7

2017-19 or earlier catalog: GE Area F

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).

Interdisciplinary creation of static and animated computational art using algorithms. General design principles in a digital setting, including color, shape, composition, perspective, principles of animation. Development of computational tools such as variables, iteration, logic, functions. Creative expression via coding and creative coding. 3 lectures, 1 laboratory. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

CSC 313. Teaching Computing. 4 units

Prerequisite: CPE/CSC 202.

An introduction to pedagogical methods and practical techniques for computer science education: selecting appropriate content, designing assignments and activities, evaluating student learning, and evaluating teaching efficacy. Hands-on guided curricular design activities and real-world practice. 3 lectures, 1 laboratory.

CSC 320. Practical Computer Security for Everyone. 4 units

2020-21 or later: Upper-Div GE Area B

2019-20 catalog: GE Area B7

2017-19 or earlier catalog: GE Area F

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs).

Exploration of practical computer security in everyday life for non-majors. Covering the principles, technologies and tools used to secure the Internet and keep ourselves 'digitally' secure, including: privacy and anonymity, web and data security, cryptography, malware, authentication and access control. 3 lectures, 1 laboratory. Fulfills GE Upper-Division B (GE Area B7 for students on the 2019-20 catalog; GE Area F for students on earlier catalogs).

CSC 321. Introduction to Computer Security. 4 units

Prerequisite: CPE/CSC 357.

Survey of topics in computer system and network security, including protection, access control, distributed access control, operating system security, applied cryptography, network security, firewalls, secure coding practices, and case studies from real-world systems. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 321.

CSC 323. Cryptography Engineering. 4 units

Prerequisite: CPE/CSC 357.

An introduction to the theory and practice of building secure, cryptographic systems. Core cryptographic primitives. Implementation, evaluation and subversion of widely deployed cryptographic products and protocols. 3 lectures, 1 laboratory.

CSC 325. Introduction to Privacy: Policy and Technology. 4 units

Prerequisite: CSC 300.

Introduction to policies and technologies related to digital privacy. Legal decisions and policies, domestic and global cultural expectations, and privacy related technologies including applications to surveillance, big data, websites, mobile, and privacy by design. 3 lectures, 1 laboratory.

CSC 344. Music Programming. 4 units

Prerequisite: CSC 141 or CSC 348; and CPE/CSC 357.

Music-producing programs. Software synthesizers: oscillators, coupled oscillators, wavetable synthesis. Sound processing units/filters: LTI, FIR, IIR, nonlinear. Physics of sound, mathematical foundations of sound synthesis and filtering, existing sound formats (both sampled and MIDI). 3 lectures, 1 laboratory.

CSC 348. Discrete Structures. 4 units

Prerequisite: CSC/CPE 102 and CSC/CPE 103, with a grade of C- or better or consent of instructor, or CSC/CPE 202 and CSC/CPE 203, with a grade of C- or better or consent of instructor.

Structures of computer science: logic, sets, relations, functions, graphs and trees. Propositional and predicate logic. Applications of predicate logic to preconditions, postconditions, and proof techniques. Complexity of algorithms. Not open to students with credit in CSC 141. 4 lectures.

CSC 349. Design and Analysis of Algorithms. 4 units

Prerequisite: CSC 141 and MATH 142; or CSC 348 and MATH 142; or CPE/CSC 102 and CPE/CSC 103 and MATH 248; or CPE/CSC 202 and CPE/CSC 203 and MATH 248.

Intermediate and advanced algorithms and their analysis. Mathematical, geometrical, and graph algorithms. NP-complete problems. Additional topics will be chosen from pattern matching, file compression, cryptology, dynamic and linear programming, and exhaustive search. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory.

CSC 350. Computing for Interactive Arts Capstone I. 2 units

Prerequisite: ART 384; CSC/CPE 103 or CSC/CPE 202; and junior standing.

Definition and specification of a team-based creative collaboration on a digital interactive art project (e.g. animation, video game, interactive media display, etc). Research and techniques, project planning and project team organization, prototype creation. 1 lecture, 1 laboratory. Crosslisted as ART/CSC 350.

CSC 357. Systems Programming. 4 units

Prerequisite: CSC/CPE 102 and CSC/CPE 103 with a grade of C- or better or consent of instructor, or CSC/CPE 202 and CSC/CPE 203 with a grade of C- or better or consent of instructor; and CSC 225 or CPE/EE 229 or CPE/EE 233.

C programming language from a system programming perspective. Standard C language including operators, I/O functions, and data types in the context of system functions. Unix commands, shell scripting, file system, editors. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 357.

CSC 365. Introduction to Database Systems. 4 units

Prerequisite: CSC 141; or CSC 348; or CPE/CSC 102 and CPE/CSC 103 and MATH 248; or CPE/CSC 202 and CPE/CSC 203 and MATH 248.

Basic principles of database management systems (DBMS) and of DBMS application development. DBMS objectives, systems architecture, database models with emphasis on Entity-Relationship and Relational models, data definition and manipulation languages, the Structured Query Language (SQL), database design, application development tools. 3 lectures, 1 laboratory.

CSC 366. Database Modeling, Design and Implementation. 4 units

Prerequisite: CSC 365.

The database modeling problem. Database modeling levels: external, conceptual, logical and physical. Database models: entity-relationship, relational, object-oriented, semantic, and object-relational. Normal forms. Distributed database design. Functional analysis of database applications and transaction specification, design, and implementation. 3 lectures, 1 laboratory.

CSC 369. Introduction to Distributed Computing. 4 units

Prerequisite: CSC/CPE 102 and CSC/CPE 103, or CSC/CPE 202 and CSC/CPE 203; and one of the following: STAT 301, STAT 312, STAT 321 or STAT 350.

Introduction to distributed computing paradigms and cloud computing. Modern distributed computing infrastructures. Problem-solving in a distributed computing environment. 3 lectures, 1 laboratory.

CSC 371. Game Design. 4 units

Prerequisite: CSC/CPE 102 and CSC/CPE 103; or CSC/CPE 202 and junior standing.

In-depth study of game design including rules, player interaction, and storytelling. Exploration of effective use of sound, art, and game controls in creating meaningful play. Development of fully functioning and engaging games, following standard domain-specific software development processes and using physical prototyping and playtesting. Current, industry-tested game engines. 3 lectures, 1 laboratory.

CSC 377. Introduction to Mixed Reality. 4 units

Prerequisite: CPE/CSC 202. Recommended: ART 376.

Project-based study and application of Mixed Reality (MR) topics including integrated mixed reality development environments, Human Computer Interaction (HCI) peripherals, 3D environment scanning, physics interaction, diminished reality, motion capture, facial recognition, and visualization hardware. 3 lectures, 1 laboratory.

CSC 378. Interactive Entertainment Engineering. 4 units

Prerequisite: CPE/CSC 102 and CPE/CSC 103, or CPE/CSC 202 and junior standing.

Project-based, software oriented, introductory study of interactive entertainment. Discussion and evaluation of classic and historically influential games. Exploration of concepts in game design and development. Topics may include interactive storytelling, game physics, game AI, character development, animation, and development of virtual worlds. Projects require significant programming. 3 lectures, 1 laboratory.

CSC 400. Special Problems. 1-4 units

Prerequisite: Consent of instructor.

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 4 units.

CSC 402. Software Requirements Engineering. 4 units

Prerequisite: CSC 307 or CSC 309.

Software requirements elicitation, analysis and documentation. Team process infrastructure and resource estimation to support appropriate levels of quality. Software architectural design. 3 lectures, 1 laboratory.

CSC 405. Software Construction. 4 units

Prerequisite: CSC 305 and CSC 402.

Design and construction of sizeable software products. Technical management of software development teams. Software development process models, software design, documentation, quality assurance during development, software unit and integration testing; CASE tools, development environments, test tools, configuration management. 3 lectures, 1 laboratory.

CSC 406. Senior Project - Software Deployment. 4 units

Prerequisite: CSC 405.

Deployment of a sizeable software product by a student team. Software maintenance and deployment economic issues. Management of deployed software: version control, defect tracking and technical support. 3 lectures, 1 laboratory.

CSC 409. Current Topics in Software Engineering. 4 units

Prerequisite: CSC 307 or CSC 309.

Selected topics in software engineering. Topics may include program generation, quality assurance, formal methods, software metrics, design methods, testing, or software development processes. The Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory.

CSC 410. Software Evaluation. 4 units

Prerequisite: CSC 349; STAT 301, STAT 312, STAT 321 or STAT 350.

Theory and practice of evaluation of software and software systems. Design of experiments for measuring software performance, measuring software output quality, comparing multiple implementations of the same algorithm, and evaluation of software heuristics. Selection of appropriate software evaluation measures and criteria. 3 lectures, 1 laboratory.

CSC 422. Network and Web Security. 4 units

Prerequisite: CPE 464.

Introduction to network and web security, including denial of service, botnets, access control, routing attacks, transport layer attacks, tunneling mechanisms, VPNs, IDS, firewalls, penetration testing, key distribution, browser security, social network security, email security, jamming, and wireless security. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 422.

CSC 424. Software Security. 4 units

Prerequisite: CPE/CSC 307 or CPE/CSC 309; CPE/CSC 321.

Principles behind secure software design including threat models, trust management, common vulnerabilities and mitigation techniques, robust software development, isolation of untrusted code, auditability, and testing. 3 lectures, 1 laboratory.

CSC 429. Current Topics in Computer Security. 4 units

Prerequisite: CPE/CSC 321 and CPE/CSC 357.

Selected topics in emerging areas of computer security. Potential topics include: network and web security, critical infrastructure protection, embedded systems security, malware analysis, mobile security, and digital forensics, among others. The Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory.

CSC 430. Programming Languages. 4 units

Prerequisite: CSC 349 and CSC/CPE 357.

Programming language design through evaluator implementation. Expressions, functions, environments, closures, mutation, objects, type systems, and syntactic abstraction. Syntactic, semantic, and static analysis properties. 3 lectures, 1 laboratory.

CSC 431. Compiler Construction. 4 units

Prerequisite: CSC 430.

Intermediate code representations, memory management, functions and parameter passing, code transformations and optimizations, code generation, register allocation. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 431.

CSC 435. Introduction to Object Oriented Design Using Graphical User Interfaces. 4 units

Prerequisite: CSC 305.

Principles of object-oriented design, with emphasis on use of these principles in the design of graphical interfaces. Comparison and contrasting of two major object-oriented languages and their corresponding GUI class libraries. Language-independent object-oriented design methods, and application of these methods in the construction of a GUI-based project. Course may be offered in classroom-based or online format. 3 lectures, 1 laboratory.

CSC 436. Mobile Application Development. 4 units

Prerequisite: CSC/CPE 357.

Inception, development, testing, and deployment of mobile applications. Introduction to tools, libraries, and frameworks for one or more mobile platforms and devices. Emphasis on software engineering best practices for developing entrepreneurial or humanitarian mobile-centric applications. 3 lectures, 1 laboratory.

CSC 437. Dynamic Web Development. 4 units

Prerequisite: CPE/CSC 357 with a grade of C- or better and CSC 365 with a grade of C- or better; or consent of instructor.

Project-based study of web-based three-tiered applications, including current best practices and tools for design, implementation and testing of browser interface, serverside business logic, object-relational mapping, databases, and web services. 3 lectures, 1 laboratory.

CSC 445. Theory of Computation I. 4 units

Prerequisite: CSC 141 or CSC 348.

Theory of formal languages and automata. Turing machines. Chomsky hierarchy. Theory of decidability and computability. 4 lectures.

CSC 448. Bioinformatics Algorithms. 4 units

Prerequisite: CSC 349.

Introduction to the use of computers to solve problems in molecular biology. The algorithms, languages, and databases important in determining and analyzing nucleic and protein sequences and their structure. 3 lectures, 1 laboratory.

CSC 450. Computing for Interactive Arts Capstone II. 2 units

Prerequisite: ART/CSC 350.

Team-based design, construction and deployment of a collaborative interactive computational art project typically found in the fields of animation, game design, and interactive media. Management of interdisciplinary teams, documentation, creative development, testing, and assessment. 2 activities. Crosslisted as ART/CSC 450.

CSC 453. Introduction to Operating Systems. 4 units

Prerequisite: CSC/CPE 357, and CSC/CPE 225 or CPE/EE 229 or CPE/EE 233.

Introduction to sequential and multiprogramming operating systems; kernel calls, interrupt service mechanisms, scheduling, files and protection mechanisms, conventional machine attributes that apply to operating system implementation, virtual memory management, and I/O control systems. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 453.

CSC 454. Implementation of Operating Systems. 4 units

Prerequisite: CSC/CPE 453.

Design and implementation of multiprogramming kernels, systems programming methodology, interprocess communications, synchronization, device drivers and network access methods. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 454.

CSC 458. Current Topics in Computer Systems. 4 units

Prerequisite: CSC/CPE 357.

Selected aspects of design, implementation and analysis of networks, advanced operating and distributed systems. Topics may include process management, virtual memory, process communication, context switching, file system designs, persistent objects, process and data migration, load balancing, security and networks. The Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 458.

CSC 466. Knowledge Discovery from Data. 4 units

Prerequisite: CSC 349 and one of the following: STAT 302, STAT 312, STAT 321 or STAT 350.

Overview of modern knowledge discovery from data (KDD) methods and technologies. Topics in data mining (association rules mining, classification, clustering), information retrieval, web mining. Emphasis on use of KDD techniques in modern software applications. 3 lectures, 1 laboratory.

CSC 468. Database Management Systems Implementation. 4 units

Prerequisite: CSC 365.

Data structures and algorithms used in the implementation of database systems. Implementation of data and transaction managers: access methods interfaces, concurrency control and recovery, query processors and optimizers. Introduction to implementation of distributed database systems. 3 lectures, 1 laboratory.

CSC 469. Distributed Systems. 4 units

Prerequisite: CSC/CPE 357.

Foundations of distributed systems, distributed hash tables (peer-to-peer systems), failure detectors, synchronization, election, inter-process communication, consensus, replication, key-value stores, and measurements. 3 lectures, 1 laboratory. Crosslisted as CSC/CPE 469.

CSC 471. Introduction to Computer Graphics. 4 units

Prerequisite: CPE/CSC 357.

Graphics software development and use of application programming interfaces for 3D graphics. The graphics pipeline, modeling, geometric and viewing transforms, lighting and shading, rendering, interaction techniques and graphics hardware. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 471.

CSC 473. Advanced Rendering Techniques. 4 units

Prerequisite: CSC/CPE 471.

Illumination models, reflectance, absorption, emittance, Gouraud shading, Phong shading, raytracing polyhedra and other modeling primitives, coherence, acceleration methods, radiosity, form factors, advanced algorithms. 3 lectures, 1 laboratory.

CSC 474. Computer Animation. 4 units

Prerequisite: CSC/CPE 471.

Basic and advanced algorithms for generating sequences of synthetic images. Interpolation in time and space, procedural and keyframe animation, particle systems, dynamics and inverse kinematics, morphing and video. 3 lectures, 1 laboratory.

CSC 476. Real-Time 3D Computer Graphics Software. 4 units

Prerequisite: CSC/CPE 471.

Basic and advanced algorithms for real-time, interactive, 3D graphics software. Modeling (polygon mesh, height field, scene graph), real-time rendering and shading (visibility processing, LOD, texture and light maps), collision detection (bounding volumes, complexity management), interactive controls, multi-player game technology, game engine architecture. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 476.

CSC 477. Scientific and Information Visualization. 4 units

Prerequisite: CSC 349.

Basic data processing (magnitude, grouping and segmentation), visualization design, cognition and perception, spatial data visualizations (2D and 3D, e.g. GIS data, medical data) information data visualization, spatial encoding, color encoding, and interaction. 3 lectures, 1 laboratory.

CSC 478. Current Topics in Computer Graphics. 4 units

Prerequisite: CSC/CPE 471.

Selected aspects of the design, implementation and analysis of computer graphics. Topics may include rendering, modeling, visualization, animation, virtual reality, computer vision, multimedia, and perception issues. The Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory.

CSC 480. Artificial Intelligence. 4 units

Prerequisite: either CSC/CPE 102 and CSC/CPE 103 with a grade of C- or better or consent of instructor; or CSC/CPE 202 with a grade of C- or better and junior standing.

Programs and techniques that characterize artificial intelligence. Programming in a high level language. 3 lectures, 1 laboratory.

CSC 481. Knowledge Based Systems. 4 units

Prerequisite: CSC 480.

In-depth treatment of knowledge representation, utilization and acquisition in a programming environment. Emphasis on the use of domain-specific knowledge to obtain expert performance in programs. 3 lectures, 1 laboratory.

CSC 482. Speech and Language Processing. 4 units

Prerequisite: CSC 466 or CSC 480 or graduate standing. Recommended: CSC 349.

Introduction to natural language processing theory; speech processing; review of recent advancements. Topics include: tokenization, part-of-speech tagging, word-sense disambiguation, natural language understanding, natural language generation, data mining, voice processing, vocalization, semantic networks, intelligent assistants, computational linguistics, stylistics and machine learning. 3 lectures, 1 laboratory.

CSC 483. Current Topics in Human-Computer Interaction. 4 units

Prerequisite: CSC 484.

Selected aspects of the field of human-computer interaction. Topics may include dynamic information visualization, universal access, social impact of technology usage, educational technology, human cognition and performance studies, and extended usability evaluation techniques. The Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory.

CSC 484. User-Centered Interface Design and Development. 4 units

Prerequisite: CSC 307 or CSC 308; junior standing.

Introduction to the importance of user-centered principles in the design of good interfaces and effective human-computer interaction. Topics include: study of human characteristics affected by interface design, effective requirements data collection and analysis, user-centered approaches to software engineering, and evaluation of interface and interaction quality. 3 lectures, 1 laboratory.

CSC 486. Human-Computer Interaction Theory and Design. 4 units

Corequisite: CSC 484.

Application of the theories of human-computer interaction to the task of user-centered design. Survey of techniques for studying and involving users in different aspects of the design process, and demonstration of where and when applicable. Combining of theoretical understanding with practical experience to design solutions to problems facing interactive systems designers. 3 lectures, 1 laboratory.

CSC 487. Deep Learning. 4 units

Prerequisite: CSC 349, and MATH 206 or MATH 244. Recommended: CSC 466 or CSC 480.

Overview of current topics in Deep Learning. Theory and practice of Deep Learning (DL) paradigms. Convolutional Neural Networks (NN), Recurrent NN, Dropout, Momentum Gradient Descent, Batch Normalization, Adversarial and Siamese NN, and new developments. Emphasis on using DL to solve a real-world application of significant scope. 3 lectures, 1 laboratory.

CSC 489. Current Topics in Artificial Intelligence. 4 units

Prerequisite: CSC 480.

Selected aspects of the design, implementation and analysis of advanced systems and concepts in the area of artificial intelligence. Topics may include knowledge representation, reasoning, learning, or planning, and specific techniques like intelligent agents, genetic algorithms, semantic web, or robotics. The Class Schedule will list topic selected. Total credit limited to 8 units. 3 lectures, 1 laboratory.

CSC 490. Selected Advanced Topics. 1-4 units

Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. Class schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

CSC 491. Senior Project I. 2 units

Prerequisite: CSC 307 or CSC 309; and consent of instructor.

Selection and completion of a project by individuals or team which is typical of problems which graduates must solve in their fields of employment. Project may include students from other disciplines. Formulation of outline, literature review, and project schedule.

CSC 492. Senior Project II. 2 units

Prerequisite: CSC 491 and consent of instructor.

Selection and completion of a project by individuals or team which is typical of problems which graduates must solve in their fields of employment. Project may include students from other disciplines. Project results are presented in a formal report.

CSC 493. Cooperative Education Experience. 2 units

CR/NC

Prerequisite: Sophomore standing and consent of instructor.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 6 units.

CSC 494. Cooperative Education Experience. 6 units

CR/NC

Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 18 units.

CSC 495. Cooperative Education Experience. 12 units

CR/NC

Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 24 units.

CSC 496. Selected Advanced Laboratory. 1-4 units

Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

CSC 497. Research Senior Project I. 2 units

Prerequisite: CSC 307 or CSC 309; and consent of instructor.

Individual research activity under faculty supervision. Problem statement and literature review. Intended for those planning to pursue graduate studies or research-oriented employment.

CSC 498. Research Senior Project II. 2 units

Prerequisite: CSC 497 and consent of instructor.

Continued individual research activity under faculty supervision. Prototype development, analysis, documentation. Intended for those planning to pursue graduate studies or research-oriented employment.

CSC 500. Directed Study. 1-4 units

CR/NC

Prerequisite: Fully classified graduate standing and consent of instructor.

Individual directed study of advanced topics. Total credit limited to 4 units. Credit/No Credit grading only.

CSC 508. Software Engineering I. 4 units

Prerequisite: CSC 307 or CSC 308 and graduate standing, or consent of instructor.

In-depth study of requirements engineering, software project management, formal specifications and object-oriented analysis. 4 seminars.

CSC 509. Software Engineering II. 4 units

Prerequisite: CSC 508 and graduate standing, or consent of instructor.

In-depth study of software modeling and design. Formal design methodologies. Design patterns. Detailed case studies of existing projects. Tools and methods for designing large software systems. 4 seminars.

CSC 515. Computer Architecture. 4 units

Prerequisite: CPE 315 or CPE 333, and graduate standing; or consent of instructor.

Comparative study and design of multiprocessor, dataflow, RISC, high level language and other new computer architectures. VLSI processor design techniques. 3 seminars, 1 laboratory. Crosslisted as CPE/CSC 515.

CSC 521. Computer Security. 4 units

Prerequisite: CPE/CSC 321 and graduate standing.

Exploration of advanced topics in computer security with an emphasis on research topics. 3 lectures, 1 laboratory.

CSC 530. Languages and Translators. 4 units

Prerequisite: CSC 430 and graduate standing, or consent of instructor.

Advanced programming language and translator concepts. Language concepts to be covered will be selected from current state-of-the-art languages and current issues in language design. Compiler concepts will include retargetable code generation, use of translator-writing systems, and error recovery. 4 seminars.

CSC 540. Theory of Computation II. 4 units

Prerequisite: CSC 445 and graduate standing, or consent of instructor.

Advanced topics in theoretical computer science from such areas as automata theory, cellular automata theory, computational complexity, and program verification. 4 seminars.

CSC 549. Advanced Algorithm Design and Analysis. 4 units

Prerequisite: CSC 349.

Advanced study of algorithmic topics including dynamic programming, network flows, and linear programming. Complexity classes and reductions. NP-complete problems, with the introduction of approximation algorithms. 4 lectures.

CSC 550. Operating Systems. 4 units

Prerequisite: CSC/CPE 453 and graduate standing, or consent of instructor.

General concepts of computer architecture and operating systems. Design features of advanced computers, general time-sharing systems and schemes for dynamic memory allocation, scheduling and protection. Dynamic linkage between subroutines. Intercommunication between input/output and processors. 4 seminars.

CSC 560. Database Systems. 4 units

Prerequisite: CSC 365 and graduate standing, or consent of instructor.

Current topics in database systems: distributed databases and transactions, nested and long-running transactions, distributed concurrency control, semantic and object-oriented data models, database systems for non-traditional applications: engineering design databases, active, logic, temporal, multimedia, and real-time databases. 4 seminars.

CSC 564. Computer Networks: Research Topics. 4 units

Prerequisite: CSC/CPE 464 and graduate standing, or consent of instructor.

Exploration of advanced topics in emerging computer networking technologies; focus on leading edge computer network research topics. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 564.

CSC 566. Topics in Advanced Data Mining. 4 units

Prerequisite: CSC 466 or CSC 480 or CSC 582.

Advanced topics in the areas of data mining, knowledge discovery in data, machine learning, information retrieval and intelligent analysis of information. The Class Schedule will list topic selected. Total credit limited to 8 units. 4 lectures.

CSC 569. Distributed Computing. 4 units

Prerequisite: CSC 141 or CSC 348; and CPE/CSC 357; or graduate standing and consent of instructor.

Principles and practices in distributed computing: interprocess communications, group communications, client-server model, distributed objects, message queue system, distributed services, mobile agents, object space, Internet protocols. Distributed algorithms: consensus protocols, global state protocols. Fault tolerance: classification of faults, replication. 3 lectures, 1 laboratory. Crosslisted as CPE/CSC 569.

CSC 570. Current Topics in Computer Science. 2-4 units

Prerequisite: Graduate standing and evidence of satisfactory preparation in computer science.

Directed group study of selected topics for graduate students. Topics will normally consist of continuations of those in CSC 520, CSC 530, CSC 540, CSC 550, CSC 560 and CSC 580, and other topics as needed. The Class Schedule will list topic selected. Topic credit limited to 12 units. 2 to 4 seminars.

CSC 572. Computer Graphics. 4 units

Prerequisite: Successful completion of CSC/CPE 471 and graduate standing, or consent of instructor.

Advanced topics in computer graphics with emphasis on leading edge computer graphics technologies and advanced topics in graphics fundamentals. 3 lectures, 1 laboratory.

CSC 580. Artificial Intelligence. 4 units

Prerequisite: CSC 480 and graduate standing, or consent of instructor.

Current research in the field of artificial intelligence with emphasis on cooperative agents, distributed agents, and decision making in complex, concurrent environments. AI programming in a distributed environment. 3 lectures, 1 laboratory.

CSC 581. Computer Support for Knowledge Management. 4 units

Prerequisite: CSC 480 or CSC 484 or consent of instructor.

Methods and techniques that computer-based systems can provide to make the management of knowledge and information in digital form easier for the user. Emphasis on support for knowledge-intensive activities performed by users. 3 lectures, 1 laboratory.

CSC 582. Computational Linguistics. 4 units

Prerequisite: CSC 482 and graduate standing. Recommended: CSC 580.

Research-based review of recent advancements in computational linguistics and natural language processing. Topics selected from: language morphology, natural language generation, feature extraction and unification, meaning representations, stylistics, discourse analysis and machine learning methods. 3 lectures, 1 laboratory.

CSC 590. Thesis Seminar. 1 unit

Prerequisite: Graduate standing or consent of instructor.

Preparation for conducting research in the field of computer science, through discussions, selected readings, and student presentations. 1 seminar.

CSC 593. Cooperative Education Experience. 2 units

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only.

CSC 594. Cooperative Education Experience. 6 units

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only.

CSC 595. Cooperative Education Experience. 12 units

CR/NC

Prerequisite: Graduate standing and consent of instructor.

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. A fully-developed formal report and evaluation by work supervisor required. Credit/No Credit grading only.

CSC 596. Research in Computer Science I. 2 units

Prerequisite: Consent of instructor.

Individual research or activity under faculty supervision, beginning work in preparation for the master's thesis.

CSC 597. Research in Computer Science II. 2 units

Prerequisite: CSC 596 and consent of instructor.

Individual research activity under faculty supervision, continuing work in preparation for the master's thesis.

CSC 599. Thesis. 4 units

Prerequisite: CSC 590; CSC 498 or CSC 597; selection of thesis committee; graduate standing; and consent of instructor.

Individual research or activity under faculty supervision leading to an acceptable Master's thesis.