COMPUTER SCIENCE

Computer Science (http://www.ewu.edu/cstem/departments/computer-science)
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Undergraduate Degrees

Bachelor of Science (BCS)

- Computer Science (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/computer-science-bcs)

Bachelor of Science (BS)

- Computer Science (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/computer-science-bs)

Undergraduate Minors

- 3D Animation (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/3d-animation-minor)
- Computer Applications (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/computer-applications-minor)
- Computer Information Systems (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/computer-information-systems-minor)
- Computer Science Programming (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/computer-science-programming-minor)
- Web Application Development (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/web-application-development-minor)

Undergraduate Programs

Computer Science is an exciting and rapidly evolving discipline involving the study of computing systems and computation. Computing systems are now a critical component in nearly every field. As computer applications have increased in number and complexity, so has the need for specialists in computer systems and software. Research in computer science continues to broaden and extend our knowledge and provide new opportunities.

The study of computer science is a challenging and satisfying intellectual activity that can be carried forward into graduate school and throughout one's life. Our graduates achieve a high degree of success in building careers in both public and private sectors.

Facilities and Equipment

The Animation Production Studio: equipped with professional grade software and hardware, this lab houses our motion capture system and blue screen and offers students an excellent environment for creating and developing quality animation, computer games and multimedia applications.

Center for Network Computing and Cyber Security: this lab contains support materials and hardware for computer science courses in secure client/server network programming, web server security, network intrusion detection and computer forensics.

Computer Architecture and Embedded Systems: resources and equipment are available to supporting studies in architecture and embedded systems.

Classroom Labs: these teaching labs provide hands-on instructional capabilities for Computer Science and Computer Literacy courses.

Lower Division Computer Science Lab: this study lab supports lower division students, staffed by peer tutors.

Upper Division Computer Science Lab: this study lab is designed to support junior and senior level Computer Science projects in software design; client/server application development; relational database design and administration; and signal processing.

Opportunities for Students: upper-division majors should check on EagleAXIS for opportunities for work-study and departmental positions as course assistants, paper graders, or tutors.

Many of our students are able to obtain internships where the theory and skills learned in the academic setting are put to the test. Internships allow you to gain new knowledge and understanding of current practices. An internship experience is an excellent opportunity to refine your career aspirations and make valuable contacts for future employment.

All students in our programs are encouraged to join the student chapter of the Association for Computing Machinery (ACM). This group sponsors colloquia, field trips, programming contests and social events. Membership in the student chapter is the beginning of a long-term opportunity to connect with professionals in your chosen field.

Preparation: High school students wanting to pursue a major in this department are advised to take as much mathematics as possible, including a course or courses in your senior year. You will benefit from computer science courses available in your high school but do not take them at the expense of mathematics courses. You also are encouraged to take laboratory science courses and a keyboarding course.

Community college transfer students interested in Computer Science should pursue mathematics courses through pre-calculus or beyond, as well as an advanced sophomore level composition course. Consult transfer guides (http://www.ewu.edu/transferguide) to determine whether your institution has developed agreements with Eastern for transfer equivalencies, and which courses are equivalent for general education requirements and courses that may apply to the major. Contact the department for advice on selecting your preparatory coursework. Courses taken to apply to the major should be taken late in your community college experience, just prior to transferring to EWU.

All prospective department majors should contact the Department of Computer Science to obtain the latest information to aid in planning a program of study. See grade requirements below.

Major Declaration

Freshman and transfer students entering Eastern with an interest in the computing sciences are encouraged to declare their major as soon as practical. To declare a major, complete the major declaration form (https://sites.ewu.edu/records-and-registration/forms), print, sign, and bring it and official or unofficial copies of all non-EWU college-level work to a meeting with a computer science advisor. You may contact an advisor for an appointment At the advising session you will have the opportunity to review course requirements, ask questions, prepare a quarterly schedule and finish the major declaration, which also requires agreeing to abide by the department's Code of Ethics and Professional Conduct (http://access.ewu.edu/computer-science/code-of-ethics.xml), which is available on the department's website.

Grade Requirements

As a computer science student, you are expected to maintain an overall university GPA ≥2.5. Each computer science course must be completed with a minimum grade ≥2.5. All supporting courses required by the department must be completed with a minimum grade ≥2.0.

Graduate Degrees

Master of Science (MS)

- Computer Science (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/computer-science-ms)
- Interdisciplinary (http://catalog.ewu.edu/science-technology-engineering-mathematics/computer-science/interdisciplinary-ms)

Application/Admission Requirements–the petitioner must:

1. meet all Eastern Washington University requirements for admission to graduate study;
2. complete and submit the online application for graduate school (http://www.ewu.edu/grad/application-procedures);
3. submit a completed departmental questionnaire;
4. supply transcripts showing completion of coursework covering the following areas:

- Fundamental Programming (see CSCD 210, CSCD 211)
- C Programming & Unix Operating System (see CSCD 240)
- Data Structures, Algorithms: (see CSCD 300, CSCD 320)
- Relational Database Systems: (see CSCD 327)
- Operating Systems (see CSCD 340)
- Design Patterns and Software Engineering (see CSCD 349, CSCD 350)
- Discrete Mathematics (see MATH 301)

If you are not taking the GRE, it is important that you indicate all grades received in these courses, or their equivalents, on your departmental questionnaire in order to prevent delays in the processing of your application.

Provide a résumé:

- if you are not a graduate of a Computer Science degree from EWU, provide two letters of recommendation, at least one from a computer science instructor or equivalent;
- submit a cover letter discussing your reasons for pursuing a master's degree, the focus of knowledge you want to explore, and an evaluation of your ability to complete this degree;
- if you are an international student, provide a TOEFL score of 580 or greater (237 CBT, 92 iBT).

Notes:

- applicants who have not completed the readiness courses may do so as post-baccalaureate students but may also petition for probationary graduate admission when they have less than a full-time load of readiness courses to complete;
- students needing to satisfy the requirements for CSCD 320 Algorithms, CSCD 340 Operating Systems or CSCD 350 Software Engineering at EWU will first need to pass the Computer Science Advancement Programming Exam;
- elective graduate courses may have prerequisites beyond the readiness requirements above and the student is responsible for mastering prerequisites before taking such courses. If the prerequisite course is not at the senior level it cannot be counted towards the graduate degree.

Subjects codes: CPLA (p. 2), CSCD (p. 3)

Computer Literacy Courses

CPLA 100. COMPUTER LITERACY I. 1 Credit.
Notes: graded Pass/No Credit; passing this course gives clearance of Computer Literacy Part I; does not count toward the 180 credit requirement.
Satisfies: pre-university basic skills, computer literacy.
This course is an introduction to computer concepts. Hardware, software and operating systems are presented on both Windows and Mac platforms. An introduction to word processing, presentation software and an introduction to basic Internet use are provided.

CPLA 101. COMPUTER LITERACY II. 1 Credit.
Notes: passing the literacy exam at the end of this course gives clearance of Computer Literacy Part II.
Pre-requisites: CPLA 100 or Computer Literacy Part I clearance.
Satisfies: university competencies, computer literacy.
Students will be introduced to and develop skills in spreadsheets, databases and the process of locating informational and reference materials using simple and refined Internet searches. Students will explore societal issues of security, privacy, viruses and computer crime.

CPLA 120. COMPUTER APPLICATIONS LITERACY. 5 Credits.
Notes: this course includes preparation for and testing of Computer Literacy I and II so that students may satisfy computer literacy requirements by taking this course and passing the literacy tests. This course introduces students to fundamental computer concepts designed to give an overview of computers, the Internet and The World Wide Web. Students will develop knowledge and skills in word processing, presentation software, spreadsheets, databases, web page creation and locating informational and reference materials using simple and refined Internet searches. No previous computer background is assumed.

CPLA 121. INTERMEDIATE COMPUTER APPLICATIONS LITERACY. 5 Credits.
Pre-requisites: CPLA 100 and CPLA 101 or CPLA 120.
A study of popular microcomputer software including, but not limited to word processing, electronic spreadsheet, database, desktop publishing, presentation graphics, internet and web tools. Course uses the Windows environment.

CPLA 196. EXPERIMENTAL COURSE. 1-5 Credits.

CPLA 198. SEMINAR. 1-5 Credits.

CPLA 199. DIRECTED STUDY. 1-5 Credits.
Pre-requisites: Permission of the instructor, department chair and college dean.

CPLA 215. INTERNET AND WWW BASICS. 2 Credits.
Pre-requisites: Computer Literacy II clearance.
Investigation of the Internet and the World Wide Web (WWW). Web searching and research techniques on the Web are presented. Each student will create a home page. Use of electronic mail, mailing lists, news readers, and FTP will be explored. Issues associated with the Internet and WWW will be discussed including privacy and social impact. Projects utilizing the Internet and WWW are major parts of the course.

CPLA 296. EXPERIMENTAL COURSE. 1-5 Credits.

CPLA 298. SEMINAR. 1-5 Credits.

CPLA 299. DIRECTED STUDY. 1-10 Credits.

CPLA 396. EXPERIMENTAL COURSE. 3-4 Credits.

CPLA 397. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.

CPLA 398. SEMINAR. 2-5 Credits.

CPLA 399. DIRECTED STUDY. 1-10 Credits.

CPLA 496. EXPERIMENTAL COURSE. 1-5 Credits.

CPLA 499. DIRECTED STUDY. 1-5 Credits.
Pre-requisites: Permission of the instructor, department chair and college dean.

CPLA 599. DIRECTED STUDY. 1-5 Credits.

CPLA 601. RESEARCH REPORT. 2-16 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.
A research study in lieu of a bound thesis conducted as partial fulfillment of a master's degree under the direction of a graduate committee.

Computer Science Courses

CSCD 110. INTRODUCTION TO PROGRAMMING. 5 Credits.
Students learn fundamental programming concepts, programming environment topics and current technologies in computing. Programming concepts include structure and design using pseudo-code, basic syntax, variables, arithmetic, decisions, repetition, input and output. Programming environment topics include editor use, saving, compiling, running and debugging. Programming projects are required.

CSCD 196. EXPERIMENTAL COURSE. 1-5 Credits.

CSCD 198. SEMINAR IN COMPUTER SCIENCE. 1-5 Credits.

CSCD 199. DIRECTED STUDY. 1-5 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.

CSCD 210. PROGRAMMING PRINCIPLES I. 5 Credits.
Pre-requisites: ≥2.0 MATH 141 and previous programming experience HIGHLY RECOMMENDED.
This course covers the concepts and practices of information representation, computer algorithms, hardware organization and computer program design and implementation. Students write, run, debug, analyze and evaluate computer programs. Topics include primitive data types, number systems, file I/O classes, control structures, method design and usage, array–sorting and searching algorithms. Programming projects are required

CSCD 211. PROGRAMMING PRINCIPLES II. 5 Credits.
Pre-requisites: CSCD 210 with a grade ≥2.5, MATH 142 with a grade ≥2.0.
This course continues coverage of concepts introduced in Programming Principles I. Topics include 2D arrays, recursion, data abstraction, polymorphism, inheritance, interfaces, inner classes, abstract classes, object cloning, file I/O, exception handling and linked lists. Programming projects are required.

CSCD 216. 3D MODELING and ANIMATION I. 4 Credits.
This course includes the fundamental concepts and implementation of 3D animation using current 3D modeling and animation software. Topics include basics of modeling, texturing and animation. This course requires 3D projects.

CSCD 240. C AND UNIX PROGRAMMING. 5 Credits.
Pre-requisites: CSCD 211 with a grade ≥2.5 or concurrent enrollment.
This course includes program development tools of the UNIX operating system and syntax and programming techniques of the C language in that environment. UNIX topics include interactive shells, common text editors, utility programs, file system structure, libraries and operating system calls and system programming. C topics include data types, structures, pointers and pointer arithmetic, arrays, linked lists, and function design and use. Programming projects are required.

CSCD 255. C PROGRAMMING FOR ENGINEERS. 5 Credits.
Pre-requisites: MATH 141 or math proficiency.
This course is an introduction to the C language in the context of beginning computer science concepts and engineering practices. Students will write, run, debug, analyze and evaluate C programs. Topics include primitive data types, number systems, file I/O, control structures, function design and usage, 1D arrays, sorting, searching and pointers. Programming projects are required.

CSCD 260. ARCHITECTURE AND ORGANIZATION. 4 Credits.
Pre-requisites: CSCD 240 with a grade ≥2.5, EENG 160 with a grade ≥2.0.
This course covers fundamentals of digital computer design and microcomputer systems. Topics include number systems, Boolean algebra, basic digital circuits, and an instruction set for a microprocessor. Homework assignments will include use of current software for the design, analysis, and simulation of digital circuits, assembly language programming emphasizing I/O device access and features that support high level languages. Programming projects are required.

CSCD 296. EXPERIMENTAL COURSE. 1-5 Credits.

CSCD 298. SEMINAR. 1-5 Credits.

CSCD 299. SPECIAL STUDIES. 1-5 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.
Subjects studied vary according to student and faculty interest.

CSCD 300. DATA STRUCTURES. 5 Credits.
Pre-requisites: CSCD 211 with a grade ≥2.5, MATH 301 with a grade ≥2.0.
This course covers fundamental abstract concepts of data structures as well as their implementation in a programming language. Topics include linked lists, stacks, queues, hashing, recursion, complexity analysis of algorithms, binary search trees and heaps. Programming projects with formal documentation are required.

CSCD 302. COMPUTING ETHICS. 4 Credits.
Pre-requisites: ENGL 101.
This course explores the uses of computing technologies from a socio-cultural and ethical perspective, including the impacts of information systems on individuals, organization, and society and future direction in which the forces of technology and computing are tending to move us.

CSCD 303. COMPUTER AND INFORMATION SECURITY. 4 Credits.
Prequisites: computer literacy clearance. This course covers fundamentals of computing security, including threat types, how computers become infected with viruses and malware, how to avoid viruses and malware, and how to secure your computers and information stored on them. Possible topics include: operating system security, email security, internet security, virus and spyware scanners, browser tools, firewalls and other defensive techniques. The course includes hands-on practice with security tools and techniques.

CSCD 305. C++ PROGRAMMING. 4 Credits.
Pre-requisites: CSCD 240 with a grade ≥2.5 or (CSCD 211 with a grade ≥2.5 and CSCD 255 with a grade ≥2.5).
This course teaches the C++ programming language. Topics include basic syntax, pointers, memory management, classes, inheritance and polymorphism, exception handling, standard template library usage, namespaces, memory management, and graphical user interface (GUI) programming. Programming projects are required.

CSCD 310. DISCRETE STRUCTURES. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, EENG 160 with a grade ≥2.0, MATH 301 with a grade ≥2.0, advancement programming exam clearance.
This course studies mathematical aspects of computer science with emphasis on data structures and algorithmic implementation. Topics include logic, methods of proof, set theory, relations and functions, numerical representations, cardinality, computability, combinatorics, discrete probability, computational complexity and graph theory.

CSCD 316. PRACTICAL PROBLEM SOLVING. 2 Credits.
Notes: repeatable up to twice.
Pre-requisites: CSCD 300 with a grade ≥2.5.
This course explores problem solving techniques. Topics covered may include: useful strategies for the ACM programming contest, strings and their manipulation; sorting strategies; number manipulation, combinations and theory; backtracking; graph algorithms and traversal; dynamic programming; geometry; and grids. Emphasis will be on understanding algorithms and recognizing which algorithm applies to a given problem. Programming projects are required.

CSCD 320. ALGORITHMS. 5 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, MATH 301 with a grade ≥2.0, advancement programming exam clearance.
This course studies data structures and algorithms, with emphasis on algorithmic strategies such as dynamic programming and emphasis on non-linear data structures such as trees and graphs. Programming projects are required.

CSCD 327. RELATIONAL DATABASE SYSTEMS. 4 Credits.
Pre-requisites: MATH 301 with a grade of ≥2.0 (or MATH proficiency) and (CSCD 211 with a grade ≥2.5 or CSCD 255 with a grade ≥2.5).
This course covers the basic concepts in relational database systems, including data manipulation language and data definition language. Relational modeling will be covered in depth together with an overview of SQL, Relational Algebra, Entity-Relationship Model and its role in application development.

CSCD 330. COMPUTER NETWORKS. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course covers fundamental concepts, protocol mechanisms and programming skills for computer networks. It includes a technical overview of telecommunication media and fundamental protocols for the Internet such as ISO/OSI layers, Ethernet, collision detection and channel allocation. Programming projects are required.

CSCD 340. OPERATING SYSTEMS. 5 Credits.
Pre-requisites: CSCD 240 with a grade ≥2.5, advancement programming exam clearance.
This course covers major concepts of computer operating systems. Topics may include historical development of operating systems, system calls, resource allocation, process and thread management, basic memory management, and file systems. Programming projects are required.

CSCD 349. DESIGN PATTERNS. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course involves program implementation of object oriented principle design patterns sets to solve real world software design problems. Programming projects and group projects are required.

CSCD 350. SOFTWARE ENGINEERING. 4 Credits.
Pre-requisites: CSCD 349 with a grade ≥2.5 and advancement programming exam clearance.
This course covers formal approaches and tools for conceiving, understanding, analyzing, designing, building, testing, deploying, documenting, and maintaining large software systems. Topics may include software lifecycle models; project and team management; verification and validation techniques; legal and ethical issues; practical development and application of skills in critical-thinking, communication, and professionalism. A major team-based software development project is required.

CSCD 370. GUI PROGRAMMING. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course explores programming techniques for the production of graphical user interfaces. Event driven programming is covered in detail. Topics include event handling, windows and dialogs, GUI widgets such as menus, toolbars, buttons, sliders, combo boxes, lists and scrolling. Multi-threading as it applies to GUI programming is also introduced. Programming projects are required.

CSCD 371. .NET PROGRAMMING. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course introduces .NET Programming and the .NET framework. Emphasis will be placed on understanding the syntactical features of the language and how to effectively use the design of the language in conjunction with the .NET Framework. Topics include .NET fundamentals, .NET assemblies, language fundamentals, object oriented design and programming, delegates and events, threading, serialization, database connectivity, windows and dialogs, and GUI components. Programming projects are required.

CSCD 372. ANDROID MOBILE DEVELOPMENT. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course introduces Android Programming and the Android framework. Emphasis is placed on understanding the syntactical features of the language, as well as how to effectively use the design of the language in conjunction with mobile development. Topics include event handling, windows and dialogs, and GUI components. Programming projects are required.

CSCD 373. iOS MOBILE DEVELOPMENT. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course introduces iOS programming and the Apple framework. Emphasis is placed on understanding the syntactical features of the language and how to effectively use the design of the language in conjunction with mobile development. Topics include event handling, windows and dialogs, and GUI components. Programming projects are required.

CSCD 378. WEB APPLICATION DEVELOPMENT. 4 Credits.
Pre-requisites: CSCD 327 with a grade ≥2.5.
(DESN 368 or XHTML/HTML knowledge (highly recommended) or permission of the instructor.) This course examines the fundamental principles and techniques associated with the development of multi-tier web applications. Topics include web standards, portability, and usability. Programming projects are required.

CSCD 379. .NET WEB APPLICATION DEVELOPMENT. 4 Credits.
Pre-requisites: CSCD 327 with a grade ≥2.5.
(DESN 368 or XHTML/HTML knowledge (highly recommended) or permission of the instructor.) This course examines the fundamental principles and techniques associated with the development of multi-tier web applications, using the .NET Framework. Topics include web standards, portability, and usability. Programming projects are required.

CSCD 386. SOUND SPACES. 3 Credits.
Cross-listed: MUSC 386.
Pre-requisites: DESN 385.
This course is a project-oriented course for designing, building, composing and performing with new instruments. Students will be encouraged to collaborate in the learning process and share their knowledge and experiences. The course is interdisciplinary in nature. Ideally the class would consist of students with backgrounds in music, programming and engineering.

CSCD 395. INTERNSHIP. 1-10 Credits.
Notes: graded Pass/Fail.
Pre-requisites: permission of the instructor, department chair and college dean.

CSCD 396. EXPERIMENTAL COURSE. 1-5 Credits.

CSCD 397. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.

CSCD 398. SEMINAR. 2-5 Credits.

CSCD 399. DIRECTED STUDY. 1-5 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.

CSCD 409. SCIENTIFIC PROGRAMMING. 4 Credits.
Pre-requisites: MATH 161 with a grade ≥2.0 and (MATH 231 with a grade ≥2.0 or MATH 301 with a grade ≥2.0).
This course provides an introduction to scientific computing in a programmable mathematics-oriented environment such as Matlab or Octave. Topics include programming constructs, data visualization, solutions to linear systems of equations and algebraic approaches to root-finding, signal processing, interpolation and optimization. Programming projects are required.

CSCD 411. MULTIMEDIA TECHNIQUES. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5 and advancement programming exam clearance or permission of instructor.
The theory and creation of multimedia using professional software is covered. This course stresses the appropriate development of a user interface. Several programming projects and research will be required.

CSCD 414. MULTIMEDIA PROGRAMMING. 4 Credits.
Pre-requisites: CSCD 411 with a grade ≥2.5 or permission of instructor.
This course studies object-oriented programming for multimedia. Students will write object-oriented programs that work with web servers and databases to create rich internet applications. Programming projects are required.

CSCD 416. 3D MODELING AND ANIMATION II. 4 Credits.
Pre-requisites: CSCD 216 with a grade ≥2.5.
This course covers intermediate 3D modeling and animation, including creation of aesthetic and technical work by manipulating light, surface materials, soft body dynamics and other features. Topics include photorealism, spline surface modeling, character development, lighting and camera techniques. This course requires projects.

CSCD 417. 3D MODELING AND ANIMATION III. 4 Credits.
Pre-requisites: CSCD 416 with a grade ≥2.5.
This course studies advanced 3D modeling, animation theory and application including creation of characters and creatures that come alive. Topics include organic modeling of character forms, analysis of character movement and 3D scripting. This course requires projects.

CSCD 418. 3D MODELING AND ANIMATION IV. 4 Credits.
Pre-requisites: CSCD 417 with a grade ≥2.5.
This course studies extensions of advanced 3D modeling, animation theory and application including further advanced 3D animation concepts. Topics addressed will include lip synchronization, facial expressions and 3D scripting. This course requires 3D projects.

CSCD 420. AUTOMATA. 4 Credits.
Pre-requisites: MATH 301 with a grade ≥2.0 or MATH 225 with a grade ≥2.0 or permission of instructor. Some prior programming experience is recommended.
This course is a study of the algebraic, structural and logical properties of sequential machines. Projects are required.

CSCD 423. RANDOMIZED ALGORITHMS AND PROBABILISTIC ANALYSIS. 4 Credits.
Notes: may be stacked with CSCD 523.
Pre-requisites: CSCD 320 with a grade ≥2.5.
This course introduces the use of probability in computer science algorithm design and analysis. The course covers two subfields. One is the design of randomized algorithms, where decisions at some steps are determined by coin tossing. The other is the probabilistic analysis of (randomized or deterministic) algorithms. The goal is to measure the expected performance of an algorithm. Basic knowledge and techniques developed from the probability theory will be introduced. Workload include problem solving homeworks and programming assignments.

CSCD 427. ADVANCED DATABASE MANAGEMENT SYSTEMS. 4 Credits.
Pre-requisites: CSCD 327 with a grade ≥2.5, advancement programming exam clearance.
This course focuses on current trends in database technologies. Topics may include secondary storage, index structures, query processing, query optimization, concurrency control, transaction management, distributed databases, data mining and information retrieval.

CSCD 429. DATA MINING. 4 Credits.
Pre-requisites: CSCD 320 with a grade ≥2.5, CSCD 327 with a grade ≥2.5, advancement programming exam clearance.
Data mining is the process of automatic discovery of patterns, changes, associations and anomalies in massive databases. This course will provide an introduction to the main topics in data mining and knowledge discovery, including: data preparation for knowledge discovery, frequent pattern and association mining, classificationand cluster analysis.

CSCD 433. ADVANCED COMPUTER NETWORKS. 4 Credits.
Pre-requisites: CSCD 330 with a grade ≥2.5, advancement programming exam clearance.
This course will cover the design, implementation, analysis and evaluation of networks. Topics include protocol mechanisms, advanced network architecture, network algorithms, network control, network simulation and performance analysis. Programming assignments are required.

CSCD 434. NETWORK SECURITY. 4 Credits.
Pre-requisites: CSCD 330 with a grade ≥2.5, advancement programming exam clearance.
This course explores practical topics in network security. Topics include policy and mechanism; malicious code; intrusion detection, prevention, response; cryptographic and protocols for privacy and integrity. This course emphasizes the trade-offs among risks of misuse, cost of prevention and social issues. Concepts are implemented in programming assignments and comprehensive projects.

CSCD 435. PRINCIPLES OF PROGRAMMING LANGUAGE. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course is a study and comparison of programming languages by evolution, formal specifications, structures, features and application domains. Implementation of syntax and semantics and program run-time behavior for several languages will be considered. Programming projects required and presentations may be required.

CSCD 437. SECURE CODING. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, CSCD 240 with a grade ≥2.5, advancement programming exam clearance.
This course will introduce a variety of topics of concern to programmers when writing code. It will examine concepts that apply to programming "in the large" as well as specific aspects such as buffer overflow. C and C ++ code will be examined. Written assignments, coding assignments and a team project are required.

CSCD 439. TOPICS IN COMPUTER SCIENCE. 2-5 Credits.
Prerequisites will be applied as required by the topic. This course is a variable topics course dealing with current trends in computer science. Possible topics include compiler design, advanced operating systems, computational complexity, computer graphics, software testing and verification, artificial intelligence, pattern recognition, computer simulation and modeling, graph algorithms.

CSCD 440. ADVANCED OPERATING SYSTEMS. 4 Credits.
Pre-requisites: CSCD 340 with a grade ≥2.5, advancement programming exam clearance.
This course covers a specific operating system involving installation, kernel configuration and kernel modification. The interaction between kernel space and user space is studied and the student designs, implements and tests programs communicating across that programming interface. Programming projects are required.

CSCD 443. DISTRIBUTED MULTIPROCESSING. 4 Credits.
Pre-requisites: CSCD 340 with a grade ≥2.5, advancement programming exam clearance.
This course explores parallel processing concepts and history, including the study and comparison of several multi-processing environments (such as Java threads, PVM and MPI) Programming projects will be required in the Unix environment, and the C and Java languages.

CSCD 445. GPU COMPUTING. 4 Credits.
Notes: may be stacked with CSCD 545.
Pre-requisites: CSCD 240 and CSCD 300 with a grade ≥2.5 and Advancement Programming Exam clearance.
Beyond its applications in Graphics, general-purpose graphics processing unit computing (GPGPU) utilizes a Graphics Processing Unit (GPU)—which typically used to perform computations exclusively for computer graphics—at present to parallelize computations traditionally performed by the CPU. GPGPU becomes more widely used in applications demanding for high performance.

CSCD 460. ADVANCED ARCHITECTURE AND ORGANIZATION. 4 Credits.
Pre-requisites: CSCD 260 with a grade ≥2.5, advancement programming exam clearance.
This course addresses computer processor design at the levels of the instruction set, the system architecture and logical gates. Knowledge of Boolean algebra and digital circuits are combined with a viewpoint of computers at the machine language level to build a complete understanding of how modern computer processors actually work, with some techniques and trade-offs that go into their design. The simulation of systems using a high-level programming language is also covered. programming projects are required.

CSCD 461. EMBEDDED SYSTEMS. 4 Credits.
Pre-requisites: CSCD 260 with a grade ≥2.5 or (CSCD 255 with a grade ≥2.5 and EENG 260 with a grade ≥2.0.)
This course introduces embedded systems with emphasis on software development. Topics includes surveys on digital systems design, software/hardware interface, communication protocols, interrupts service routine and applications programming on an embedded controller.

CSCD 462. EMBEDDED REAL-TIME CONTROL. 4 Credits.
Pre-requisites: EENG 160 with a grade ≥2.0, MATH 161 with a grade ≥2.0 and (CSCD 240 with a grade ≥2.5 or CSCD 255 with a grade ≥2.5).
This course covers technologies typically found in embedded control systems, including basic hardware/software interfaces, multitasking, real-time scheduling and feedback control.

CSCD 467. PARALLEL AND CLOUD COMPUTING. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5 and advancement programming exam.
This course explores up-to-date parallel platforms, such as Cluster computing and Cloud computing that use networked computers to store and process large datasets in parallel. Topics include synchronization techniques, high-performance server/service design, performance issues, distributed file systems and MapReduce framework, virtualization and VPN technology in the Cloud, Cloud scalability and availability and Cloud storage. Hands-on assignments and projects are required.

CSCD 470. 3D COMPUTER GRAPHICS PRINCIPLS. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, MATH 231 with a grade ≥2.0, advancement programming exam clearance.
This course introduces the basic theoretical concepts involved in 3D computer graphics. Concepts will be illustrated using 3D rendering software allowing students to understand the practical application of the theory. Programming projects will be required.

CSCD 471. ADVANCED 3D COMPUTER GRAPHICS. 4 Credits.
Pre-requisites: CSCD 470 with a grade ≥2.5, advancement programming exam clearance.
This course involves program implementation of 3D computer graphics theory elements from previous graphics courses using a commonly available cross platform 3D graphics application program interface. Programming assignments include implementation of topics from CSCD 470 such as generation of graphics primitives, the virtual camera, perspective projection, modeling and representation of three-dimensional objects and basic lighting. Additional topics include the theory and implementation of realistic object rendering using Phong and Gouraud shading techniques, texture mapping and other advanced rendering techniques such as the production of shadows and reflections and the use of advanced rendering techniques in 3D games. Programming projects are required.

CSCD 474. COMPUTER GAMES DEVELOPMENT. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5, advancement programming exam clearance.
This course is an in-depth analysis of the source code of a commercial 3D game leading to a major modification of the code and related elements to produce a new 3D game. Topics may include techniques for modification of game graphics, game artificial intelligence and game physics, as well as exploration of external applications for model production, animation and skinning and game level production. Programming projects and game modifications are required.

CSCD 476. ADVANCED 3D MODELING. 4 Credits.
Pre-requisites: CSCD 110 with a grade ≥2.5, CSCD 416 with a grade ≥2.5.
This course involves compositing with complex animation software plug-ins. Topics include reassembling 3D animations in 2D compositing space, color depth, advanced 3D scripting and integration, 3D animations and live-action footage. Professional-level 3D projects are required.

CSCD 480. INTELLIGENT SYSTEMS. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5 and advancement programming exam.
Fundamental concepts and techniques of modeling, simulating, visualizing and analyzing complex real-world systems by using artificial intelligence, knowledge acquisition and representation, reasoning, planning, machine learning, expert systems, intelligent agents and multiagent architectures, and search strategies; emphasizes practical applications to modern smart and mobile devices.

CSCD 487. HUMAN COMPUTER INTERFACE. 4 Credits.
Pre-requisites: CSCD 300 with a grade ≥2.5 or permission of instructor.
This course will begin with a brief historical overview of human-computer user interfaces with an eye to identifying the key steps in their conceptual development. Students will read in the field of classical human factors, focusing on findings of a particular relevance to user interface design and operation. They will explore the domain of interaction design and testing and intellectual property protection as it relates to human-computer interfaces, investigating what constitutes (or does not constitute) a patentable method and how patent protections are pursued. Written projects and team projects are required.

CSCD 488. SENIOR PROJECT. 5 Credits.
Notes: students will receive a Y grade until successful completion of CSCD 490.
Pre-requisites: CSCD 327 with a grade ≥2.5, CSCD 350 with a grade ≥2.5, either CSCD 378 or CSCD 379, and advancement programming exam clearance.
This course is the first of a two-quarter project sequence. Students will take CSCD 490 Senior Capstone the quarter following successful completion of Senior Project. Student teams apply computer science principles to client-sponsored projects. Based on requirements provided by the client, each team will use appropriate tools, digital systems, and management skills in support of project development.

CSCD 490. SENIOR CAPSTONE. 5 Credits.
Pre-requisites: CSCD 488 prior quarter.
Satisfies: senior capstone university graduation requirement.
This course is the second course of a two-quarter project sequence and must be taken the quarter following successful completion of the Senior Project course. During this course the client-specified project is completed using appropriate tools and digital systems development methodologies to additionally specify, design, implement, install and test a systems solution that meets the client's needs. Milestone reports, including a final oral report and complete final project documentation (in printed and electronic form) are required.

CSCD 495. INTERNSHIP. 1-10 Credits.
Notes: graded Pass/Fail.
Pre-requisites: CSCD 300 a grade ≥2.5; permission of the instructor, department chair and college dean.

CSCD 496. EXPERIMENTAL COURSE. 1-5 Credits.

CSCD 497. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.
Selected topics to be arranged in consulation with the requesting organization.

CSCD 498. SEMINAR. 1-5 Credits.
Pre-requisites: permission of the instructor.

CSCD 499. DIRECTED STUDY. 1-5 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.

CSCD 500. COLLOQUIUM IN COMPUTER SCIENCE. 1 Credit.
Pre-requisites: graduate standing.
This course presents a speaker based seminar for graduate students intended as an introduction to research currently conducted by CS faculty and graduate students with some outside presenters from other institutions and corporations. Students will gain knowledge of current faculty research in order to familiarize them aid them with research in CS sub-disciplines and aid them in selecting a graduate advisor.

CSCD 501. ADVANCED ALGORITHMS. 5 Credits.
Pre-requisites: CSCD 320 and either MATH 301 or CSCD 310 or equivalent.
This course studies advanced data structures and skills for designing and analyzing nontrivial algorithms. The course will progress toward advanced topics based on the foundation of basic algorithm design and analysis skills such as divide-conquer and dynamic programming. The course will cover topics including approximate algorithms, randomized algorithms and statistical analysis, string algorithms, algorithms for network flow problems, various advanced data structures and the NP-completeness theory.

CSCD 505. CRYPTOGRAPHY. 4 Credits.
Pre-requisites: MATH 225 or MATH 301 or equivalent.
This course covers the general principles of modern cryptography, including symmetric cryptosystems, asymmetric cryptosystems, secure hash functions and cryptographic level randomness. Other topics may include historic cryptosystems and their cryptanalysis, information entropy, zero knowledge proofs, trusted computing architectures, and information theory as it relates to cryptography. Programming assignments will be required. Writing and class presentations may be required.

CSCD 506. RESEARCH METHODS IN COMPUTER SCIENCE. 5 Credits.
Pre-requisites: graduate or post baccalaureate standing.
This course explores research and research methods in the computer science discipline. Topics covered include literature review, hypothesis formation, quantitative methods, paper and thesis writing, and presentation skills. Students will also be exposed to research conducted by department faculty and graduate students as well as presenters from other institutions. Students will gain knowledge of current faculty research, which will aid them in choosing their research focus.

CSCD 523. RANDOMIZED ALGORITHMS AND PROBABILISTIC ANALYSIS. 4 Credits.
Notes: may be stacked with CSCD 423.
Pre-requisites: CSCD 320 with a grade ≥2.5.
This course introduces the use of probability in computer science algorithm design and analysis. The course covers two subfields. One is the design of randomized algorithms, where decisions at some steps are determined by coin tossing. The other is the probabilistic analysis of (randomized or deterministic) algorithms. The goal is to measure the expected performance of an algorithm. Basic knowledge and techniques developed from the probability theory will be introduced. Workload include problem solving homeworks, programming assignments and a term project.

CSCD 524. ADVANCED SOFTWARE ENGINEERING. 5 Credits.
Pre-requisites: CSCD 350 a grade ≥2.5 or equivalent software development experience.
A variable content survey of fundamental and advanced topics in software engineering. The course includes the study of the evolving methods and techniques available to develop high quality, reliable and maintainable software with efficient allocation of organizational resources. Possible topics include system reliability and security, open source development, system architecture, components and system reuse. Individual research projects are required.

CSCD 527. MODERN DATABASE SYSTEMS. 5 Credits.
Pre-requisites: CSCD 327 or equivalent.
An in-depth study of relational DBMSs and other selected database topics. Possible topics include recovery, concurrency control, transaction management, distributed DB models and various NoSQL systems.

CSCD 533. COMPUTER NETWORKS. 4 Credits.
Pre-requisites: CSCD 330 or equivalent.
Advanced topics in computer networks is the primary focus of this course. Design and performance of networks are studied in depth. Some hardware concepts such as routers, switches and physical connection media are covered. Protocol analysis and design is covered using existing protocol common in today's networks. Performance of networks is also studied including TCP/IP protocols, Ipv6, possibly ATM or other circuit switched technologies. Programming assignments and hands-on labs will be expected.

CSCD 538. TOPICS IN COMPUTER HARDWARE. 4 Credits.
Pre-requisites: graduate standing in computer science or permission of the instructor.
A variable content course dealing with some aspect of computer hardware. Possible topics include network theory, VLSI design, control systems, digital systems design, switching and automata theory, computer-aided engineering.

CSCD 539. TOPICS IN COMPUTER SCIENCE. 4 Credits.
Pre-requisites: graduate standing in computer science or permission of the instructor.
A variable content course dealing with an area of computer science other than hardware. Possible topics include compiler design, advanced operating systems, computational complexity, computer graphics, software testing and verification, artificial intelligence, pattern recognition, computer architecture, simulation and modeling, graph algorithms.

CSCD 540. ADVANCED OPERATING SYSTEMS. 5 Credits.
Pre-requisites: CSCD 340 or equivalent.
The course covers synchronization in concurrent/distributed computing (which modern operating systems must support) and the implementation of virtual machine operating systems. Implementation includes file systems, memory management, paging, task switching, process management and basic operating system services. The virtual machine must be able to support various CPU time allocations schemes to simulate multiprocessor systems of different processing speeds.

CSCD 543. DISTRIBUTED MULTIPROCESSING ENVIRONMENTS. 4 Credits.
Pre-requisites: CSCD 340 or equivalent.
This course explores parallel processing concepts and history, including the study and comparison of several multi-processing environments (such as Java threads, PVM and MPI). Programming projects will be required in the Unix environment and the C and Java languages.

CSCD 544. TIME CRITICAL NETWORKING. 4 Credits.
Pre-requisites: CSCD 330 or equivalent.
This course studies multimedia networking concepts and history, including the study of current practices in multimedia networking technologies and protocols for multimedia signal transport. Selected contemporary multimedia networking application areas are studied as examples. Special Emphasis is placed on challenges to multimedia signal transport involving quality of service such as signal latency and jitter. Research projects are required.

CSCD 545. GPU COMPUTING. 4 Credits.
Notes: may be stacked with CSCD 445.
Pre-requisites: CSCD 240 and CSCD 300 with a grade ≥2.5 and Advancement Programming Exam clearance.
Beyond its applications in Graphics, General-Purpose Graphics Processing Unit computing (GPGPU) utilizes a Graphics Processing Unit (GPU)—which typically used to perform computations exclusively for computer graphics—at present to parallelize computations traditionally performed by the CPU. GPGPU becomes more widely used in applications demanding for high performance.

CSCD 567. PARALLEL AND CLOUD COMPUTING. 4 Credits.
Pre-requisites: CSCD 300 and Advancement Programming Exam clearance or equivalent.
This course studies the core technologies used to develop the essential components in modern distributed, parallel and Cloud systems using networked computers to store and process large datasets in parallel. Topics include synchronization techniques, high-performance server/service design, performance issues, MPI programming, distributed file systems and MapReduce framework, Virtualization and VPN technology in Cloud, Cloud scalability and availability and data consistency in the Cloud. Graduate students are required to read research papers and implement the methodology on parallel platforms or in the Cloud.

CSCD 570. PHOTO-REALISTIC COMPUTER GRAPHICS. 4 Credits.
Pre-requisites: CSCD 471 or equivalent.
Theory and programming techniques of global illumination for photorealistic rendering in computer graphics. Included topics: basic of ray tracing, advanced ray tracing topics including stochastic ray tracing, incorporation of other global illumination techniques including radiosity and photon tracing. Requires programming assignments.

CSCD 575. COMPUTER SYSTEMS DESIGN. 4 Credits.
A survey of computer system architecture including levels of machine description, instruction sets, interrupt handling, memory hierarchies, I/O subsystems, and buses.

CSCD 580. INTELLIGENT SYSTEMS. 4 Credits.
Fundamental concepts and techniques of modeling, simulating, visualizing, and analyzing complex real-world quantitative and qualitative systems of systems including artificial intelligence, knowledge acquisition and representation, reasoning, planning, machine learning, expert systems, intelligent agents and multi-agent systems, and search strategies; emphasizes practical applications to contemporary smart and mobile devices. A research project is required.

CSCD 587. HUMAN-COMPUTER INTERFACE. 4 Credits.
Pre-requisites: CSCD 210 or CSCD 305.
This course will begin with a brief overview of human-computer user interfaces historically, with an eye to identifying the key steps in their development conceptually. Students will read in the field of classical human factors, focusing on finding a particular relevance to user interface design and operation. Exploration of the domain of interaction design and testing and intellectual property protection as it relates to human-computer interfaces, investigating what constitutes (or does not constitute) a patentable method, and how patent protections are pursued will be discussed. Written projects and team projects are required.

CSCD 595. PROFESSIONAL INTERNSHIP. 2-16 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.
Professional Internship.

CSCD 596. EXPERIMENTAL COURSE. 2-5 Credits.

CSCD 597. WORKSHOP, SHORT COURSE, CONFERENCE, SEMINAR. 1-5 Credits.
Notes: only one workshop course for up to 3 credits may be used to fulfill graduate degree requirements.

CSCD 598. SEMINAR. 1-5 Credits.

CSCD 599. DIRECTED STUDY. 1-6 Credits.
Pre-requisites: permission of the instructor, department chair and college dean.

CSCD 600. THESIS. 1-16 Credits.
Notes: graded Pass/No Credit.
Pre-requisites: permission of the instructor, department chair and college dean.
A research thesis under the direction of a graduate committee.

CSCD 601. RESEARCH REPORT. 1-16 Credits.
Notes: graded Pass/No Credit.
Pre-requisites: permission of the instructor, department chair and college dean.
A research study in lieu of a bound thesis conducted as partial fulfillment of a master's degree under the direction of a graduate committee.

CSCD 602. INDUSTRY PROJECT. 1-16 Credits.
Notes: graded Pass/No Credit.
Development and documentation of applied computer science project in an industry setting.

CSCD 695. DEPARTMENTAL INTERNSHIP. 1-16 Credits.
Notes: graded Pass/No Credit.
Pre-requisites: graduate standing; permission of the instructor, department chair and college dean.
Support work for the department relating to computer science. Activities will take place under the supervision of a department faculty or staff member. May involve experiences such as teaching lower-division coursework, systems administration activities and assisting with research activities.