Department of Computer Science

Contact Information:
Campus Location: Main office: 1120 Science and Engineering Offices (SEO); Student Affairs office: 905 SEO
Main office: (312) 996–3422; Student Affairs office: (312) 355–3463
cs-ugrad@uic.edu
cs.uiuc.edu

Administration:
Professor and Head of the Department, Robert Sloan
Director of Undergraduate Studies, Chris Kanich, cs-dugs@uic.edu

Computer science is a relatively young but extremely rich and diverse discipline. At one end of the spectrum, computer science may be viewed as the formal study of what can be computed and what resources are required for computation. At the other end of the spectrum, computer science may be seen as the application of human resources, software, and, of course, computers to solve computational problems relating to society’s and individuals’ needs.

A well-trained computer scientist requires knowledge of both ends of this spectrum—and several points in between. The Computer Science program in the Department of Computer Science is intended to provide that broad background. Along with a strong theoretical component, the Computer Science program places special emphasis on the development of applied skills in design, implementation, and validation of computer systems. In our experience, industry and graduate programs alike value—above all—people who can solve real problems, and who come prepared to use the tools of their trade.

All students acquire a common background in the fundamental areas of computer science: computer systems, organization and architecture, algorithms and data structures, principles of software design, elements of the theory of computation, and operating systems. In addition, students obtain specialized backgrounds through the selection of five technical elective courses in computer science. Required and elective courses in the sciences and mathematics, along with additional courses in writing, humanities, social sciences, and the arts give students the opportunity to expand their horizons and to prepare for multidisciplinary careers.

There are very few areas in modern society untouched by computer science. Computer science is present in everything from healthcare, telecommunications, and entertainment, to transportation, education, and defense. The result of this diversity is that a computer scientist must be capable of working with people outside his or her field. In support of this, the Computer Science program provides its students with a well-rounded education requiring significant course work outside the Department of Computer Science, placing a strong emphasis on writing and communication skills.

Given the breadth and diversity of the computer science discipline, the Department of Computer Science also offers a Computer Systems Concentration within the BS in Computer Science program. The Computer Systems Concentration represents a sub-specialty that provides more emphasis on understanding and designing computer hardware. The student continues to learn the fundamental areas of computer science, including programming, data structures, discrete math, algorithms, formal languages, architecture, and operating systems. Unlike traditional computer science, however, the student also studies low-level circuit analysis and high-level system design, and has the option to take additional hardware-oriented courses. The result is a unique blend of computer science and computer engineering.

The Department of Computer Science also offers a Human-Centered Computing Concentration (HCC) within the BS in Computer Science program. The HCC concentration emphasizes the knowledge and skills needed to begin a professional practice in areas such as: user-interface design and development for desktop or mobile devices; computer graphics and animation for video games, movie special effects; and scientific, engineering, and medical visualization. The concentration continues to cover in depth the fundamental areas of computer science including programming, data structures, discrete mathematics, algorithms, formal languages, computer architecture, and operating systems. In addition the concentration focuses on key topics of human-centered computing practice such as user-interface design, computer graphics, visual media, and natural language processing.

The Department of Computer Science also offers a Software Engineering Concentration within the BS in Computer Science program. The Software Engineering Concentration emphasizes the knowledge and skills needed to begin a professional practice in software engineering. The concentration continues to cover in depth the fundamental areas of computer science, including programming, data structures, discrete mathematics, algorithms, formal languages, computer architecture, and operating systems. In addition, the concentration focuses on key topics of software engineering practice such as software cost estimation, large-scale software development, and risk management.

The BS in Data Science is designed for undergraduates who plan to pursue technical or professional careers in the burgeoning field of data science, or for graduate study in the area. As the world is becoming overwhelmingly data-driven, with companies employing entire departments just for collecting and analyzing data to help them make business decisions, employment opportunities for a data scientist are increasingly lucrative. Indeed data scientists are needed in virtually every industry and organization, public or private: health care, computer science, information technology, retail, marketing, manufacturing, transportation, communication, education, insurance, finance, science, security, law enforcement, and more.

Accreditation
The computer science program at UIC is accredited by the Computing Accreditation Commission of ABET

Degree Programs
Computer Science
• BS in Computer Science
• BS in Computer Science with Computer Systems Concentration
• BS in Computer Science with Human-Centered Computing Concentration
• BS in Computer Science with Software Engineering Concentration
• BS in Computer Science and Design
• Joint BS in Computer Science/MS in Computer Science

Data Science
• BS in Data Science with Bioinformatics Concentration
• BS in Data Science with Business Analytics Concentration
• BS in Data Science with Computer Science Concentration
Minors

- Minor in Computer Science
- Minor in Information Technology

**CS 100. Discovering Computer Science. 3 hours.**
Fundamentals of computing; history of computation; computer organization; program design, testing and debugging; web design; computer animation; software tools; societal and legal issues in computing. Course Information: Credit is not given for CS 100 if the student has credit in CS 111 or CS 112 or CS 113 or CS 107 or CS 109 or MCS 260. No graduation credit given to students enrolled in Engineering. No graduation credit for students enrolled in a major offered by the Departments of Biomedical Engineering, Chemical Engineering, Civil Materials and Environmental Engineering, Computer Science, Electrical and Computer Engineering, or Mechanical and Industrial Engineering. Extensive computer use required. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion. Natural World - No Lab course.

**CS 107. Introduction to Computing and Programming. 4 hours.**
Access and use of computing resources. Programming and program design. Problem solving. Data types, control structures, modularity, information hiding. Course Information: Credit is not given for CS 107 if the student has credit for CS 102. Previously listed as EECS 171. Prerequisite(s): Credit or concurrent registration in MATH 180. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

**CS 109. Programming for Engineers with MatLab. 3 hours.**
Program design and problem solving using MATLAB; numeric computation; data types and operators; control structures; functions; file I/O; arrays and structures; engineering applications: matrices and equation solution; programming assignments. Course Information: Credit is not given for CS 109 if the student has credit for CS 110. Extensive computer use required. Prerequisite(s): Credit or concurrent registration in MATH 180. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

**CS 110. MATLAB Programming for Engineers. 1 hour.**
Program design and problem solving using MATLAB. Numeric computation, control structures, vectors, matrices, file I/O, data analysis, visualization. Engineering applications; programming assignments. Course Information: Credit is not given for CS 110 if the student has credit for CS 109. Extensive computer use required. Meets 3 days each week for 5 weeks of the semester. Prerequisite(s): CS 107 or CS 111; or appropriate score on the department placement test.

**CS 111. Program Design I. 3 hours.**
Introduction to programming: control structures; variables and data types; problem decomposition and procedural programming; input and output; aggregate data structures including arrays; programming exercises. Course Information: 3 hours. Previously listed as CS 101. Extensive computer use required. Credit is not given for CS 111 if student has credit in CS 112 or CS 113. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

**CS 112. Program Design I in the Context of Biological Problems. 3 hours.**
Introduction to programming using Biology as the context for programming in a high-level language; control structures, variables, simple and aggregate data types; problem-solving techniques; biology topics include central dogma and genetics. Course Information: Same as BIOS 112. Credits is not given for CS 111 if student has credit in CS 111 or CS 113. Course Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

**CS 113. Program Design I in the Context of Law and Public Policy. 3 hours.**
Introduction to programming using law and public policy as the context for programming; control structures, variables, simple and aggregate data types; problem-solving techniques; legal topics: security, privacy, encryption, and predictive policing. Course Information: Credit is not given for CS 113 of student has credit in CS 111 or CS 112. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

**CS 141. Program Design II. 3 hours.**
Data abstraction and modular design; recursion; lists and stacks; dynamic memory allocation; file manipulation; programming exercises. Course Information: 3 hours. Previously listed as CS 102. Extensive computer use required. Prerequisite(s): Grade of C or better in CS 111 or Grade of C or better in CS 109; and Credit or concurrent registration in MATH 180. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

**CS 151. Mathematical Foundations of Computing. 3 hours.**
Discrete mathematics concepts fundamental to computing: propositional logic, predicates and quantifiers; proofs; sets; recursive definitions and induction; functions, relations and graphs; combinatorics and discrete probability; applications. Course Information: 3 hours. Credit is not given for CS 151 if the student has credit in MCS 361. Prerequisite(s): MATH 180; and Grade of C or better in CS 111. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

**CS 194. Special Topics in Computer Science. 1-3 hours.**
Multidisciplinary computer science topics at first-year level that vary from term to term depending on current student and instructor interests.

**CS 201. Data Structures and Discrete Mathematics I. 4 hours.**
Lists, stacks, queues, sets, hash tables, introduction to trees and graphs. Algorithm correctness and complexity, inductive proofs, logic. Programming projects. Course Information: Previously listed as EEC 260. Credit is not given for CS 201 if the student has credit for MCS 261. Prerequisite(s): MATH 180; and grade of C or better in CS 102 or grade of C or better in CS 107.
CS 211. Programming Practicum. 3 hours.
Software development tools and practices; debugging and testing; advanced language features; standard libraries; code management. Course Information: 2 hours. Extensive computer use required. Prerequisite(s): Grade of C or better in CS 141; or Grade of C or better in CS 107. The option to use CS 107 as a prerequisite (in place of CS 141) is only for Computer Engineering majors or students doing a Computer Engineering minor. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory-Discussion.

CS 251. Data Structures. 4 hours.
Design, usage and analysis of data structures: review of lists, stacks and queues; hash tables, priority queues, search trees, introduction to graphs; searching and sorting; runtime analysis; programming projects and lab exercises. Course Information: 4 hours. Prerequisite(s): Grade of C or better in CS 141; and Credit or concurrent registration in CS 211. To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

CS 261. Machine Organization. 4 hours.
Data representation and computer arithmetic; machine language; addressing; memory hierarchy; subroutines; data structures; processor architecture: hardware components, pipelining. Course Information: Credit is not given for CS 261 if the student has credit for CS 366 or ECE 267 or ECE 366. Extensive computer use required. Prerequisite(s): Grade of C or better in CS 141; and Credit or concurrent registration in CS 211. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

CS 277. Technical and Professional Communication in Computer Science. 3 hours.
Communication skills for computing students and professionals in various contexts: technical writing, portfolios, job interviews, demos, sales, with speech organization, visuals, and delivery. Attendance, participation, and presentations required. Course Information: Prerequisite(s): CS 141. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Discussion.

CS 294. Special Topics in Computer Science. 1-3 hours.
Multidisciplinary computer science topics at sophomore level that vary from term to term depending on current student and instructor interests. Course Information: Prerequisite(s): Consent of the instructor.

CS 301. Languages and Automata. 3 hours.
Regular sets and finite automata. Context-free languages and push-down automata. Parsing. Computability theory including Turing machines and decidability. Course Information: Previously listed as EECS 361. Prerequisite(s): Grade of C or better in CS 151; and Credit or concurrent registration in CS 251. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

CS 341. Programming Language Design and Implementation. 3 hours.
Programming language paradigms, design and implementation; syntax and semantics; parsing; runtime systems; control; data types; subroutines and exceptions; data and procedural abstraction; functional programming. Course Information: Extensive computer use required. Prerequisite(s): Grade of C or better in CS 211 and Grade of C or better in CS 251; and CS 261.

CS 342. Software Design. 3 hours.
Software design principles and practices: Object-oriented design; design patterns; software reuse; testing; event driven programming and concurrency; graphical user interface design and development; Team development. Course Information: Extensive computer use required. Credit is not given for CS 342 if the student has credit for CS 340. Prerequisite(s): Grade of C or better in CS 251 and Grade of C or better in CS 211.

CS 351. Advanced Data Structure Practicum. 3 hours.
Design and implementation details of advanced data structure and non-trivial algorithms with an emphasis on amortized analysis. Course Information: Prerequisite(s): CS 251.

CS 361. Systems Programming. 4 hours.
Study of computer systems emphasizing impact on application level programming. Virtual memory and memory management; code optimization; system-level I/O; concurrency: processes, threads, synchronization; introduction to network programming. Course Information: Extensive computer use required. Prerequisite(s): Grade of C or better in CS 251 and Grade of C or better in CS 211; and CS 261. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

CS 362. Computer Design. 4 hours.
Computer hardware building blocks. logic gates; combinational circuits; arithmetic circuits; flip flops and sequential circuits; registers and memory; CPU design; I/O design. Course Information: 3 hours. Extensive computer use required. Credit is not given for CS 362 if the student has credit in ECE 285. Prerequisite(s): Grade of C or better in CS 211; and CS 261. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

CS 377. Ethical Issues in Computing. 3 hours.
Communication skills for computing professionals: presentation organization, visual aides, delivery techniques, argument support. Ethical and societal issues in computing: privacy, intellectual property and ownership, crime. Course Information: 3 hours. Extensive computer use required. Prerequisite(s): Credit or concurrent registration in CS 251. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Discussion.

CS 378. Framework-based Software Development for Hand-held Devices. 3 hours.
Multi-platform app development using software frameworks; the integration of framework-generated code with native code of mobile operating systems; numerous programming assignments in multiple programming languages. Course Information: Prerequisite(s): CS 342.

CS 391. Computer Science Practicum. 1 hour.
Provides students with the opportunity to apply the skills and knowledge gained in previous engineering courses within a professional, working environment. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 3 hour awarded toward degree requirements. Prerequisite(s): Approval of the Department.

CS 394. Special Topics in Computer Science. 1-3 hours.
Multidisciplinary computer science topics at junior-senior level that vary from term to term depending on current student and instructor interests. Course Information: Prerequisite(s): Consent of the instructor.

CS 398. Undergraduate Design/Research. 1-3 hours.
Design and/or research experience for undergraduate Computer Science majors under close supervision of a CS faculty member. Course Information: Previously listed as EECS 398. Prerequisite(s): Consent of the instructor.
CS 401. Computer Algorithms I. 3 or 4 hours.
Design and analysis of computer algorithms. Divide-and-conquer, dynamic programming, greedy method, backtracking. Algorithms for sorting, searching, graph computations, pattern matching, NP-complete problems. Course Information: Same as MCS 401. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in MCS 360; or Grade of C or better in CS 251.

CS 402. Algorithms in Practice. 3 or 4 hours.
Design, implementation and presentation of algorithms and data structures emphasizing dynamic programming and both exact and heuristic approaches to NP-hard problems; problem solving sessions, programming projects and presentations. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 401; and consent of the instructor.

CS 407. Economics and Computation. 3 or 4 hours.
Techniques for analysis of markets, making decisions with other strategic agents, and understanding how algorithms affect the incentives of market participants. These include game theory, mechanism design, auction theory, and social choice theory. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CS 251.

CS 411. Artificial Intelligence I. 3 or 4 hours.
Problem representation; rule-based problem-solving methods; heuristic search techniques. Application to expert systems, theorem proving, language understanding. Individual projects. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CS 251.

CS 412. Introduction to Machine Learning. 3 or 4 hours.
Mechanisms, implementation, and application of systems that improve automatically based on past experience, including classification, density estimation, clustering, and online learning tasks and solutions. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. MATLAB will be used for some of the homework assignments, but prior experience with it is not required. Prerequisite(s): Grade of C or better in CS 251; and IE 342 or STAT 381 or ECE 341.

CS 415. Computer Vision I. 3 or 4 hours.
Computer vision system design. Segmentation and representation of regions and boundaries; image filtering; object recognition; advanced topics (examples: texture, stereo, color); applications. Programming assignments. Course Information: 3 undergraduate hours. 4 graduate hours. Previously listed as EECS 487. Prerequisite(s): CS 202 or MCS 360; or consent of the instructor.

CS 418. Introduction to Data Science. 3 or 4 hours.
Provides an in-depth overview of data science in engineering. Topics include modeling, storage, manipulation, integration, classification, analysis, visualization, information extraction, and big data in the engineering domain. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Grade of C or better in CS 251; and STAT 381 or IE 342 or ECE 341.

CS 421. Natural Language Processing. 3 or 4 hours.
Design of natural language processing systems; part-of-speech tagging, statistical and symbolic parsers; semantic interpretation; discourse and dialogue processing; natural language generation; applications. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 301 or MCS 441.
CS 442. Software Engineering II. 3 or 4 hours.
Advanced concepts in software development: requirements engineering, cost estimation, risk analysis, extreme programming, regression test case selection, and design patterns. Software lab assignments required. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): CS 440.

CS 450. Introduction to Networking. 3 or 4 hours.
Network protocols, algorithms, and software issues. Topics include the Open Systems Interconnect model, data link, network and transport layers, TCP/IP, ATM, mobile networks. Course Information: 3 undergraduate hours. 4 graduate hours. Credit is not given for CS 450 if the student has credit for ECE 433. Prerequisite(s): CS 361.

CS 453. Introduction to Parallel and Distributed Processing. 3 or 4 hours.
Foundations of parallel and distributed processing; clusters and parallel systems; communication primitives; programming with MPI; scalability; distributed graph algorithms; distributed mutual exclusion, deadlock detection, peer-to-peer systems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CS 251. Recommended background: CS 401.

CS 454. Principles of Concurrent Programming. 3 or 4 hours.
Focuses on the foundations and basic principles of concurrent programming, covering high-level notions of concurrent correctness and connecting those abstract concepts to real-world programming constructs and algorithms used in practice. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 361.

CS 455. Design and Implementation of Network Protocols. 3 or 4 hours.
Network protocols and their software. Examines OS network interface through network layers. Topics include routing, congestion control, fault tolerance, security, name servers, multicast, and performance. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 340 and CS 450.

CS 461. Operating Systems Design and Implementation. 3 or 4 hours.
Kernel design and implementation; process management; effective management of machine resources: resource allocation and scheduling, mutual exclusion, deadlock avoidance, memory management policies, devices and file systems, and client-server systems. Course Information: 3 undergraduate hours; 4 graduate hours. Previously listed as CS 385. Extensive computer use required. Prerequisite(s): CS 361.

CS 463. Systems Performance and Concurrent Computing. 3 or 4 hours.
Understanding the many systems factors that affect program performance, including program design for concurrent computing, profiling and program optimization. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 361. Recommended Background: CS 461.

CS 466. Computer Architecture. 3 or 4 hours.
Design principles of computer architecture. Topics include: instruction set architecture, pipelining, instruction-level parallelism, caches, main memory, and thread-level parallelism. Course Information: Same as ECE 466. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ECE 366 or CS 261.

CS 468. Network Security. 3 or 4 hours.
Covers the principles and practice of network security. Given the ubiquitous nature of network communications in modern computing, we will cover a wide range of systems and applications, and the security threats that they face. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Credit or concurrent registration in CS 450; or consent of the instructor.

CS 473. Compiler Design. 3 or 4 hours.
Language translation: lexical analysis, parsing schemes, symbol table management, syntax and semantic error detection, and code generation. Development of fully-functional compiler. Course Information: Same as MCS 411. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CS 301 or Grade of C or better in MCS 441; and Grade of C or better in CS 251 or Grade of C or better in MCS 360; and Grade of C or better in CS 261.

CS 474. Object-Oriented Languages and Environments. 3 or 4 hours.
Data abstraction, classes and objects, messages and methods, polymorphism and dynamic binding, inheritance. Object-oriented design. Pure and hybrid object-oriented languages. Course Information: 3 undergraduate hours. 4 graduate hours. Previously listed as EECS 474. Prerequisite(s): CS 342.

CS 475. Object-Oriented Programming. 3 or 4 hours.
OO Paradigm: classes, messages, methods, variables, inheritance, polymorphism; the C++ and Java languages; programming labs required. Course Information: 3 undergraduate hours. 4 graduate hours. Credit is not given for CS 475 if the student has credit for CS 340 or CS 474. Extensive computer use required. Prerequisite(s): CS 202; and consent of the instructor.

CS 476. Programming Language Design. 3 or 4 hours.
Definition, design, and implementation of programming languages. Syntactic and semantic description; variable bindings, control and data structures, parsing, code generation, optimization; exception handling; data abstraction. Course Information: Same as MCS 415. 3 undergraduate hours. 4 graduate hours. Previously listed as EECS 476. Prerequisite(s): MCS 360; or CS 341.

CS 477. Public Policy, Legal, and Ethical Issues in Computing, Privacy, and Security. 3 or 4 hours.
Contemporary topics involving legal, public policy, and/or ethical issues in computing, especially privacy, security, and surveillance. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Consent of the instructor.

CS 478. Software Development for Mobile Platforms. 3 or 4 hours.
Design and implementation of mobile applications; operating systems, object-oriented languages and programming environments for mobile platforms; integration with hardware components; and location-aware applications. Programming assignments required. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): CS 342.

CS 479. Wearables and Nearables Technology Laboratory. 3 or 4 hours.
Practical experience in design and development of wearable and nearable devices. Acquisition and processing of sensors data. Design and development of user-friendly user interface. Course Information: Same as BME 479. 3 undergraduate hours; 4 graduate hours. Extensive computer use required. Prerequisite(s): BME 240; or CS 251; or consent of the instructor. Recommended background: ECE 210 and CS 109.
CS 480. Database Systems. 3 or 4 hours.
Database design, logical design, physical design. Relational databases. Recovery, concurrency control. Normalization. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CS 251.

CS 483. Big Data Mining. 3 or 4 hours.
Data mining for very large datasets from a foundational and practical standpoint including similarity search, data-stream processing, advanced technology for search engines, recommendation systems, and graph analytics. Course Information: 3 undergraduate hours; 4 graduate hours. Credit is not given for CS 483 if the student has credit in CS 583. Prerequisite(s): Grade of C or better in CS 251; and ECE 341 or IE 342 or STAT 381. Recommended background: CS 401 and CS 480.

CS 484. Secure Web Application Development. 3 or 4 hours.
Web applications integrate concepts from software engineering, systems programming, and computer security. Teaches security through web development, enabling students to design, deploy, scale, attack, and defend modern web applications. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Credit or concurrent registration in CS 341.

CS 485. Networked Operating Systems Programming. 4 or 5 hours.
Concepts, design, and programming of multi-process and distributed systems; inter-process communications; fault tolerance; distributed programming semantics. Programming assignments and project required. Course Information: 4 undergraduate hours. 5 graduate hours. Previously listed as ECECS 471. Prerequisite(s): CS 385.

CS 486. Secure Operating System Design and Implementation. 3 or 4 hours.
Design of operating systems; operating system kernel implementation; secure coding and systems; virtual machines; extensive programming in a systems language such as C. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Credit or concurrent registration in CS 385; and credit or concurrent registration in CS 450 or consent of the instructor.

CS 487. Building Secure Computer Systems. 3 or 4 hours.
Building and programming secure systems; protecting systems from threats and reduction of vulnerabilities; Includes application, host and network security. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Grade of C or better in CS 385; and senior standing or above; or consent of the instructor.

CS 488. Introduction to Cryptography. 3 or 4 hours.
Foundational concepts: encryption schemes, hash functions, message authentication codes, digital signatures. Practical systems: stream and block ciphers, SHA. Advanced topics: secure computation, zero-knowledge proofs, blockchain. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Prerequisite(s): Grade of C or better in CS 251; and IE 342 or STAT 381 or STAT 401.

CS 489. Human Augmentics. 3 or 4 hours.
Study of technologies for augmentation of human capabilities; human limitations; implants and wearable technologies; implants; brain-computer interfaces; exoskeletons; sensors and networks. Includes project work. Course Information: Same as BME 489. 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Grade of C or better in CS 251; or consent of the instructor.