C S 110. Computer Literacy  
3 Credits (3)  
This course provides a broad introduction to computing, including computer and information technology concepts; economic and social implications of technology; database management, spreadsheet, word processing, and presentation applications.

C S 111. Computer Science Principles  
4 Credits (3+2P)  
This course provides a broad and exciting introduction to the field of computer science and the impact that computation has today on every aspect of life. It focuses on exploring computing as a creative activity and investigates the key foundations of computing: abstraction, data, algorithms, and programming. It looks into how connectivity and the Internet have revolutionized computing and demonstrates the global impact that computing has achieved, and it reveals how a new student in computer science might become part of the computing future.  
Prerequisite(s): MATH 120 or higher.

C S 117. Introduction to Computer Animation  
3 Credits (3)  
Introductory course for learning to program with computer animation as well as learning basic concepts in computer science. Students create interactive animation projects such as computer games and learn to use software packages for creating animations in small virtual worlds using 3D models. Recommended for students considering a minor/major in computer science or simply interested in beginning computer animation or programming.

C S 150. C Programming  
3 Credits (2+2P)  
Programming in the C language. May be repeated up to 3 credits.  
Prerequisite(s): MATH 120 or higher.

C S 151. C++ Programming  
3 Credits (2+2P)  
Introduction to object-oriented programming in the C++ language. May be repeated up to 3 credits.  
Prerequisite(s): MATH 120 or higher.

C S 152. Java Programming  
3 Credits (2+2P)  
Programming in the Java language. May be repeated up to 3 credits.  
Prerequisite(s): MATH 120 or higher.

C S 153. Python Programming I  
3 Credits (3)  
This course is an introduction to programming in the Python language, covering fundamental scripts, data types and variables, functions, and simple object creation and usage. The focus will be on preparing students to use Python in their own areas. No prior programming experience is required.  
Prerequisite(s): MATH 120 or higher.

C S 154. Python Programming II  
3 Credits (3)  
This course covers advanced Python programming, including classes, objects, and inheritance, embedded programming in domain applications, database interaction, and advanced data and text processing. The focus will be on preparing students to use Python in their own areas.  
Prerequisite(s): C S 153 or C S 453.

C S 155. Internet Programming I  
3 Credits (3)  
This course is an introduction to programming for the Web in PHP and Javascript, covering fundamental web scripting ideas, CSS, data types and variables, functions, simple object creation and usage. Javascript usage will focus on dynamic page content. No prior programming experience is required, though a basic understanding of HTML will be assumed.  
Prerequisite(s): MATH 120 and a basic understanding of HTML.

C S 156. Internet Programming II  
3 Credits (3)  
This course covers advanced web scripting, including Javascript with AJAX, PHP integration with databases, object oriented features of PHP and Javascript, advanced CSS usage, and using web application frameworks.  
Prerequisite(s): C S 155 or C S 455.

C S 157. Topics in Software Programming and Applications  
3 Credits (2+2P)  
Current topics in computer programming and software applications. Topic announced in the Schedule of Classes. May be repeated if subtitle is different.

C S 158. R Programming I  
3 Credits (3)  
This course covers advanced R programming, including advanced data collection processing, advanced data visualizations, object oriented features of R, and file processing. It is recommended that students have one statistics course before taking this course.  
Prerequisite(s): C S 158 or C S 458.

C S 159. R Programming II  
3 Credits (3)  
This course covers advanced R programming, including advanced data collection processing, advanced data visualizations, object oriented features of R, and file processing. It is recommended that students have one statistics course before taking this course.  
Prerequisite(s): C S 159 or C S 459.

C S 171G. Introduction to Computer Science  
4 Credits (3+2P)  
Computers are now used widely in all area of modern life. This course provides understanding of the theoretical and practical foundations for how computers work, and provides practical application and programming experience in using computers to solve problems efficiently and effectively. The course covers broad aspects of the hardware, software, and mathematical basis of computers. Weekly labs stress using computers to investigate and report on data-intensive scientific problems. Practical experience in major software applications includes an introduction to programming, word processing, spreadsheets, databases, presentations, and Internet applications.  
Prerequisite(s): MATH 210G or MATH 120 or higher.

C S 172. Computer Science I  
4 Credits (3+2P)  
Computational problem solving; problem analysis; implementation of algorithms using Java. Object-oriented concepts, arrays, searching, sorting, and recursion. May be repeated up to 4 credits. Crosslisted with: C S 460.  
Prerequisite(s): MATH 121G or higher; C S 111 or successful placement.

C S 209. Special Topics.  
1-3 Credits  
May be repeated for a maximum of 12 credits.
C S 371. Object Oriented Programming
4 Credits (3+2P)
Introduction to problem analysis and problem solving in the object-oriented paradigm. Practical introduction to implementing solutions in the C++ language. Pointers and dynamic memory allocation. Hands-on experience with useful development tools. May be repeated up to 4 credits.
Prerequisite(s): At least a C- in C S 172 or E E 112.

C S 272. Introduction to Data Structures
4 Credits (3+2P)
Design, implementation, use of fundamental abstract data types and their algorithms: lists, stacks, queues, deques, trees; imperative and declarative programming. Internal sorting; time and space efficiency of algorithms.
Prerequisite(s): At least a C- in C S 172, or placement.

C S 273. Machine Programming and Organization
4 Credits (3+2P)
Computer structure, instruction execution, addressing techniques; programming in machine and assembly languages. May be repeated up to 4 credits.
Prerequisite(s): At least a C- in C S 172 or E E 112.

C S 278. Discrete Mathematics for Computer Science
4 Credits (3+2P)
Discrete mathematics required for Computer Science, including the basics of logic, number theory, methods of proof, sequences, mathematical induction, set theory, counting, and functions. Crosslisted with: MATH 278.
Prerequisite(s): At least C- in C S 172.

C S 343. Algorithm Design & Implementation
3 Credits (3)
Prerequisite(s): At least a C- in C S 272, or consent of instructor.

C S 370. Compilers and Automata Theory
4 Credits (3+2P)
Methods, principles, and tools for programming language processor design; basics of formal language theory (finite automata, regular expressions, context-free grammars); development of compiler components. May be repeated up to 4 credits.
Prerequisite(s): At least a C- in C S 271, C S 272, and C S 273.

C S 371. Software Development
4 Credits (3+2P)
Software specification, design, testing, maintenance, documentation; informal proof methods; team implementation of a large project.
Prerequisite(s): At least a C- in C S 271 and C S 272.

C S 372. Data Structures and Algorithms
4 Credits (3+2P)
Prerequisite(s): At least a C- in CS 272 and C S 278.

C S 375. Introduction to Intelligent Agents Using Science Fiction
3 Credits (3)
This course uses science-fiction movies to introduce fundamental principles and techniques in agents and multi-agent systems. It covers game theory, decision theory, machine learning, and distributed systems.

C S 409. Independent Study
1-6 Credits (1-6)
Faculty supervised investigation, to culminate in a written report. May be repeated up to 6 credits.
Prerequisite(s): Written agreement with faculty supervisor.

C S 419. Computing Ethics and Social Implications of Computing
1 Credit (1)
An overview of ethics for computing majors includes: history of computing, intellectual property, privacy, ethical frameworks, professional ethical responsibilities, and risks of computer-based systems. May be repeated up to 1 credits. S/U Grading (S/U, Audit).
Prerequisite(s): At least a C- in C S 371.

C S 448. Senior Project
4 Credits (4)
Capstone course in which C S majors work in teams and apply computer science skills to complete a large project. May be repeated up to 4 credits. Consent of Instructor required. Restricted to: C S majors.
Prerequisite(s): At least a C- in C S 370 and C S 371.

C S 449. Senior Thesis
4 Credits (4)
Capstone course in which C S majors apply computer science skills to complete a research project, culminating in a written thesis report. May be repeated up to 4 credits. Consent of Instructor required. Restricted to: C S majors.
Prerequisite(s): At least a C- in C S 370 and C S 371.

C S 450. C Programming
3 Credits (2+3P)
Programming in the C language. More advanced than C S 150. Recommended for nonmajors only. May be repeated up to 3 credits.
Prerequisite(s): Graduate standing.

C S 451. C++ Programming
3 Credits (3)
Programming in the C++ language. More advanced than C S 151. Recommended for nonmajors only. May be repeated up to 3 credits.
Prerequisite(s): Graduate standing.

C S 452. Java Programming
3 Credits (2+2P)
Programming in the Java language. More advanced than C S 152. Recommended for nonmajors only. May be repeated up to 3 credits.
Prerequisite(s): Graduate standing.

C S 453. Python Programming I
3 Credits (3)
This course is an introduction to programming in the Python language, covering fundamental scripts, data types and variables, functions, and simple object creation and usage. The focus will be on preparing students to use Python in their own areas. No prior programming experience is required. More advanced than C S 153. May be repeated up to 3 credits. Restricted to: exclude Computer Science majors.
Prerequisite(s): Understanding of college algebra or higher.
C S 464. Machine Programming and Organization Transition
3 Credits (3)
Computer structure, instruction execution, addressing techniques; programming in machine and assembly languages. Cannot be used in a C S student’s program of study. Consent of Instructor required.
Prerequisite(s): At least a C- in C S 172 or C S 460 or consent of instructor.

C S 465. Discrete Math for Computer Science Transition
3 Credits (3)
Logical connectives, sets, functions, relations, graphics, trees, proofs, induction, and application to computer science. Cannot be used in a C S student’s program of study. Consent of Instructor required.
Prerequisite(s): At least a C- in C S 172 or C S 460 or consent of instructor.

C S 466. Compilers and Automata Transition
3 Credits (3)
Methods, principles, and tools for programming language processor design; basics of formal language theory (finite automata, regular expressions, context-free grammars); development of compiler components. For C S graduate students only; cannot be used in a students program of study. May be repeated up to 3 credits. Consent of Instructor required.
Prerequisite(s): At least a C in (C S 271 or C S 462), in (C S 272 or C S 463), in (C S 273 or C S 464), or consent of instructor.

C S 468. Software Development Transition
3 Credits (3)
Software specification, design, testing, maintenance, documentation; informal proof methods; team implementation of a large project. Cannot be used in a C S student’s program of study. Consent of Instructor required.
Prerequisite(s): At least a C- in C S 271 or C S 462, in C S 272 or C S 463, or consent of instructor.
C S 469. Data Structure and Algorithms Transition
3 Credits (3)
Prerequisite(s): At least a C- in C S 272 or C S 463, in C S 278 or C S 465, or consent of instructor.

C S 471. Programming Language Structure I
3 Credits (3)
Syntax, semantics, implementation, and application of programming languages; abstract data types; concurrency. Not for C S graduate students. May be repeated up to 3 credits.
Prerequisite(s): At least a C- in C S 370 and C S 371.

C S 473. Architectural Concepts I
3 Credits (3)
Comparison of architectures to illustrate concepts of computer organization; relationships between architectural and software features. Not for C S graduate students.
Prerequisite(s): At least a C- in C S 273 and C S 370.

C S 474. Operating Systems I
3 Credits (3)
Operating system principles and structures, and interactions with architectures. Not for C S graduate students.
Prerequisite(s): At least a C- in C S 273, C S 371, and C S 372.

C S 475. Artificial Intelligence I
3 Credits (3)
Fundamental principles and techniques in artificial intelligence systems. Intelligent Agents; solving problems by searching; local search techniques; game-playing agents; constraint satisfaction problems; knowledge representation and reasoning. Further selected topics may also be covered. Not for C S graduate students.
Prerequisite(s): At least a C- in C S 273, C S 370, and C S 372.

C S 476. Computer Graphics I
3 Credits (3)
Languages, programming, devices, and data structures for representation and interactive display of complex objects. Not for C S graduate students.
Prerequisite(s): At least C- in C S 370 or C S 371.

C S 477. Digital Game Design
3 Credits (3)
An introduction to digital game design. Topics include design, development, and playtesting of games. The course is structured to use team-based learning. Not for C S graduate students.
Prerequisite(s)/Corequisite(s): C S 371 or consent of instructor.

C S 478. Computer Security
3 Credits (3)
Introduction to the art and science of computer security. Fundamentals of computer security including elementary cryptography, authentication and access control, security threats, attacks, detection and prevention in application software, operating systems, networks and databases. May be repeated up to 3 credits.
Prerequisite(s): At least a C- in C S 272, C S 273 or consent of instructor.

C S 479. Special Topics
1-12 Credits
Topics announced in the Schedule of Classes. May be repeated under different subtitles. Not for C S graduate students. May be repeated up to 12 credits.

C S 480. Linux System Administration
3 Credits (3)
Basic system administration for Linux environments. Topics include user managements, file systems, security, backups, system monitoring, kernel configuration and other relevant aspects of system administration. Not for Computer Science graduate students.

C S 481. Visual Programming
3 Credits (3)
Design and implementation of programs using visual (i.e. dataflow or diagrammatic) programming techniques, with an emphasis on real-time data processing. Students will learn how to design visual programs, including how to handle cycles and state maintenance, and will learn to process audio, video, and other data using visual programs. Not for C S graduate students. May be repeated up to 3 credits.
Prerequisite(s): At least a C- in C S 272 and C S 278.

C S 482. Database Management Systems I
3 Credits (3)
Database design and implementation; models of database management systems; privacy, security, protection, recovery. Not for C S graduate students.
Prerequisite(s): At least C- in C S 272 and C S 278.

C S 483. Introduction to Robotics
3 Credits (3)
Basic AI-based robotic architecture and concepts, with an emphasis on building and programming mobile robots. Not for C S graduate students. Consent of Instructor required.
Prerequisite(s): At least a C- in C S 272 and C S 273.

C S 484. Computer Networks I
3 Credits (3)
Fundamental concepts of computer communication networks: layered network architecture, network components, protocol stack and service. Example of application, transport, network and data link layers, protocols primarily drawn from the Internet (TCP, UDP, and IP) protocol multimedia networks; network management and security. Not for C S graduate students. Consent of Instructor required.
Prerequisite(s): At least a C- in C S 272 and CS 273.

C S 485. User Interface Design
3 Credits (3)
Covers iterative, human-centered interface design, including prototyping and evaluation. Basics of graphic design and visualization. Not for C S graduate students.
Prerequisite(s): At least C- in C S 273.

C S 486. Bioinformatics
3 Credits (3)
Introduction to bioinformatics and computational biology. Computational approaches to sequences analysis, protein structure prediction and analysis, and selected topics from current advances in bioinformatics. Not for C S graduate students.
Prerequisite(s): At least a C- in C S 272 and C S 278.
C S 487. Applied Machine Learning I
3 Credits (3)
An introductory course on practical machine learning. An overview
of concepts for both unsupervised and supervised learning. Topics
include classification, regression, clustering, and dimension reduction.
Classical methods and algorithms such as linear regression, neural
networks, support vector machines, and ensemble approaches. Recent
techniques such as deep learning. Focused on applying of machine
learning techniques in application domains. Not for Graduate Majors.
Prerequisite(s): At least a C- in C S 272, MATH 191G; or consent of
instructor.

C S 488. Introduction to Data Mining
3 Credits (3)
Techniques for exploring large data sets and discovering patterns in
them. Data mining concepts, metrics to measure its effectiveness.
Methods in classification, clustering, frequent pattern analysis. Selected
topics from current advances in data mining. Taught with C S 508.
Prerequisite(s): At least a C- in C S 272 and C S 278.

C S 489. Bioinformatics Programming
3 Credits (3)
Application of computer programming languages to address data
processing and analysis problems in modern molecular biology. R/Perl/
Python programming; Web API programming. Automatic manipulation
of next generation sequence data, analysis of large gene expression tables,
access to online biological databases, performing statistical analysis,
and visualization of data and results. Taught with C S 509.
Prerequisite(s): At least a C- in C S 272 and C S 278.

C S 491. Parallel Programming
3 Credits (3)
Programming of shared memory and distributed memory machines;
tools and languages for parallel programming; techniques for parallel
programming; parallel programming environments. Not for C S graduate
students. May be repeated up to 3 credits.
Prerequisite(s): At least a C- in C S 370 or consent of instructor.

C S 493. Algorithm Design and Implementation
3 Credits (3)
This course introduces the basic knowledge of designing classical
algorithms and implementing these algorithms using a programming
language. In particular, the course teaches various data structures,
including graphs and balanced binary search trees, and efficient
schemes to implement these data structures. This course also teaches
basic algorithm design techniques including divide-and-conquer,
greedy scheme, and dynamic programming. This course covers graph
algorithms, including graph traversals (depth-first search and breadth-
first search), connectivity, shortest paths, and minimum spanning trees.
May be repeated up to 3 credits. Graduate standing. Not for CS students.
Restricted to: C S majors.
Prerequisite(s): At least a C- in C S 272, or Consent of Instructor.

C S 494. Introduction to Smart Grids
3 Credits (3)
This course is an introduction to the technologies and design strategies
associated with the Smart Grid. The emphasis will be on the development
of communications, energy delivery, coordination mechanisms, and
management tools to monitor transmission and distribution networks.
Topics include: Smart grid introduction and evolution; Power systems;
Networking and transport control; Artificial intelligence & agent
coordination; Data mining for smart grids.
Prerequisite(s): At least a C- in C S 272 and a C- in E E 201 or 280; or
Consent of instructor.

C S 496. Cloud and Edge Computing
3 Credits (3)
The course presents a top-down view of cloud computing, from
applications and administration to programming and infrastructure. Its
main focus is on the concepts of networking and parallel programming
for cloud computing and large scale distributed systems which form the
cloud infrastructure. The topics include: overview of cloud computing,
cloud systems, parallel processing in the cloud, distributed storage
systems, virtualization, security in the cloud, and multicore operating
systems. Students will study state-of-the-art approaches to cloud
computing followed by large cloud corporations, namely Google, Amazon,
Microsoft, and Yahoo. Students will also apply what they learn through
project developments using Amazon Web Services. Not for graduate CS
majors. Crosslisted with: C S 522.
Prerequisite(s): At least a C- in C S 372; background in C S 484/504 is
preferred or consent of instructor.

C S 502. Database Management Systems I
3 Credits (3)
Database design and implementation; models of database management
systems; privacy, security, protection, recovery; requires more advanced
graduate work than C S 482. Students are expected to have solid
knowledge of data structures and discrete mathematics.

C S 503. Introduction to Robotics
3 Credits (3)
Basic AI-based robotic architectures and concepts, with an emphasis
on building and programming mobile robots; requires more advanced
graduate work than C S 483. Students are expected to have solid
knowledge of data structures and machine-level programming.

C S 504. Computer Networks I
3 Credits (3)
Fundamental concepts of computer communication networks: layered
network architecture, network components, protocol stack and service.
Example of application, transport, network and data link layers, protocols
primarily drawn from the Internet (TCP, UDP, and IP) protocol suite; local
and wide area networks, wireless and mobile networks, multimedia
networks; network management and security; requires more advanced
graduate work than C S 484. Students are expected to have solid
knowledge of data structures, machine-level programming. Knowledge of
statistics (at the level of STAT 371 or 470) is recommended.

C S 505. Artificial Intelligence I
3 Credits (3)
Fundamental principles and techniques in artificial intelligence systems.
Knowledge representation formalisms; heuristic problem solving
techniques; automated logical deduction; robot planning methods;
algorithmic techniques for natural language understanding, vision and
learning; requires more advanced graduate work than C S 475. Students
are expected to have strong knowledge of algorithms and data structures
(at the level of C S 372).

C S 506. Computer Graphics I
3 Credits (3)
Languages, programming, devices, and data structures for representation
and interactive display of complex objects. Requires more advanced
graduate work than C S 476. Students are expected to have knowledge of
compilers design and software engineering equivalent to CS 370 and CS
371.
C S 508. Introduction to Data Mining  
3 Credits (3)  
Techniques for exploring large data sets and discovering patterns in them. Data mining concepts, metrics to measure its effectiveness. Methods in classification, clustering, frequent pattern analysis. Selected topics from current advances in data mining. Students are expected to have a preparation in Discrete Mathematics and Data Structures equivalent to C S 272 and C S 278. Requires more advanced graduate work than C S 488. Crosslisted with: C S 488.

C S 509. Bioinformatics Programming  
3 Credits (3)  
Application of computer programming languages to address data processing and analysis problems in modern molecular biology. R/Perl/Python programming: Web API programming. Automatic manipulation of next generation sequence data, analysis of large gene expression tables, access to online biological databases, performing statistical analysis, and visualization of data and results. Requires a preparation in discrete mathematics and data structures equivalent to C S 272 and C S 278. Taught with C S 489.

C S 510. Automata, Languages, Computability  
3 Credits (3)  
Regular and context-free languages, pushdown and finite-slate automata, turing machines, models of computation, halting problems. Students are expected to have knowledge of compilers design and algorithms equivalent to C S 370 and C S 372.

C S 511. Computer Security  
3 Credits (3)  
Introduction to the art and science of computer security. Fundamentals of computer security including elementary cryptography, authentication and access control, security threats, attacks, detection and prevention in application software, operating systems, networks and databases. Recommended knowledge of materials in C S 272 and C S 273. May be repeated up to 3 credits.  
Prerequisite(s): At least a C in C S 273 or consent of instructor.

C S 514. Introduction to Smart Grids  
3 Credits (3)  
This course is an introduction to the technologies and design strategies associated with the Smart Grid. The emphasis will be on the development of communications, energy delivery, coordination mechanisms, and management tools to monitor transmission and distribution networks. Topics include: Smart grid introduction and evolution; Power systems; Networking and transport control; Artificial intelligence & agent coordination; Data mining for smart grids. Requires more advanced work than C S 494.  
Prerequisite(s): At least a C- in C S 272 and a C- in E E 201 or 280; or Consent of instructor.

C S 515. Human-Centered Computing  
3 Credits (3)  
Covers iterative, human-centered interface design, including prototyping and evaluation. Basics of graphic design and visualization. Requires more advanced graduate work than C S 485 with an emphasis on studying recent research in human-computer interaction. Students are expected to have knowledge of software engineering equivalent to C S 371.

C S 516. Bioinformatics  
3 Credits (3)  
Introduction to bioinformatics and computational biology. Computational approaches to sequences analysis, protein structure prediction and analysis, and selected topics from current advances in bioinformatics; requires more advanced graduate work than C S 486. Students are expected to have knowledge of algorithms and data structures equivalent to C S 372 or exposure to Biology (equivalent to BIOL 221 or BIOL 311).

C S 517. Digital Game Design  
3 Credits (3)  
An introduction to digital game design. Topics include design, development, and playtesting of games. The course is structured to use team-based learning. Requires more advanced graduate work than C S 477 with deeper attention to a team game project.

C S 518. Visual Programming  
3 Credits (3)  
Design and implementation of programs using visual (i.e. dataflow or diagrammatic) programming techniques, with an emphasis on real-time data processing. Students will learn how to design visual programs, including how to handle cycles and state maintenance, and will learn to process audio, video, and other data using visual programs. Requires more advanced graduate work than C S 481. May be repeated up to 3 credits.  
Prerequisite(s): Graduate standing.

C S 519. Applied Machine Learning I  
3 Credits (3)  
An introductory course on practical machine learning. An overview of concepts for both unsupervised and supervised learning. Topics include classification, regression, clustering, and dimension reduction. Classical methods and algorithms such as linear regression, neural networks, support vector machines, and ensemble approaches. Recent techniques such as deep learning. Focused on applying of machine learning techniques in application domains. Crosslisted with: C S 487.

C S 521. Parallel Programming  
3 Credits (3)  
Programming of shared memory and distributed memory machines; tools and languages for parallel programming; parallelizing compilers; parallel programming environments; requires more advanced graduate work than C S 491. Students are expected to have knowledge of programming and machine organization equivalent to C S 271 and C S 273.

C S 522. Cloud and Edge Computing  
3 Credits (3)  
The course presents a top-down view of cloud computing, from applications and administration to programming and infrastructure. Its main focus is on the concepts of networking and parallel programming for cloud computing and large scale distributed systems which form the cloud infrastructure. The topics include: overview of cloud computing, cloud systems, parallel processing in the cloud, distributed storage systems, virtualization, security in the cloud, and multicore operating systems. Students will study state-of-the-art approaches to cloud computing followed by large cloud corporations, namely Google, Amazon, Microsoft, and Yahoo. Students will also apply what they learn through project developments using Amazon Web Services. Might have additional requirements for graduate students. Crosslisted with: C S 496.  
Prerequisite(s): background in C S 484/504 is preferred or consent of instructor.
C S 570. Analysis of Algorithms
3 Credits (3)
Techniques for design and analysis of algorithms; time and space complexity; proving correctness of programs. Particular algorithms such as sorting, searching, dynamic programming. NP complete problems. Students are expected to have knowledge of algorithms and data structures equivalent to C S 372.

C S 571. Programming Language Structure II
3 Credits (3)
Formal semantics of programming languages. Students are expected to have knowledge of algorithms and data structures equivalent to C S 372, and knowledge of principles of programming languages equivalent to C S 471.

C S 573. Architectural Concepts II
3 Credits (3)
Advanced topics related to computer architecture, guided by the current literature. Students are expected to have knowledge of computer architectures equivalent to C S 473 and of operating systems equivalent to C S 474. Crosslisted with: E E564.

C S 574. Operating Systems II
3 Credits (3)
Advanced topics related to operating system principles, guided by the current literature. Students are expected to have knowledge of computer architectures and operating systems equivalent to C S 473 and C S 474.

C S 575. Artificial Intelligence II
3 Credits (3)
Covers advanced theory and application of artificial intelligence. Concentration on several specific research areas, such as knowledge representation, problem solving, common-sense reasoning, natural language understanding, automated tutoring systems, learning systems. Students are expected to have knowledge of artificial intelligence equivalent to C S 475.

C S 579. Special Topics
1-6 Credits
Topic announced in the Schedule of Classes.

C S 581. Advanced Software Engineering
3 Credits (3)
Advanced tools and methods for developing large software systems. Topics include object-oriented modeling and design, component architectures, templates and generic programming, software configuration and revision control, static and dynamic analysis tools, model, checking, advanced testing, and verification. Students are expected to have knowledge of software engineering equivalent to C S 371.

C S 582. Database Management Systems II
3 Credits (3)
Advanced data models and abstractions, dependencies, implementations, languages, database machines, and other advanced topics. Students are expected to have knowledge of data base management systems equivalent to CS 482.

C S 583. Advanced Cryptography
3 Credits (3)
This is an advanced cryptography course, which will cover cryptographic protocols such as zero-knowledge proofs, secret sharing schemes, secure two-party/multi-party computation, and more. We will also briefly cover real-world applications of these protocols. Students will also be exposed to recent research topics in cryptography (exact topics might vary every offering).
Prerequisite(s): At least a C- in C S 465.

C S 584. Computer Networks II
3 Credits (3)
Advanced topics in computer networks. Covers advanced topics in networking, with emphasis on wireless, and IP networks. Students are expected to have knowledge of computer networks equivalent to C S 484, and of statistics equivalent to STAT 371 or STAT 470.

C S 586. Algorithms in Systems Biology
3 Credits (3)
The course will introduce important algorithms and computational models used in systems biology to study molecular mechanisms for cellular dynamics, processes, and systems. Cellular processes, such as metabolism and signal transduction, are studied as systems and networks quantitatively from high throughput molecular measurements. The topics include molecular biological systems, network alignment, model simulation, network inference, model optimization, and hybrid models. Students will be able to construct models and analyze their properties in the context of molecular biological systems. Students are expected to have knowledge of algorithms and data structures equivalent to C S 372.

C S 587. Advanced Human-Centered Computing
3 Credits (3)
Covers a range of methods available for performing research in the field of human-computer interaction in order to develop insights into effective human-centered designs of computing systems. Students will develop insights into how humans live, play, and work and best practices in system design.
Prerequisite(s): Consent of instructor or at least a C- in one of the following: C S 485/515, SOC 352, PSY 430/530, or ANTH 520.

C S 589. Special Research Problems
1-6 Credits
Faculty-supervised investigation, to culminate in a written report. May be repeated; maximum of 6 credits may be applied toward M.S. degree. Restricted to majors.
Prerequisite: written agreement with faculty supervisor.

C S 598. Master's Project
1-6 Credits
Project-oriented capstone course to be completed by M.S. students under supervision of their advisor. Maximum of 6 credits may be applied toward M.S. degree. Restricted to C S majors.
Prerequisite: written agreement with instructor.

C S 599. Master's Thesis
1-6 Credits (1-6)
Thesis to be developed by M.S. Students under supervision of their advisor. May be repeated for a maximum of 6 credits. Restricted to majors.
Prerequisite: consent of instructor.

C S 600. Pre-dissertation Research
1-15 Credits
Pre-dissertation research.
C S 700. Doctoral Dissertation
1-15 Credits
Dissertation.