

## COMPUTER SCIENCE (CS)

### CS LDEA, LOWER DIVISION ED ABROAD, 0-16 Credits

*This course is repeatable for 99 credits.*

### CS UDEA, UPPER DIVISION ED ABROAD, 0-16 Credits

*This course is repeatable for 99 credits.*

### CS 101, COMPUTERS: APPLICATIONS AND IMPLICATIONS, 4 Credits

The varieties of computer hardware and software. The effects, positive and negative, of computers on human lives. Ethical implications of information technology. Hands-on experience with a variety of computer applications.

*Available via Ecampus*

### CS 161, INTRODUCTION TO COMPUTER SCIENCE I, 4 Credits

Overview of fundamental concepts of computer science. Introduction to problem solving, software engineering, and object-oriented programming. Includes algorithm design and program development.

**Prerequisite:** MTH 112 (may be taken concurrently) with C or better or MTH 112Z (may be taken concurrently) with C or better or Math Placement Test with a score of 33 or Math Placement - ALEKS with a score of 061

*Available via Ecampus*

### CS 162, INTRODUCTION TO COMPUTER SCIENCE II, 4 Credits

Provides an overview of the fundamental concepts of computer science. Studies basic computer programming techniques and application of software engineering principles.

**Prerequisite:** CS 161 with C or better or ENGR 103 with C or better or ENGR 103H with C or better or DS 231 with C or better

**Equivalent to:** CS 162H

*Available via Ecampus*

### CS 162H, INTRODUCTION TO COMPUTER SCIENCE II, 4 Credits

Provides an overview of the fundamental concepts of computer science. Studies basic computer programming techniques and application of software engineering principles.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** CS 161 with C or better or ENGR 103 with C or better or ENGR 103H with C or better or DS 231 with C or better

**Equivalent to:** CS 162

*Available via Ecampus*

### CS 175, \*COMMUNICATIONS SECURITY AND SOCIAL MOVEMENTS, 3 Credits

Equipping students with the theory and practice of communications security, this course explores how social movements can remain effective in the context of mass surveillance and state repression.

**Attributes:** CPDP – Bacc Core, Perspectives, Difference/Power/Discrimination

*Available via Ecampus*

### CS 199, SPECIAL TOPICS/COMPUTER SCIENCE, 1-16 Credits

*This course is repeatable for 16 credits.*

### CS 201, COMPUTER PROGRAMMING FOR NON-CS MAJORS, 3 Credits

Covers a variety of fundamental topics in computer programming relevant to anyone who wants to write or work with computer code in their work or studies. Teaches basic computational thinking and programming skills which will allow students to solve a variety of real-world problems. In addition, students will learn more advanced topics such as how some basic algorithms work and can be written in computer code.

**Prerequisite:** MTH 111Z with C- or better or MTH 111 with C- or better or MTH 112Z with C- or better or MTH 112 with C- or better or MTH 227 with C- or better or MTH 231 with C- or better or MTH 231H with C- or better or MTH 241 with C- or better or MTH 245 with C- or better or MTH 251Z with C- or better or MTH 251HZ with C- or better or MTH 251 with C- or better or MTH 251H with C- or better

*Available via Ecampus*

### CS 225, DISCRETE STRUCTURES IN COMPUTER SCIENCE, 4 Credits

An introduction to the discrete mathematics of computer science, including logic, set and set operations, methods of proof, recursive definitions, combinatorics, and graph theory.

**Prerequisite:** MTH 111 with C or better or MTH 111Z with C or better or MTH 112 (may be taken concurrently) with C or better or MTH 112Z (may be taken concurrently) with C or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 061

*Available via Ecampus*

### CS 261, DATA STRUCTURES, 4 Credits

Abstract data types, dynamic arrays, linked lists, trees and graphs, binary search trees, hash tables, storage management, complexity analysis of data structures.

**Prerequisite:** (CS 162 with C or better or CS 162H with C or better or CS 165 with C or better) and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

**Equivalent to:** CS 261H

*Available via Ecampus*

### CS 261H, DATA STRUCTURES, 4 Credits

Abstract data types, dynamic arrays, linked lists, trees and graphs, binary search trees, hash tables, storage management, complexity analysis of data structures.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** (CS 162 with C or better or CS 162H with C or better or CS 165 with C or better) and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

**Equivalent to:** CS 261

## CS 271, COMPUTER ARCHITECTURE AND ASSEMBLY LANGUAGE, 4 Credits

Introduces functional organization and operation of digital computers. Coverage of assembly language; addressing, stacks, argument passing, arithmetic operations, decisions, macros, modularization, linkers, and debuggers.

**Prerequisite:** CS 151 with C or better or CS 161 with C or better or CS 165 with C or better or ENGR 103 with C or better or ENGR 103H with C or better

*Available via Ecampus*

## CS 274, INTRODUCTION TO SYSTEMS PROGRAMMING, 4 Credits

Explores systems-level programming using compiled languages such as C and C++. Explores terminals, shells, C and C++ syntax, pointers, memory models, and more. Learn to design and implement C and C++ programs, navigate language build pipelines, use terminals and shells, solve problems with different memory models, and manage dynamic memory. Gains practical skills for real-world coding challenges.

**Prerequisite:** CS 162 with C or better or CS 162H with C or better

*Available via Ecampus*

## CS 290, WEB DEVELOPMENT, 4 Credits

How to design and implement a multi-tier application using web technologies: Creation of extensive custom client- and server-side code, consistent with achieving a high-quality software architecture.

**Prerequisite:** CS 162 with C or better or CS 162H with C or better or CS 165 with C or better

*Available via Ecampus*

## CS 299, SPECIAL TOPICS, 0-4 Credits

*This course is repeatable for 99 credits.*

## CS 312, SYSTEM ADMINISTRATION, 4 Credits

Introduction to system administration. Network administration and routing. Security issues. Computer, server, and network hardware.

**Prerequisite:** (CS 311 with C or better or CS 344 with C or better or CS 374 with C or better) and (CS 372 [C] or ECE 372 [C])

## CS 321, INTRODUCTION TO THEORY OF COMPUTATION, 3 Credits

Survey of models of computation including finite automata, formal grammars, and Turing machines.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

**Equivalent to:** CS 321H

*Available via Ecampus*

## CS 321H, INTRODUCTION TO THEORY OF COMPUTATION, 3 Credits

Survey of models of computation including finite automata, formal grammars, and Turing machines.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

**Equivalent to:** CS 321

## CS 325, ANALYSIS OF ALGORITHMS, 4 Credits

Recurrence relations, combinatorics, recursive algorithms, proofs of correctness.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

**Equivalent to:** CS 325H

*Available via Ecampus*

## CS 325H, ANALYSIS OF ALGORITHMS, 4 Credits

Recurrence relations, combinatorics, recursive algorithms, proofs of correctness.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

**Equivalent to:** CS 325

## CS 331, INTRODUCTION TO ARTIFICIAL INTELLIGENCE, 4 Credits

Fundamental concepts in artificial intelligence using the unifying theme of an intelligent agent. Topics include agent architectures, search, games, logic and reasoning, and Bayesian networks.

**Prerequisite:** CS 325 with C or better or CS 325H with C or better

**Equivalent to:** CS 331H

## CS 331H, INTRODUCTION TO ARTIFICIAL INTELLIGENCE, 4 Credits

Fundamental concepts in artificial intelligence using the unifying theme of an intelligent agent. Topics include agent architectures, search, games, logic and reasoning, and Bayesian networks.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** CS 325 with C or better or CS 325H with C or better

**Equivalent to:** CS 331

## CS 332, INTRO TO APPLIED DATA SCIENCE WITH PROGRAMMING, 4 Credits

Explores the data science life cycle using appropriate Python libraries.

Topics include current data science areas, data gathering, cleaning, formatting, and types, an introduction to supervised (decision trees) and unsupervised (clustering) learning, exploratory data analysis, data communication, decision science methodologies, storytelling, and narratives in data science.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

**Recommended:** MTH 252Z or MTH 264 and Python

*Available via Ecampus*

## CS 340, INTRODUCTION TO DATABASES, 4 Credits

Design and implementation of relational databases, including data modeling with ER or UML, diagrams, relational schema, SQL queries, relational algebra, user interfaces, and administration.

**Prerequisite:** CS 290 with C or better

*Available via Ecampus*

## CS 352, INTRODUCTION TO USABILITY ENGINEERING, 4 Credits

Explores basic principles of usability engineering methods for the design and evaluation of software systems. Includes the study of human-machine interactions, user interface characteristics and design strategies, software evaluation methods, and related guidelines and standards.

**Prerequisite:** CS 151 with C or better or CS 161 with C or better or CS 165 with C or better or CS 295 with C or better or ECE 151 with C or better or ENGR 103 with C or better or ENGR 103H with C or better

*Available via Ecampus*

## CS 361, SOFTWARE ENGINEERING I, 4 Credits

Introduction to the "front end" of the software engineering lifecycle; requirements analysis and specification; design techniques; project management.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

*Available via Ecampus*

## CS 362, SOFTWARE ENGINEERING II, 4 Credits

Introduction to the "back end" of the software engineering lifecycle implementation; verification and validation; debugging; maintenance.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

**Equivalent to:** CS 362H

**Recommended:** Experience with object-oriented programming and data structures (eg. CS 161, CS 162, CS 361)

*Available via Ecampus*

## CS 362H, SOFTWARE ENGINEERING II, 4 Credits

Introduction to the "back end" of the software engineering lifecycle implementation; verification and validation; debugging; maintenance.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

**Equivalent to:** CS 362

**Recommended:** Experience with object-oriented programming and data structures (eg. CS 161, CS 162, CS 361)

*Available via Ecampus*

## CS 370, INTRODUCTION TO SECURITY, 4 Credits

Introductory course on computer security with the objective to introduce concepts and principles of computer systems security. Notions of security, basic cryptographic primitives and their application, basics of authentication and access control, basics of key-management, basics of malware and software security.

**Prerequisite:** CS 344 (may be taken concurrently) with C or better or CS 374 (may be taken concurrently) with C or better

*Available via Ecampus*

## CS 372, INTRODUCTION TO COMPUTER NETWORKS, 4 Credits

Computer network principles, fundamental networking concepts, packet-switching and circuit switching, TCP/IP protocol layers, reliable data transfer, congestion control, flow control, packet forwarding and routing, MAC addressing, multiple access techniques. CROSSLISTED as CS 372/ ECE 372.

**Prerequisite:** (CS 261 with C or better or CS 261H with C or better) and (ECE 271 [C] or CS 271 [C])

**Equivalent to:** ECE 372

**Recommended:** C programming and Unix familiarity.

*Available via Ecampus*

## CS 373, DEFENSE AGAINST THE DARK ARTS, 4 Credits

Introduction to the current state of the art in anti-malware, computer forensics, and networking, messaging, and web security. Broad introduction to the field of computer security.

**Prerequisite:** CS 340 with C or better and (CS 344 [C] or CS 374 [C]) and (CS 372 [C] or ECE 372 [C])

*Available via Ecampus*

## CS 374, OPERATING SYSTEMS I, 4 Credits

Introduction to operating systems using UNIX as the case study. Emphasizes system calls and utilities, fundamentals of processes, and interprocess communication.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and (CS 271 [C] or ECE 271 [C])

**Equivalent to:** CS 344

*Available via Ecampus*

## CS 381, PROGRAMMING LANGUAGE FUNDAMENTALS, 4 Credits

An introduction to the concepts found in a variety of programming languages. Programming languages as tools for problem solving. A brief introduction to languages from a number of different paradigms.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and (CS 225 [C] or MTH 231 [C] or MTH 231H [C])

*Available via Ecampus*

## CS 391, \*SOCIAL AND ETHICAL ISSUES IN COMPUTER SCIENCE, 3 Credits

In-depth exploration of the social, psychological, political, and ethical issues surrounding the computer industry and the evolving information society.

**Attributes:** CSST – Bacc Core, Synthesis, Science/Technology/Society

**Equivalent to:** CS 391H

**Recommended:** CS 101 or computer literacy

*Available via Ecampus*

## CS 391H, \*SOCIAL AND ETHICAL ISSUES IN COMPUTER SCIENCE, 3 Credits

In-depth exploration of the social, psychological, political, and ethical issues surrounding the computer industry and the evolving information society.

**Attributes:** CSST – Bacc Core, Synthesis, Science/Technology/Society; HNRS – Honors Course Designator

**Equivalent to:** CS 391

**Recommended:** CS 101 or computer literacy

**CS 399, SPECIAL TOPICS, 0-4 Credits**

*This course is repeatable for 99 credits.*

*Available via Ecampus*

**CS 401, RESEARCH, 1-16 Credits**

*This course is repeatable for 16 credits.*

*Available via Ecampus*

**CS 403, THESIS, 1-16 Credits**

*This course is repeatable for 16 credits.*

*Available via Ecampus*

**CS 404, WRITING AND CONFERENCE, 1-16 Credits**

*This course is repeatable for 16 credits.*

**CS 405, READING AND CONFERENCE, 1-16 Credits**

*This course is repeatable for 16 credits.*

**CS 406, PROJECTS, 1-16 Credits**

*This course is repeatable for 16 credits.*

*Available via Ecampus*

**CS 407, SEMINAR, 1-16 Credits**

**Equivalent to:** CS 407H

*This course is repeatable for 16 credits.*

**CS 407H, SEMINAR, 1-16 Credits**

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** CS 407

*This course is repeatable for 16 credits.*

**CS 410, OCCUPATIONAL INTERNSHIP, 1-16 Credits**

*This course is repeatable for 16 credits.*

**CS 419, SELECTED TOPICS IN COMPUTER SCIENCE, 0-5 Credits**

**Equivalent to:** CS 419H

*This course is repeatable for 99 credits.*

**CS 419H, SELECTED TOPICS IN COMPUTER SCIENCE, 0-5 Credits**

**Attributes:** HNRS – Honors Course Designator

**Equivalent to:** CS 419

*This course is repeatable for 99 credits.*

**CS 420, GRAPH THEORY WITH APPLICATIONS TO COMPUTER SCIENCE, 3 Credits**

Directed and undirected graphs; paths, circuits, trees, coloring, planar graphs, partitioning; computer representation of graphs and graph algorithms; applications in software complexity metrics, program testing, and compiling.

**Prerequisite:** CS 325 with C or better or CS 325H with C or better

**CS 424, CYBERSECURITY PRACTICUM I, 5 Credits**

Applies cybersecurity theories and principles in practice through clinical rotations at a security operations center serving a consortium of regional clients. Interactively examines and analyzes network, client, and sensor data to aid in the detection and remediation of cyber attacks. Applies incident management and response frameworks to create improved outcomes for security operations center clients. Explores technical, programmatic, and architectural solutions to common security operations problems. Recognizes professional responsibilities and makes informed judgments in cybersecurity practice based on legal and ethical principles.

**Prerequisite:** CS 370 with C or better and (CS 372 [C] or ECE 372 [C])

**Recommended:** CS 478

**CS 425, CYBERSECURITY PRACTICUM II, 5 Credits**

Applies cybersecurity theories and principles in practice through clinical rotations at a security operations center serving a consortium of regional clients. Interactively examines and analyzes security architectures at the CyberClinic Security Operations Center and at consortium client locations. Develops improved outcomes for security operations center clients through the application of cybersecurity engineering principles. Explores technical, programmatic, and architectural solutions to common security operations problems. Recognizes professional responsibilities and makes informed judgments in cybersecurity practice based on legal and ethical principles.

**Prerequisite:** CS 424 with C or better

**Recommended:** CS 478

**CS 426, +CYBERSECURITY PRACTICUM III, 4 Credits**

Applies cybersecurity theories and principles in practice through clinical rotations at a security operations center serving a consortium of regional clients. Interactively assesses client security maturity and risk and advises clients on prevention, defense, and response strategies. Applies network and end-client analysis to develop improved outcomes for security operations center clients through the application of threat-hunting principles and techniques. Recognizes professional responsibilities and makes informed judgments in cybersecurity practice based on legal and ethical principles.

**Attributes:** CSC2 – Core Ed - Beyond OSU Career Engagement

**Prerequisite:** CS 425 with C or better and ENGR 102 [C]

**Recommended:** CS 478

**CS 427, CRYPTOGRAPHY, 4 Credits**

Introduction to the theory and practice of modern cryptography. Fundamental primitives including pseudorandom generators, block ciphers, hash functions. Symmetric-key cryptography for privacy and authenticity. Public-key cryptography based on number-theoretic problems.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better or MTH 355 with C or better or MTH 310 with C or better

*Available via Ecampus*

## CS 428, ^CYBERSECURITY CAPSTONE PROJECT, 3 Credits

Utilize foundational knowledge of cybersecurity to complete a cybersecurity operations project. Develops skills for project development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (WIC)

**Prerequisite:** CS 424 with C or better and (WR 327 [C] or WR 327H [C] or WR 227Z [C] or WR 227HZ [C])

**Recommended:** CS 478 and CS 426

## CS 432, INTRODUCTION TO APPLIED MACHINE LEARNING, 4 Credits

Explores and applies machine learning models and methods including unsupervised learning and supervised learning. Focuses on gathering, cleaning, and preparing data for various analyses. Distinguishes between unsupervised methods including clustering, and dimensionality reduction and supervised modeling methods including Decision Trees, Random Forest, Naive Bayes, Support Vector Machines, and Regression). Covers Training and Testing, Confusion Matrices, x-fold cross validation, visualization options, decision science, ethical considerations, and data communication. Uses Python, Sklearn, and related Python packages/libraries.

**Prerequisite:** CS 332 with C or better

*Available via Ecampus*

## CS 434, MACHINE LEARNING AND DATA MINING, 4 Credits

Introduces machine learning and data mining algorithms and tools that are widely employed in industrial and research settings. Explores supervised learning for prediction problems, both discrete and real-valued; unsupervised learning for clustering data and discovering patterns in data sets; and reinforcement learning for controlling complex processes based on positive and negative feedback. Applies machine learning and data mining techniques to real problems with programming assignments and written homework assignments.

**Prerequisite:** (CS 325 with C or better or CS 325H with C or better) and (ST 314 [C] or ECE 353 [C])

**Equivalent to:** CS 434H

## CS 434H, MACHINE LEARNING AND DATA MINING, 4 Credits

Introduces machine learning and data mining algorithms and tools that are widely employed in industrial and research settings. Explores supervised learning for prediction problems, both discrete and real-valued; unsupervised learning for clustering data and discovering patterns in data sets; and reinforcement learning for controlling complex processes based on positive and negative feedback. Applies machine learning and data mining techniques to real problems with programming assignments and written homework assignments.

**Attributes:** HNRS – Honors Course Designator

**Prerequisite:** (CS 325 with C or better or CS 325H with C or better) and (ST 314 [C] or ECE 353 [C])

**Equivalent to:** CS 434

## CS 435, APPLIED DEEP LEARNING, 4 Credits

Explores and applies several neural network architectures, including fully-connected, convolutional, and sequence model based network structures. Topics including gradient descent and optimization, feed forward and back propagation methods, loss functions, activation functions, training, testing, and validation of the networks, as well as other types of advanced networks. Applications including areas such as text sentiment analysis, image classification, and language translation.

**Prerequisite:** CS 432 with C or better or CS 434 with C or better or CS 434H with C or better

*Available via Ecampus*

## CS 440, DATABASE MANAGEMENT SYSTEMS, 4 Credits

Relational database design, normalization, file structures, disk storage, query processing and optimization, team development of database applications.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better and CS 340 [C]

## CS 446, NETWORKS IN COMPUTATIONAL BIOLOGY, 3 Credits

Emphasizes computational and applied mathematical methods for modeling and analyzing biological networks. Covers various network centralities, topological measures, clustering algorithms, probabilistic annotation models and inference methods. Introduces those concepts in the context of protein interaction, gene regulatory, and metabolic networks. Uses graph frameworks, data frames (and related data structures for data science), and programming in Python or R. CROSSLISTED as BDS 446/CS 446.

**Prerequisite:** CS 161 with C or better or BDS 310 with C or better or BDS 470 with C or better or BOT 470 with C or better or BOT 476 with C or better or ENGR 103 with C or better or ENGR 103H with C or better

**Equivalent to:** BDS 446

**Recommended:** Completion or concurrent enrollment in CS 325

## CS 450, INTRODUCTION TO COMPUTER GRAPHICS, 4 Credits

Theoretical and practical treatment of 3D computer graphics using OpenGL: geometric modeling, transformations, viewing, lighting, texture mapping, shading, rendering, and animation.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

*Available via Ecampus*

## CS 453, SCIENTIFIC VISUALIZATION, 4 Credits

Applies 3D computer graphics methods to visually understand scientific and engineering data. Methods include hyperbolic projections; mapping scalar values to color spaces; data visualization using range sliders; scalar visualization (point clouds, cutting planes, contour plots, isosurfaces); vector visualization (arrow clouds, particle advection, streamlines); terrain visualization; Delauney triangulation; and volume visualization.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

**Recommended:** Prior experience with Unix or Windows, programming experience

## CS 457, COMPUTER GRAPHICS SHADERS, 4 Credits

Emphasizes theoretical and practical treatment of computer graphics shaders, including both RenderMan and GPU shaders. Explores programming in both RenderMan and OpenGL shading languages.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better

**Recommended:** Graphics pipeline programming experience

*Available via Ecampus*

## CS 458, INTRODUCTION TO INFORMATION VISUALIZATION, 4 Credits

Introduces data visualization concepts and techniques that aid knowledge discovery. Explores visualization design principles that are beneficial to cognitive learning and natural to human perception are the focus. Discussion topics will include graphs, trees, texts, time series and multivariate data.

**Prerequisite:** CS 361 with C or better

## CS 461, ^SENIOR SOFTWARE ENGINEERING PROJECT I, 3 Credits

Utilize software engineering methodology in a team environment to develop a real-world application. Teams will be responsible for all phases of software development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (WIC)

**Prerequisite:** (CS 325 with C or better or CS 325H with C or better) and CS 361 [C] and (CS 362 [C] or CS 362H [C])

**Equivalent to:** CS 461H

*Available via Ecampus*

## CS 461H, ^SENIOR SOFTWARE ENGINEERING PROJECT I, 3 Credits

Utilize software engineering methodology in a team environment to develop a real-world application. Teams will be responsible for all phases of software development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (WIC); HNRS – Honors Course Designator

**Prerequisite:** (CS 325 with C or better or CS 325H with C or better) and CS 361 [C] and (CS 362 [C] or CS 362H [C])

**Equivalent to:** CS 461

## CS 462, ^SENIOR SOFTWARE ENGINEERING PROJECT II, 3 Credits

Utilize software engineering methodology in a team environment to develop a real-world application. Teams will be responsible for all phases of software development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (WIC)

**Prerequisite:** (CS 362 with C or better or CS 362H with C or better) and (CS 461 [C] or CS 461H [C])

**Equivalent to:** CS 462H

*Available via Ecampus*

## CS 462H, ^SENIOR SOFTWARE ENGINEERING PROJECT II, 3 Credits

Utilize software engineering methodology in a team environment to develop a real-world application. Teams will be responsible for all phases of software development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (WIC); HNRS – Honors Course Designator

**Prerequisite:** (CS 362 with C or better or CS 362H with C or better) and (CS 461 [C] or CS 461H [C])

**Equivalent to:** CS 462

## CS 463, +SENIOR SOFTWARE ENGINEERING PROJECT III, 2 Credits

Utilize software engineering methodology in a team environment to develop a real-world application. Work as a team to complete all phases of software development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSC2 – Core Ed - Beyond OSU Career Engagement

**Prerequisite:** (CS 462 with C or better or CS 462H with C or better) and ENGR 102 [C]

**Equivalent to:** CS 463H

*Available via Ecampus*

## CS 463H, +SENIOR SOFTWARE ENGINEERING PROJECT III, 2 Credits

Utilize software engineering methodology in a team environment to develop a real-world application. Work as a team to complete all phases of software development, including project planning, requirements analysis, design, coding, testing, configuration management, quality assurance, documentation, and delivery.

**Attributes:** CSC2 – Core Ed - Beyond OSU Career Engagement; HNRS – Honors Course Designator

**Prerequisite:** (CS 462 with C or better or CS 462H with C or better) and ENGR 102 [C]

**Equivalent to:** CS 463

## CS 464, OPEN SOURCE SOFTWARE, 4 Credits

Provides a theoretical foundation of the history, key concepts, technologies, and practices associated with modern Free and Open Source Software (FOSS) projects. Provides opportunity to explore and make contributions to FOSS projects with some mentoring and guidance.

**Prerequisite:** CS 361 with C or better or CS 362 with C or better  
*Available via Ecampus*

## CS 466, SOFTWARE START-UP I, 4 Credits

Emphasizes real-world, hands-on learning in a high-tech web/mobile-based company environment. Covers research in the development of product ideas, hypotheses, and business models to create customer experiments. Conducts prototyping and statistical analysis to develop, optimize, and evaluate solutions. Includes rapid iteration/refactoring based on customer input, web analytics, and user engagement metrics.

**Corequisites:** CS 461

## CS 467, ONLINE CAPSTONE PROJECT, 4 Credits

Real-world team-based experience with the software engineering design and delivery cycle, including requirements analysis and specification, design techniques, and requirements and final project written documentation.

**Prerequisite:** CS 361 with C or better and (CS 362 [C] or CS 362H [C]) and (CS 344 [C] or CS 374 [C])  
*Available via Ecampus*

## CS 468, INCLUSIVE DESIGN (HCI), 4 Credits

Inclusive design is designing software that works for a wide variety of differently abled customers. Teaches the skills needed to design inclusively without having to have a separate design for each differently abled customer.

**Prerequisite:** CS 352 with C or better

## CS 469, STRUCTURED PROJECT, 2 Credits

Facilitates the completion of a working software product chosen and designed by the student. Introduces students to planning, reporting progress, and presenting results of software development work carried out as a structured project.

*This course is repeatable for 16 credits.*  
*Available via Ecampus*

## CS 472, COMPUTER ARCHITECTURE, 4 Credits

Computer architecture using processors, memories, and I/O devices as building blocks. Issues involved in the design of instruction set architecture, processor, pipelining and memory organization. Design philosophies and trade-offs involved in Reduced Instruction Set Computer (RISC) architectures. CROSSLISTED as CS 472/ECE 472.

**Prerequisite:** ECE 370 with C or better or ECE 370H with C or better or ECE 375 with C or better

**Equivalent to:** ECE 472  
*Available via Ecampus*

## CS 473, INTRODUCTION TO DIGITAL FORENSICS, 4 Credits

Introduces concepts related to digital forensics, its role and importance, and tools and techniques for collecting and curating digital evidence. Discusses the role of evidence in the justice system and related legal aspects pertaining to digital forensics. Introduces tools and techniques for digital forensics.

**Prerequisite:** BA 479 with C or better or BIS 471 with C or better or ((CS 344 with C or better or CS 374 with C or better) and CS 370 [C])

**Equivalent to:** CS 477  
*Available via Ecampus*

## CS 474, OPERATING SYSTEMS II, 4 Credits

Examines principles of computer operating systems: concurrent processes, memory management, job scheduling, multiprocessing, file systems, performance evaluation, and networking.

**Prerequisite:** (CS 344 with C or better or CS 374 with C or better) and (CS 271 [C] or ECE 375 [C])

**Equivalent to:** CS 444  
*Available via Ecampus*

## CS 475, INTRODUCTION TO PARALLEL PROGRAMMING, 4 Credits

Theoretical and practical survey of parallel programming, including a discussion of parallel architectures, parallel programming paradigms, and parallel algorithms. Programming one or more parallel computers in a higher-level parallel language.

**Prerequisite:** CS 261 with C or better or CS 261H with C or better  
*Available via Ecampus*

## CS 476, ADVANCED COMPUTER NETWORKING, 4 Credits

Covers advanced computer networking concepts: queuing theory, quality-of-service, buffer management, resource allocation and sharing, service models, scheduling policies, and performance modeling and analysis. CROSSLISTED as CS 476/ECE 476.

**Prerequisite:** (CS 372 with C or better or ECE 372 with C or better) and (ECE 353 [C] or ST 314 [C] or ST 314H [C])

**Equivalent to:** ECE 476

## CS 478, NETWORK SECURITY, 4 Credits

Basic concepts and techniques in network security, risks and vulnerabilities, applied cryptography and various network security protocols. Coverage of high-level concepts such as authentication, confidentiality, integrity, and availability applied to networking systems. Fundamental techniques including authentication protocols, group key establishment and management, trusted intermediaries, public key infrastructures, SSL/TLS, IPsec, firewalls and intrusion detection CROSSLISTED as CS 478/ECE 478.

**Prerequisite:** CS 372 with C or better or ECE 372 with C or better  
**Equivalent to:** ECE 478

**Recommended:** CS 370  
*Available via Ecampus*

## CS 480, TRANSLATORS, 4 Credits

Explores content on the subject of compilers; attribute grammars, syntax-directed translation, lex, yacc, LR(1) parsers, symbol tables, semantic analysis, and peep-hole optimization.

**Prerequisite:** CS 381 with C or better and (CS 321 [C] or CS 321H [C]) and (CS 344 [C] or CS 374 [C])

## CS 491, COMPUTER SCIENCE SKILLS FOR SIMULATION AND GAME PROGRAMMING, 4 Credits

Game and simulation development is very much a data and math-intensive activity. A certain number of actions must be produced, and producing them by hand is hard. This is a middleware CS course that fills in many of the missing pieces for those wanting to enter the simulation and game development worlds in a software tool-building capacity.

**Prerequisite:** (CS 261 with C or better or CS 261H with C or better) and (CS 225 [C] or MTH 231 [C] or MTH 231H [C]) and (MTH 252Z [C] or MTH 252HZ [C] or MTH 252 [C] or MTH 252H [C])

## CS 492, MOBILE SOFTWARE DEVELOPMENT, 4 Credits

Introduction to concepts and techniques for developing mobile applications. Become familiar with modern mobile structure, implementation, development tools, and workflow.

**Prerequisite:** CS 344 with C or better or CS 374 with C or better

Available via Ecampus

## CS 493, CLOUD APPLICATION DEVELOPMENT, 4 Credits

Covers developing RESTful cloud services, an approach based on representational state transfer technology, an architectural style and approach to communications used in modern cloud services development.

**Prerequisite:** CS 290 with C or better and CS 340 [C] and CS 372 [C]

Available via Ecampus

## CS 494, ADVANCED WEB DEVELOPMENT, 4 Credits

Explores advanced concepts and techniques for developing client-side web applications. Emphasizes modern application design using contemporary tools and technologies such as component-based UI frameworks.

**Prerequisite:** CS 290 with C or better and CS 340 [C]

## CS 499, SPECIAL TOPICS, 0-16 Credits

*This course is repeatable for 16 credits.*

Available via Ecampus

## CS 501, RESEARCH, 1-16 Credits

*This course is repeatable for 99 credits.*

Available via Ecampus

## CS 503, COMPUTER SCIENCE MS THESIS, 1-16 Credits

*This course is repeatable for 999 credits.*

Available via Ecampus

## CS 504, WRITING AND CONFERENCE/ EXPLORATION, 1-9 Credits

*This course is repeatable for 15 credits.*

## CS 505, READING AND CONFERENCE, 1-16 Credits

*This course is repeatable for 20 credits.*

## CS 506, PROJECTS, 1-16 Credits

*This course is repeatable for 99 credits.*

## CS 507, SEMINAR, 1-16 Credits

*This course is repeatable for 16 credits.*

## CS 510, OCCUPATIONAL INTERNSHIP, 1-16 Credits

*This course is repeatable for 99 credits.*

Available via Ecampus

## CS 511, PROGRAMMING AND DATA STRUCTURES, 4 Credits

Focuses on computer programming, problem solving, data structures, object-oriented programming, sorting, asymptotic time complexity.

**Recommended:** College algebra, plus the ability to navigate an operating system, manipulate files, and use a command line.

Available via Ecampus

## CS 512, DATA SCIENCE TOOLS AND PROGRAMMING, 4 Credits

Accessing and distributing data in the cloud; relational and non-relational databases; map reduction; cloud data processing; load balancing; types of data-stores used in the cloud.

**Recommended:** CS 511 or an equivalent course or programming experience in a high-level language like Python, Java or C++

Available via Ecampus

## CS 513, APPLIED MACHINE LEARNING, 4 Credits

Explores machine learning basics (variance and bias, underfitting and overfitting, etc). Reviews linear algebra and Numpy. Examines k-nearest neighbors, linear classification (perceptron and online learning), and linear and non-linear regression. Explores applications in housing price prediction (Kaggle contest) and text classification (sentiment analysis).

Available via Ecampus

## CS 514, ALGORITHMS: DESIGN, ANALYSIS, AND IMPLEMENTATION, 4 Credits

Explores sorting and selection algorithms including divide-and-conquer, quicksort/quick select, merge sort, binary search trees, memorization, heaps and heapsort, priority queues, hashing, hashed heaps; asymptotic complexity analysis including the Master equation, tree method, amortization; Dynamic Programming on sequences, graphs, trees, and intervals; Graph algorithms including breadth-first search, depth-first search, topological sort, shortest path, minimum spanning tree, network flow. NP-hard and NP-Complete problems.

**Recommended:** Experience with algorithms and CS 261 or an equivalent undergraduate Data Structures course with a minimum grade of B

*Available via Ecampus*

## CS 515, ALGORITHMS AND DATA STRUCTURES, 4 Credits

Greedy algorithms, divide and conquer, dynamic programming, network flow, data structures.

**Recommended:** Undergraduate course in algorithms

## CS 517, THEORY OF COMPUTATION, 4 Credits

Turing machines, decidability, NP-completeness, complexity classes, randomized computation, relativization, circuit complexity, interactive proof systems, lower bounds, cryptography.

## CS 519, SELECTED TOPICS IN COMPUTER SCIENCE, 0-5 Credits

*This course is repeatable for 99 credits.*

## CS 520, GRAPH THEORY WITH APPLICATIONS TO COMPUTER SCIENCE, 3 Credits

Directed and undirected graphs; paths, circuits, trees, coloring, planar graphs, partitioning; computer representation of graphs and graph algorithms; applications in software complexity metrics, program testing, and compiling.

**Recommended:** CS 325

*Available via Ecampus*

## CS 524, CYBERSECURITY PRACTICUM I, 5 Credits

Applies cybersecurity theories and principles in practice through clinical rotations at a security operations center serving a consortium of regional clients. Interactively examines and analyzes network, client, and sensor data to aid in the detection and remediation of cyber attacks. Applies incident management and response frameworks to create improved outcomes for security operations center clients. Explores technical, programmatic, and architectural solutions to common security operations problems. Recognizes professional responsibilities and makes informed judgments in cybersecurity practice based on legal and ethical principles.

## CS 525, CYBERSECURITY PRACTICUM II, 5 Credits

Applies cybersecurity theories and principles in practice through clinical rotations at a security operations center serving a consortium of regional clients. Interactively examines and analyzes security architectures at the CyberClinic Security Operations Center and at consortium client locations. Develops improved outcomes for security operations center clients through the application of cybersecurity engineering principles. Explores technical, programmatic, and architectural solutions to common security operations problems. Recognizes professional responsibilities and makes informed judgments in cybersecurity practice based on legal and ethical principles.

**Prerequisite:** CS 524 with C or better

## CS 526, CYBERSECURITY PRACTICUM III, 4 Credits

Applies cybersecurity theories and principles in practice through clinical rotations at a security operations center serving a consortium of regional clients. Interactively assesses client security maturity and risk and advises clients on prevention, defense, and response strategies. Applies network and end-client analysis to develop improved outcomes for security operations center clients through the application of threat-hunting principles and techniques. Recognizes professional responsibilities and makes informed judgments in cybersecurity practice based on legal and ethical principles.

**Prerequisite:** CS 525 with C or better

## CS 527, ERROR-CORRECTING CODES, 4 Credits

Hamming codes, linear codes, cyclic codes, BCH and Reed-Solomon codes. Introduction to Galois fields. Encoding and decoding algorithms. Burst error correcting codes, asymmetric and unidirectional codes. Applications of codes for computer systems.

**Recommended:** Discrete math and probability

## CS 529, SELECTED TOPICS IN THEORETICAL COMPUTER SCIENCE, 1-5 Credits

*This course is repeatable for 99 credits.*

**Recommended:** CS 515

*Available via Ecampus*

## CS 540, DATABASE MANAGEMENT SYSTEMS, 4 Credits

Purpose of database systems, levels of data representation. Entity-relationship model. Relational systems: data definition, data manipulation, query language (SQL), relational calculus and algebra, data dependencies and normal forms. DBTG network model. Query optimization, recovery, concurrency control.

**Recommended:** CS 261

*Available via Ecampus*

## CS 546, NETWORKS IN COMPUTATIONAL BIOLOGY, 3 Credits

Emphasizes computational and applied mathematical methods for modeling and analyzing biological networks. Covers various network centralities, topological measures, clustering algorithms, probabilistic annotation models and inference methods. Introduces those concepts in the context of protein interaction, gene regulatory, and metabolic networks. Uses graph frameworks, data frames (and related data structures for data science), and programming in Python or R. CROSSLISTED as BDS 546/CS 546.

**Equivalent to:** BDS 546

## CS 549, SELECTED TOPICS ON DATA SCIENCE & SYSTEMS, 1-5 Credits

*This course is repeatable for 99 credits.*

**Recommended:** CS 540

## CS 550, INTRODUCTION TO COMPUTER GRAPHICS, 4 Credits

Theoretical and practical treatment of 3D computer graphics using OpenGL: geometric modeling, transformations, viewing, lighting, texture mapping, shading, rendering, and animation.

**Recommended:** CS 261

*Available via Ecampus*

## CS 551, COMPUTER GRAPHICS, 4 Credits

3-D graphics hardware: Line and polygon scan conversion, modeling transformations, viewing transformations, matrix stacks, hierarchical models, perspective and orthographic projections, visible surface determination, illumination models, shading models, texture mapping, ray tracing.

**Recommended:** CS 450 or CS 550

## CS 552, COMPUTER ANIMATION, 4 Credits

Traditional animation concepts: production pipeline, keyframing implementation, interpolation, point-mass dynamics, spring-mass systems, rigid body dynamics, forward and inverse kinematics, human motion control, motion capture.

**Recommended:** CS 551

## CS 553, SCIENTIFIC VISUALIZATION, 4 Credits

Applies 3D computer graphics methods to visually understand scientific and engineering data. Methods include hyperbolic projections; mapping scalar values to color spaces; data visualization using range sliders; scalar visualization (point clouds, cutting planes, contour plots, isosurfaces); vector visualization (arrow clouds, particle advection, streamlines); terrain visualization; Delauney triangulation; and volume visualization.

**Recommended:** Prior experience with Unix or Windows, programming experience

## CS 554, GEOMETRIC MODELING IN COMPUTER GRAPHICS, 4 Credits

Advanced topics in computer graphics focusing on representation and processing of polygonal models and their application. Surface fundamentals; discrete differential geometry and topology; data structures for representing 3-D surfaces; surface subdivision and smoothing; mesh simplification and multi-resolution representation of 3-D surfaces; geometry compression; surface parameterization; geometry remeshing; topological simplification; implicit surfaces.

**Recommended:** CS 450

## CS 557, COMPUTER GRAPHICS SHADERS, 4 Credits

Emphasizes theoretical and practical treatment of computer graphics shaders, including both RenderMan and GPU shaders. Explores programming in both RenderMan and OpenGL shading languages.

**Recommended:** Graphics pipeline programming experience

*Available via Ecampus*

## CS 558, INTRODUCTION TO INFORMATION VISUALIZATION, 4 Credits

Introduces data visualization concepts and techniques that aid knowledge discovery. Explores visualization design principles that are beneficial to cognitive learning and natural to human perception are the focus. Discussion topics will include graphs, trees, texts, time series and multivariate data.

## CS 559, SELECTED TOPICS IN COMPUTER GRAPHICS AND VISION, 0-5 Credits

*This course is repeatable for 99 credits.*

## CS 560, DATA-DRIVEN SOFTWARE ENGINEERING, 4 Credits

An overview of data-driven empirical research methods that can be used to understand the different aspects of software engineering.

**Prerequisite:** CS 561 with C or better

## CS 561, SOFTWARE ENGINEERING METHODS, 4 Credits

Master software engineering methods and supporting tools in the context of agile processes. Teams will engage in all aspects of software development including design, testing, implementation, deployment and maintenance.

**Recommended:** CS 362

*Available via Ecampus*

## CS 562, SOFTWARE PROJECT MANAGEMENT, 4 Credits

Apply project management principles for software development projects. Provide practice for different software leadership roles during a simulated real-world hardware-software project. Apply software project management principles and industry best practices to manage the development of a term-long real-world project chosen and designed by the student. Topics include project planning, scope, work breakdowns, incremental development, scheduling and budgeting, risk management, change management, progress reporting, and final deliverables.

**Recommended:** CS 162, CS 361, CS 362 or equivalent experience in software development and software engineering

*Available via Ecampus*

## CS 563, SOFTWARE MAINTENANCE AND EVOLUTION, 4 Credits

Contribute to the cutting-edge of software engineering. Explore existing techniques and supporting tools, with a particular focus on maintenance and evolution. Identify opportunities to support software maintenance and evolution more effectively, by creating new knowledge and supporting systems through research and innovation.

## CS 564, FIELD STUDIES IN SE AND HCI, 4 Credits

Deals with the type of empirical study known as the "case" study. These are studies that collect data from natural software development situations as they really occur in the field, in which the researcher does not manipulate or "control" anything. The course is an end-to-end coverage of the process. Mainly focuses on case studies involving human software developers in the field. The student will conduct a field study as part of this course.

## CS 565, HUMAN-COMPUTER INTERACTION, 4 Credits

Basic principles of Human-Computer Interaction (HCI) for the design and evaluation of software systems. Includes research methods for studying human-machine interactions and user interfaces, design strategies, software evaluation methods, and related guidelines and standards.

*Available via Ecampus*

## CS 567, LABORATORY STUDIES IN SE AND HCI, 4 Credits

Empirical lab studies of software development. Covers how to go about designing, preparing for, running, analyzing, and writing-for-publication lab experiments of programming situations involving human subjects. This is an end-to-end coverage of the entire process, and will put students in a position to conduct lab studies of their own with human subjects.

## CS 568, INCLUSIVE DESIGN (HCI), 4 Credits

Inclusive design is designing software that works for a wide variety of differently abled customers. Teaches the skills needed to design inclusively without having to have a separate design for each differently abled customer.

**Recommended:** CS 352 or CS 565 with a minimum grade of C

## CS 569, SELECTED TOPICS IN SOFTWARE ENGINEERING, 1-5 Credits

*This course is repeatable for 99 credits.*

**Recommended:** CS 561

## CS 570, HIGH PERFORMANCE COMPUTER ARCHITECTURE, 4 Credits

Advanced concepts in computer architecture. Performance improvement employing advanced pipelining and multiple instruction scheduling techniques. Issues in memory hierarchy and management. **CROSSLISTED** as CS 570/ECE 570.

**Equivalent to:** ECE 570

**Recommended:** ECE 472 or ECE 572

## CS 572, COMPUTER ARCHITECTURE, 4 Credits

Computer architecture using processors, memories, and I/O devices as building blocks. Issues involved in the design of instruction set architecture, processor, pipelining and memory organization. Design philosophies and trade-offs involved in Reduced Instruction Set Computer (RISC) architectures. **CROSSLISTED** as CS 572/ECE 572.

**Equivalent to:** ECE 572

**Recommended:** ECE 370 or ECE 375

*Available via Ecampus*

## CS 573, INTRODUCTION TO DIGITAL FORENSICS, 4 Credits

Introduces concepts related to digital forensics, its role and importance, and tools and techniques for collecting and curating digital evidence. Discusses the role of evidence in the justice system and related legal aspects pertaining to digital forensics. Introduces tools and techniques for digital forensics.

*Available via Ecampus*

## CS 574, OPERATING SYSTEMS II, 4 Credits

Examines principles of computer operating systems: concurrent processes, memory management, job scheduling, multiprocessing, file systems, performance evaluation, and networking.

**Equivalent to:** CS 544

## CS 575, INTRODUCTION TO PARALLEL PROGRAMMING, 4 Credits

Theoretical and practical survey of parallel programming, including a discussion of parallel architecture, parallel programming paradigms, and parallel algorithms. Programming one or more parallel computers in a higher-level parallel language.

*Available via Ecampus*

## CS 576, ADVANCED COMPUTER NETWORKING, 4 Credits

Covers advanced computer networking concepts: queuing theory, quality-of-service, buffer management, resource allocation and sharing, service models, scheduling policies, and performance modeling and analysis. **CROSSLISTED** as CS 576/ECE 576.

**Equivalent to:** ECE 576

**Recommended:** (CS 372 or ECE 372) and (ECE 353 or ST 314)

*Available via Ecampus*

## CS 577, PRIVACY AND SURVEILLANCE, 4 Credits

Explores the need for privacy and theories of surveillance. Examines the current state of privacy-enhancing technologies. Emphasizes the critical reading and discussion of technical literature on privacy-enhancing technologies.

## CS 578, CYBER-SECURITY, 4 Credits

A broad overview of the field of computer and network security. Essential cryptographic mechanisms such as symmetric and public-key cryptography (e.g., encryption, signatures), network security and authentication protocols (e.g., Kerberos, TLS, IPSec), system security (e.g., access control, firewalls), advanced topics (e.g., searchable encryption, cloud security, secure computation). CROSSLISTED as CS 578/ECE 578.

**Equivalent to:** ECE 578

## CS 579, TOPICS IN COMPUTER ARCHITECTURE AND PARALLEL PROCESSING, 0-5 Credits

*This course is repeatable for 99 credits.*

**Recommended:** CS 575 or CS 572 or ECE 572

*Available via Ecampus*

## CS 581, PROGRAMMING LANGUAGES I, 4 Credits

Introduces functional programming and programming language theory. Focuses on strongly typed functional programming, abstract syntax and grammars, interpreters, denotational and/or operational semantics, and lambda calculus.

*Available via Ecampus*

## CS 582, PROGRAMMING LANGUAGES II, 4 Credits

Essentials of programming language theory for understanding and conducting programming language research. Dependently typed programming in Agda, Coq, or Idris; operational semantics; type systems; unification and type inference.

**Prerequisite:** CS 581 with C or better

## CS 583, ADVANCED FUNCTIONAL PROGRAMMING, 4 Credits

Advanced functional programming concepts and strategies, with a focus on techniques useful for the design and implementation of programming languages. Includes higher-order abstract syntax, functors and monads, generalized algebraic data types, functional data structures, and graph reduction.

**Prerequisite:** CS 581 with C or better

## CS 585, DOMAIN-SPECIFIC LANGUAGES, 4 Credits

Introduction to the design and implementation of domain-specific languages (DSLs). Domain analysis; review and revision of language designs; binding constructs to support abstraction; definition of syntax and semantics of DSLs; prototype implementation of embedded DSL.

**Prerequisite:** CS 581 with C or better

## CS 589, SELECTED TOPICS IN PROGRAMMING LANGUAGES, 1-5 Credits

*This course is repeatable for 99 credits.*

## CS 599, SPECIAL TOPICS, 0-16 Credits

*This course is repeatable for 16 credits.*

## CS 601, RESEARCH, 1-16 Credits

*This course is repeatable for 99 credits.*

## CS 603, COMPUTER SCIENCE PHD THESIS, 1-16 Credits

*This course is repeatable for 999 credits.*

## CS 605, READING AND CONFERENCE, 1-16 Credits

*This course is repeatable for 16 credits.*

## CS 607, SEMINAR, 1-16 Credits

*This course is repeatable for 16 credits.*