

# COMPUTER SCIENCE

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csc.as.miami.edu

**Dept. Code:** CSC

## Introduction

The Department of Computer Science offers undergraduate and graduate education in Computer Science, and performs research in various areas of Computer Science. Faculty research interests include algorithm engineering, applied cryptography & cybersecurity, automated reasoning, bioinformatics, computational complexity, computational geometry & computer graphics, computational neuroscience, data mining & data science, machine learning & neural networks, music information retrieval, robotics, scientific computing, semantic web, and sensors & wireless systems.

## Educational Objectives

The Department of Computer Science educates students in the science of software development: the analysis of domain problems, the development of algorithms and programs, the use of specialist computing techniques, the system-software and hardware platforms, and the production and deployment of efficient and robust computer software. Instruction ranges from introductory programming classes and laboratories, through to faculty research areas.

## Degree Programs

The Department of Computer Science offers

- a Master of Science (MS) in Computer Science
- a track in the university-wide Master of Science (MS) in Data Science
- a Doctor of Philosophy (PhD) in Computer Science

## Masters Programs in Computer Science

- MS in Computer Science (<http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/computer-science/computer-science-ms/>)
- Five-Year BS and MS in Computer Science (<http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/computer-science/five-year-bs-ms-computer-science/>)
- MS in Data Science (<http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/data-science/>)

## Doctoral Program in Computer Science

- Ph.D. in Computer Science (<http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/computer-science/computer-science-phd/>)

### CSC 607. Logic. 3 Credit Hours.

Propositional and first order logic: completeness. Computational logic: Robinson's resolution. Formalized theories: arithmetic, Godel's incompleteness theorem, Tarski's theorem on undefinability of truth.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

### CSC 609. Data Security and Cryptography. 3 Credit Hours.

Access, information flow, and inference controls. Network security and management. Encryption algorithms. Cryptographic techniques.

Prerequisite: CSC 317 or CSC 427.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

### CSC 616. Cybersecurity. 3 Credit Hours.

Introduction to Cyberspace. Foundations of Cybersecurity. Blockchain and its applications. Malware and counter measures against malware. Firewalls. Intrusion detection and prevention systems. Security for cloud computing and the Internet of Things. Design and implementation of secure software systems.

Prerequisite: CSC 317, and MTH 224, and MTH 309 or MTH 230.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 618. Interpreters and Compiler Theory. 3 Credit Hours.**

Translation of higher-level languages into machine language. Grammars, parsing, scanners, precedence relations. Run-time storage and symbol table organization. Semantic routines. Chaining and hashing. Code generation and optimization. Macro implementation.

Prerequisite: CSC 419.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 623. Theory of Relational Databases. 3 Credit Hours.**

Relational operators. Functional dependencies. Covers for functional dependencies. Multivalued dependencies. Joint dependencies. Normal Forms, Representation theory. Query systems. Acyclic database schemes.

Prerequisite: CSC 423.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 629. Introduction to Computer Graphics. 3 Credit Hours.**

Graphic systems. Graphic communication. Geometric modeling (2D and 3D representations). Rendering. Advanced techniques. Display and input devices. Software packages.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 631. Introduction to Software Engineering. 3 Credit Hours.**

Software processes, requirements and specifications, design, validation, evolution. Project management, tools and environments. Foundations of human-computer interaction. Risks and liabilities of computer-based systems. Intellectual property.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 632. Introduction to Parallel Computing. 3 Credit Hours.**

Parallel computing systems shared-memory parallel programming, with open MP, distributed-memory parallel programming, software with open MPI software package. Applications: vector and matrix operations, sorting, image processing.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 640. Algorithm Design and Analysis. 3 Credit Hours.**

Design techniques include divide-and-conquer, greedy method, dynamic programming, backtracking. Time and space complexity. Sorting, searching, combinatorial and graph algorithms.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 642. Statistical Learning with Applications. 3 Credit Hours.**

Supervised and unsupervised learning. Regression and classification. Model assessment and selection. Resampling methods. Statistical learning methods: K-Nearest Neighbors, linear models and regularization, non-linear regression models, tree-based and ensemble methods, kernels and support vector machines. Dimensionality reduction and clustering. Applications using R.

Prerequisite: MTH 224.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**CSC 645. Introduction to Artificial Intelligence. 3 Credit Hours.**

Search and constraint satisfaction. Knowledge representation and reasoning. Natural language processing. Machine learning and neural networks. Game theory. AI programming.

Prerequisite: CSC 317 Or ECE 318 And MTH 224 Or ECE 310 Or IEN 310.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**CSC 646. Introduction to Machine Learning with Applications. 3 Credit Hours.**

Python and probability, the Numpy package. K-means clustering. The Gaussian mixture model. Kernel density estimation. Dimensionality reduction. Classification. Regression, SVM, and SVR. Ensemble learning. Cross validation for model selection. Signal encoding-decoding. Dictionary learning. Metrics for performance evaluation. Deep neural networks. Neural networks, the Pytorch and Keras packages. Computational graph and automatic differentiation. Convolutional neural networks. Autoencoders. Generative adversarial networks. Transfer learning.

Prerequisite: MTH 210 and MTH 224.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 647. Computational Geometry. 3 Credit Hours.**

Algorithms for solving geometric problems arising from application domains including graphics, robotics, and GIS.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 648. Problem Solving for Bioinformatics. 3 Credit Hours.**

Grand challenges, solutions, and emerging opportunities in bioinformatics. PERL programming from the most basic to advanced contents such as multidimensional array, regular expression, hash, and sorting. Theories and hands-on projects in 3D genome structure inference, protein secondary structure prediction, protein tertiary structure prediction, protein model quality assessment, protein function prediction, and biological network analysis. Analysis of real-world biomedical data. Applications of machine learning algorithms.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**CSC 649. Biomedical Data Science. 3 Credit Hours.**

The computational skills needed for analysis of genomic and biomedical data sets, including: The basics of a command line interface. Programming in (bio-)python. Running programs on Pegasus. Writing scripts for downloading, manipulating, and analyzing data. File sharing and version control using Github. Analyzing a Next Generation Sequencing data set, and Interpreting the results. Responsible Conduct of Research.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**CSC 650. Computational Neuroscience. 3 Credit Hours.**

Introduction to computational neuroscience. Analysis and modeling of neural systems. Neurons, populations of neurons, perception, behavior.

Connections to machine learning. Tutorials in Matlab.

Prerequisite: MTH 162 and MTH 224.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 656. Multimedia Systems. 3 Credit Hours.**

Specification and requirements of a multimedia hardware system. Multimedia data technologies. Graphics file formats. Compression and decompression. Multimedia application development.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 670. Directed Reading. 1-3 Credit Hours.**

Directed reading in Computer Science - content varies by semester.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**CSC 685. Topics in Computer Science. 1-3 Credit Hours.**

Topics in Computer Science - content varies by semester.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 686. Topics in Computer Science. 1-3 Credit Hours.**

Topics in Computer Science - content varies by semester.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 687. Topics in Computer Science. 1-3 Credit Hours.**

Topics in Computer Science - content varies by semester.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 688. Topics in Computer Science. 1-3 Credit Hours.**

Topics in Computer Science - content varies by semester.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 689. Topics in Computer Science. 1-3 Credit Hours.**

Topics in Computer Science - content varies by semester.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 690. Seminar for Graduate Students I. 1-3 Credit Hours.**

Flexible topics of interest to graduate students.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 692. Seminar for Graduate Students II. 1-3 Credit Hours.**

Flexible topics of interest to graduate students.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 707. Logic Programming. 3 Credit Hours.**

Programming in Prolog, Fix-point semantics, Declarative semantics, Completeness of SLD-resolution, Negation, Implementation of logic programming languages. Deductive databases.

Prerequisite: MTH 506 and CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 710. Computer Science Software Project Design. 1-3 Credit Hours.**

Design of a Computer Science software project, including: Problem analysis. System architecture design. Algorithm and data structure selection. User interface design. Verification and validation plan. Prototyping.

Requisite: Students must complete at least 18 credits prior to enrolling.

**Components:** PRA.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**CSC 712. Computer Science Graduate Internship. 1-6 Credit Hours.**

This course monitors students doing an internship in a professional computer science environment. The exact nature of the course will be dependent on the nature of the internship and the requirements of the host organizations. Normally 50 internship hours are required per credit earned (the host organization must supply documentary evidence of hours worked).

Requisite: Students must complete at least 18 credits prior to enrolling in the internship course.

**Components:** PRA.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**CSC 713. Computer Science Software Project Implementation. 1-3 Credit Hours.**

Implementation of a Computer Science software project, including: Hardware preparation. Component implementation. System integration. Verification and validation. Documentation.

Requisite: Students must complete at least 18 credits prior to enrolling.

**Components:** PRA.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**CSC 724. Mobile Wireless Systems. 3 Credit Hours.**

Cellular Systems, multiple access techniques, wireless networking, mobile IP, power management, user location information management, TDMA, CDMA, and GSM systems, data broadcasting.

Prerequisite: CSC 424.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 727. Theory of Computation. 3 Credit Hours.**

Recursive functions, Markov algorithms, Turing machines. Unsolvability.

Prerequisite: CSC 317 or CSC 517.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 732. Parallel Algorithms. 3 Credit Hours.**

Parallel computation models; sorting networks; parallel algorithms for sorting, searching, graph problems, prefix computation, pattern matching, and fast Fourier transforms; theory of P-completeness, the class NC.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**CSC 746. Neural Networks and Deep Learning. 3 Credit Hours.**

Fundamentals of artificial neural networks: Perceptrons, Single-layer perceptron classifiers, Multi-Layer feedforward networks, Error back-propagation training. Deep Feedforward Networks: Regularization for deep learning, Optimization for training deep models, Convolution networks. Applications: Computer vision, speech recognition, Natural language processing.

Prerequisite: CSC 317.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 747. Complexity Theory. 3 Credit Hours.**

Models of computations, Blum's axioms, intractability, NP-completeness.

Prerequisite: CSC 427.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 749. Automated Reasoning. 3 Credit Hours.**

Propositional and 1st order logic. Reasoning and resolution. More complex inference rules. Using contemporary ATP systems. Prolog as an ATP system and as a programming language. Applications of ATP in research and industry.

Prerequisite: CSC 317 or CSC 645.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 751. Semantic Web. 3 Credit Hours.**

An overview of the underlying semantic web technologies. Ontology construction and implementation using tools and APIs (logic, XML, RDF, RDFS). Theoretical and practical aspects of knowledge representation (description logic, RDF, RDFS, SPARQL, SROIQ(D)). Designing and debugging ontologies (ontology engineering, entailment tools, project).

Prerequisite: CSC 317, and MTH 309 or MTH 230.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**CSC 752. Autonomous Robotic Systems. 3 Credit Hours.**

Introduction: autonomous systems, autonomous robots, RoboCup, typical components of an autonomous robot. Modeling: perception, noise, modeling, recursive state estimation, Bayes' filter, particle filter, self-localization. Control and motion: PIO-control, calibration of parameters, controlling a wheeled robot, controlling joints, walking motion. Learning (optional, if time permits): overview, different types of learning, reinforcement learning.

Prerequisite: CSC 317 and MTH 210.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 785. Advanced Topics in Computer Science. 1-3 Credit Hours.**

Advanced Topics in Computer Science

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 786. Advanced Topics in Computer Science. 1-3 Credit Hours.**

Advanced Topics in Computer Science

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 787. Advanced Topics in Computer Science. 1-3 Credit Hours.**

Advanced Topics in Computer Science

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 788. Advanced Topics in Computer Science. 1-3 Credit Hours.**

Advanced Topics in Computer Science

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 789. Advanced Topics in Computer Science. 1-3 Credit Hours.**

Advanced Topics in Computer Science

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**CSC 793. Research Project. 1-6 Credit Hours.**

Supervised research project preceding dissertation research for the Ph.D.

**Components:** IND.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**CSC 794. Research Project. 1-6 Credit Hours.**

Supervised research project preceding dissertation research for the Ph.D.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**CSC 810. Master's Thesis. 1-6 Credit Hours.**

The student working on his/her master's thesis enrolls for the number of credit s as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall & Spring.

**CSC 825. Continuous Registration--Master's Study. 1 Credit Hour.**

To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full time residence.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**CSC 830. Pre-Candidacy DOCTORAL DISSERTATION. 1-12 Credit Hours.**

Required of all candidates for the Ph.D. The student will enroll for credit as determined by his/her advisor, but for not less than a total of 12 hours. Up to 12 hours may be taken in a regular semester, but not more than six in a summer session.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**CSC 840. Post-Candidacy Doctoral Dissertation. 1-12 Credit Hours.**

Required of all candidates for the Ph.D. who have advanced to candidacy. The student will enroll for credit as determined by his/her advisor, but not for less than a total of 12. Not more than 12 hours of CSC 740 may be taken in a regular semester, nor more than six in a summer session.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**CSC 850. Research in Residence. 1 Credit Hour.**

Used to establish research in residence for Ph.D. students after the student has enrolled for permissible cumulative total in appropriate doctoral research. Regarded as full-time residence.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.