COMPUTER SCIENCE DEPARTMENT

http://www.uvm.edu/~cems/cs/

Computer Science (CS) is a vibrant subject with academic depth, enormous growth, and universal economic impact. Computers are now ubiquitous in society and influence the way we learn, the way we do science and business, and the way we interact with and understand our world.

Edsger Dijkstra (a renowned computer scientist, 1930-2002) is reputed to have said “Computer Science is no more about computers, than astronomy is about telescopes.” Rather, CS is aptly defined as the science of problem solving. CS requires a combination of logical thinking, creativity, problem decomposition, implementation, verification and validation, and teamwork. Computing Careers are extremely versatile, lucrative, and in tremendous and growing demand.

CURRICULA

At the undergraduate level, UVM Computer Science offers three bachelor’s degrees, an accelerated M.S. degree, a minor, and a non-degree Certificate in Computer Software:

- **BS CS**: The Bachelor of Science in Computer Science provides the most depth in computer science, complemented by breadth in math, science, humanities, and social sciences. The BS CS is offered through the College of Engineering & Mathematical Sciences.

- **BS CSIS**: The Bachelor of Science, major in Computer Science and Information Systems, is an interdisciplinary degree that combines computer science with business, offering a competitive combination of skills and knowledge. The BS CSIS is offered through the College of Engineering and Mathematical Sciences, in cooperation with the School of Business Administration.

- **BA CS**: The Bachelor of Arts, major in Computer Science, provides a computer science major in the context of a liberal education, and has sufficient flexibility to facilitate a double major in another field such as mathematics, biology, music, etc. The BA is offered through the College of Arts and Sciences, and information for this program can be found under the Arts and Sciences portion of the Undergraduate Catalog Website.

- **AMP**: The Accelerated Masters Program is open to academically strong CS juniors in any of our 3 undergraduate majors. The AMP allows students to apply two CS upper division courses towards both a bachelor’s and master’s degree, enabling completion of the Master of Science in CS in as little as one additional year beyond their Bachelor’s degree. Information on the AMP can be found under the Graduate Catalog Website.

- **CS minor**: The minor in Computer Science is a flexible 6-course program, which is a great complement to virtually any other UVM major and adds marketable skills.

- **Certificate in CS**: A non-degree Certificate in Computer Software is a flexible 5-course program offered jointly with the Division of Continuing Education. It can be used to obtain career skills or to make up pre-requisites for the MS program in CS. Information about this program can be found on the Continuing Education Website.

UVM CS courses provide a mixture of lecture-based and hands-on experiential learning exercises. Our curricula provide a solid foundation in both applied and theoretical aspects of computing, preparing students for future careers and/or graduate study in computing. Many of our students complete paid internships during their summers.

ACADEMIC STANDARDS

In order to continue as a major in the Department of Computer Science in CEMS, a student must achieve a 2.00 cumulative grade-point average at the end of the semester in which 60 cumulative credits have been attempted. No more than three repeated course enrollments are allowed during this 60-credit period. In the case of transfer students, applicable transfer credits will be included in determining the 60 credits, but grades in these courses will not be included in the grade-point average.

Students who receive a cumulative or semester grade-point average of less than 2.00 will be placed on trial. Students who have failed half their course credits for any semester, or who have had two successive semester averages below 2.00, or three successive semesters in which their cumulative grade-point average falls below 2.00, are eligible for dismissal.

To receive a degree, students must have a minimum cumulative average of 2.00. Students must complete 30 of the last 45 hours of credit in residence at UVM as matriculated students in the College of Engineering and Mathematical Sciences.

No more than three grades of D+, D, or D- in computer science courses numbered CS 124 and higher may be applied to the Bachelor of Science in Computer Science. No more than three grades of D+, D, or D- in computer science courses numbered CS 124 and higher or BSAD courses numbered 100 and higher may be applied to the Bachelor of Science with a major in Computer Science & Information Systems.

MAJORS

COMPUTER SCIENCE MAJORS

Computer Science B.S.CS.

Computer Science and Information Systems B.S.

Data Science B.S.

MINORS

COMPUTER SCIENCE MINOR

Computer Science
GRADUATE
Computer Science AMP
Computer Science M.S.
Computer Science Ph.D.

See the online Graduate Catalogue for more information.

Courses

**CS 002. MS Office: Beyond the Basics. 0 or 3 Credits.**
Word documents looking dull? Excel charts lacking something? PowerPoint slides fizzling? All this and more is covered. Learn more than just the basics.

**CS 005. Introductory Special Topics. 0-3 Credits.**
Prerequisite: Instructor permission. Hours variable. May not be taken for credit after any Computer Science course numbered CS 016 or higher.

**CS 008. Intro to Web Site Development. 0 or 3 Credits.**
Provides a strong foundation in HTML, CSS, images, beginning web programming, and web design so that the student can create a complete functional web site.

**CS 014. Visual Basic Programming. 3 Credits.**
Introduction to Microsoft's rapid development environment. Create playful and relevant Windows applications.

**CS 020. Programming for Engineers. 0 or 3 Credits.**
Introduction to computer programming principles using MATLAB, with applications chosen from civil, electrical, environmental, and mechanical engineering. Co-requisite: MATH 021. Cross-listed with: ENGR 020.

**CS 021. Computer Programming I. 0 or 3 Credits.**
Introduction to algorithmic problem solving and computer programming. Designed to provide a foundation for further studies in computer science.

**CS 031. C Programming. 1-3 Credits.**
Introduction to C programming for those already familiar with another programming language. Variable types, pointers, memory allocation, input/output, math, time, and other library calls. Prerequisite: CS 020 or CS 021.

**CS 032. Puzzles, Games & Algorithms. 0 or 3 Credits.**
Introductory computer science through exploration and analysis of mathematical puzzles and games, and the algorithms that handle them.

**CS 050. Seminar for New CS Majors. 1 Credit.**
A fun and accessible breadth-first introduction to the CS community and curricula at UVM. CS faculty serve as guest lecturers to introduce new CS majors to selected topics covered in upper division UVM CS electives. Prerequisites: Computer Science or Computer Science & Information Systems majors who have not yet completed CS 110. Co-requisite: CS 021 or CS 110.

**CS 064. Discrete Structures. 3 Credits.**
Introduction to analytic and formal methods of computer science with practical examples, including analysis or data structures, recursion relations, proof methods, and logic programming. Credit not given for more than one of CS 064, MATH 052 or MATH 054. Prerequisites: CS 020 or CS 021; MATH 021.

**CS 090. Internship. 1-3 Credits.**
An on-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

**CS 095. Special Topics. 1-18 Credits.**
See Schedule of Courses for specific titles. Prerequisite: Instructor permission.

**CS 110. Intermediate Programming. 0 or 4 Credits.**
Intermediate programming concepts including common data structures, algorithms, style, design, documentation, testing and debugging techniques, and an introduction to object-oriented programming. Prerequisite: One of CS 020 or CS 021 with a grade of C- or better.

**CS 120. Advanced Programming. 3 Credits.**
Build programming maturity and proficiency through significant projects with spiral development, including program specification, design, implementation, debugging, testing, validation, internal and external documentation. Focus on advanced topics including efficiency, profiling, modularity, extensibility, programming paradigms, design patterns, memory management, and generics. Prerequisite: CS 110 with a grade of C- or better.

**CS 121. Computer Organization. 0 or 3 Credits.**
Introduction to computer system organization including performance, assembly language, machine-level data representation, arithmetic for computers, processor datapath control, memory, and input/output. Prerequisite: CS 110.

**CS 124. Data Structures & Algorithms. 3 Credits.**
Design and implementation of linear structures, trees and graphs. Examples of common algorithmic paradigms. Theoretical and empirical complexity analysis. Sorting, searching, and basic graph algorithms. Prerequisites: CS 110; CS 064 or MATH 052.

**CS 125. Computability and Complexity. 3 Credits.**

**CS 128. Probability Models & Inference. 3 Credits.**
Introduction to probability and statistics with computer science applications: probability spaces, discrete and continuous random variables, distributions, conditional probability, Markov chains, statistical estimation and regression. Prerequisites: CS 064 or MATH 052.
CS 142. Advanced Web Design. 0-3 Credits.
Advanced web site design, including structure, architecture, and usability, etc., to help create a pleasing user experience. Prerequisite: CS 008.

CS 148. Database Design for the Web. 0 or 3 Credits.
Design and implementation of a relational database model using SQL and PHP. Typical project includes creation of ecommerce shopping site. Prerequisites: CS 008 and CS 021.

CS 189. CS for Geospatial Technologies. 0 or 3 Credits.
Introductory course providing hands-on experience with activities involving programming languages, platforms, and technologies in use by the GIS programmer/developer. Prerequisite: One of CS 020, CS 021, CE 010, GEOG 081, or NR 143.

CS 190. Internship. 1-18 Credits.
An on-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

CS 191. Teaching Assistantship. 1-3 Credits.
Undergraduate student service as a teaching assistant, usually in an introductory level course in the discipline, for which credit is awarded. Offered at department discretion.

CS 192. Service Learning in CS. 1-3 Credits.
Service learning experience that benefits the University or the Community under the direction of a CS faculty member. Prerequisite: Instructor permission.

CS 195. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles. Prerequisite: Instructor permission.

CS 196. Undergraduate Research. 1-18 Credits.
Undergraduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CS 198. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting? under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

CS 201. Operating Systems. 0 or 3 Credits.
Supervisory and control software for multiprogrammed computer systems. Processes synchronization, interprocess communication, scheduling, memory management, resource allocation, performance evaluation, object-oriented systems, case studies. Prerequisites: CS 121 and CS 124.

CS 204. Database Systems. 3 Credits.
Techniques for processing very large collections of data. Secondary storage. Database design and management. Query languages and optimization. Database recovery. Prerequisite: CS 124.

CS 205. Software Engineering. 3 Credits.
Treatment of software engineering problems and principles, including documentation, information hiding, and module interface specification syntax and semantics. Requires participation in a team project. Prerequisite: CS 124.

CS 206. Evolutionary Robotics. 3 Credits.
Exploration of the automated design of autonomous machines using evolutionary algorithms. Coursework involves reading of research papers, programming assignments and a final project. Prerequisites: Junior standing and programming experience, or Instructor permission.

CS 222. Computer Architecture. 3 Credits.
Architecture of computing systems. Control unit logic, input/output processors and devices, asynchronous processing, concurrency, parallelism, and memory hierarchies. Prerequisite: CS 121.

CS 224. Algorithm Design & Analysis. 3 Credits.
Comprehensive study of algorithms including greedy algorithms, divide and conquer, dynamic programming, graph algorithms and network flow. Computational intractability. Approximation, local search and randomization. Prerequisite: CS 124. Pre/Co-requisites: Recommended: CS 125; STAT 143, STAT 151, or CS 128.

CS 225. Programming Languages. 3 Credits.
The principles of programming language design and fundamental implementation concepts. Syntax, semantics, and static program analysis for various paradigms. Programming language metatheory, including confluence and type safety. Stack-based implementation and memory management issues. Prerequisites: CS 124, CS 125.

CS 228. Human-Computer Interaction. 3 Credits.
The design, implementation and evaluation of user interfaces for computers and other complex, electronic equipment. Includes a significant project. Pre/co-requisites: Programming experience and Junior standing or Instructor permission.

CS 231. Programming for Bioinformatics. 3 Credits.
Introductory course on computing (including scripting, database, and statistical analysis) for developing bioinformatics applications. Particular emphasis is given to comparative genomics and systems biology scenarios. Prerequisites: STAT 151, STAT 153 or Instructor permission. Cross-listed with: MMG 231.

CS 232. Methods in Bioinformatics. 3 Credits.
This course provides a methodological survey of bioinformatics. Particular emphasis is given to algorithms associated with sequence analysis, comparative genomics, structural biology, and systems biology. Prerequisites: STAT 151, STAT 153, or Instructor permission. Cross-listed with: MMG 232.

CS 243. Theory of Computation. 3 Credits.
Reducibility and decidability, recursion theory, time and space complexity, P, NP, NP-completeness, PSPACE, PSPACE-completeness, L and NL, advanced topics in computability and complexity. Prerequisites: CS 124 and CS 125.
CS 251. Artificial Intelligence. 3 Credits.
Introduction to methods for realizing intelligent behavior in computers. Knowledge representation, planning, and learning. Selected applications such as natural language understanding and vision. Prerequisites: CS 103 or CS 123; Prerequisites: CS 124; CS 128 or STAT 151 or STAT 143. Cross-listed with: CSYS 251.

CS 254. Machine Learning. 3 Credits.
Introduction to machine learning, including supervised and unsupervised learning algorithms, reinforcement learning, and computational learning theory. Prerequisites: CS 128 or STAT 151 or STAT 143; MATH 121; MATH 122 or MATH 124.

CS 256. Neural Computation. 3 Credits.
Introduction to artificial neural networks, their computational capabilities and limitations, and the algorithms used to train them. Statistical capacity, convergence theorems, backpropagation, reinforcement learning, generalization. Prerequisites: MATH 122 or MATH 124 or MATH 271; CS 128 or STAT 143 or STAT 151; CS 110. Cross-listed with: STAT 256, CSYS 256.

CS 260. Parallel Computing. 3 Credits.
Taxonomy of parallel computers, basic concepts for parallel computing, effectiveness and scalability, parallel algorithms for variety of problems, distributed memory and shared memory paradigms. Prerequisite: CS 124.

CS 265. Computer Networks. 3 Credits.
Introduction to the theoretical and pragmatic principles and practices of computer networking. Topics include: local area networks; the Internet; network and world-wide-web application programming. Prerequisites: CS 110; CS 121; STAT 143.

CS 266. Network Security & Cryptography. 3 Credits.

CS 274. Computer Graphics. 3 Credits.
Graphical representation of two- and three-dimensional objects on color raster displays. Line generation, region filling, geometric transformations, hidden line and surface removal, rendering techniques. Prerequisites: CS 104 or CS 124; MATH 122 or MATH 124 or MATH 271 recommended.

CS 275. Mobile Apps & Embedded Devices. 3 Credits.
A projects-based course focused on applications development on wireless and embedded platforms, including iOS, Arduino, and Linux-based devices. Emphasis on C programming and cyber-physical systems software. Prerequisite: CS 124. Pre/Co-requisites: Recommended: CS 148 or CS 204.

CS 283. Undergraduate Honors Thesis. 3 Credits.
See description of Honors Thesis Program in the College of EM section of this catalog.

CS 284. Undergraduate Honors Thesis. 3 Credits.
See description of Honors Thesis Program in the College of EM section of this catalog.