COMPUTER SCIENCE IN THE COLLEGE OF ARTS AND SCIENCES

https://www.uvm.edu/cems/cs

The Department of Computer Science resides in the College of Engineering and Mathematics Sciences (CEMS). The College of Arts and Sciences (CAS) offers a B.A. with a major in Computer Science. CEMS offers two B.S. programs in the discipline of computer science.

Edsgar 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, Computer Science (CS) is aptly defined as the Science of Problem Solving. CS thus requires a combination of logical thinking, creativity, problem decomposition, implementation, verification and validation, and teamwork.

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 business, and the way we understand our world. Whether your passion is to help fight global warming, uncover the secrets of the human genome, evolve intelligent robots, bring history to life through mobile apps, prevent terrorism, study human social phenomena, understand financial markets, create digital art, improve healthcare, find useful patterns in Big Data, or invent the technologies of the future, computing is central to these and virtually all modern endeavors. Because of this, computing-related careers are among the most versatile, creative, satisfying, lucrative, and in-demand. The demand for computer scientists continues to grow at an incredible pace and shows no sign of slowing down.

At the undergraduate level, UVM Computer Science offers 3 bachelor's degrees, an accelerated M.S. degree, and a minor:

- B.S.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 B.S.CS. is offered through the College of Engineering and Mathematical Sciences.
- B.S.: The Bachelor of Science 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 B.S. is offered through the College of Engineering and Mathematical Sciences, in cooperation with the Grossman School of Business.
- B.A.: The Bachelor of Arts 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, or music. The B.A. is offered through the College of Arts and Sciences.
- Accelerated M.S.: CS juniors who are academically strong may enter our accelerated M.S. program. This allows them to apply two of their upper division courses towards both a bachelor's and master's degree, enabling completion of the M.S. in as little as one additional year beyond their bachelor's degree.
- CS minor: We offer a flexible 6-course minor in Computer Science, which is a great complement to virtually any other major and adds marketable skills.

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, and UVM CS alumni survey respondents typically report 100 percent employment or graduate student status one year after graduation.

MAJORS

COMPUTER SCIENCE MAJOR

Computer Science B.A.

MINORS

COMPUTER SCIENCE MINOR

This minor is administered by the College of Engineering and Mathematical Sciences.

Computer Science

GRADUATE

Computer Science AMP

Computer Science M.S.

Computer Science Ph.D.

See the online Graduate Catalogue for more information.

Computer Information Systems Courses

CIS 1010. Cybersecurity Law & Policy. 3 Credits.
U.S. statues, regulations, and judicial decisions dealing with cybersecurity; politics and policies that are relevant to cyberspace governance; ways to create digitally resilient organizations; the relationship between cybersecurity and sustainability. Catamount Core: SU.

CIS 1990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CIS 1991. Internship. 1-3 Credits.
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.

CIS 1993. 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.

CIS 2330. Privacy Law & Policy. 3 Credits.
Privacy and Data Security have become increasingly prominent issues in recent years. Taught by a practicing consumer protection attorney, students will learn the role privacy plays in society, both now and historically, identify and interpret the domestic and internal laws that protect privacy, understand global privacy regimes, and engage in the ongoing privacy debate and prepare for future privacy concerns. Prerequisites: CDAE 1020, CDAE 1240, CDAE 1400, OR CDAE 1610. Cross-listed with: CDAE 2330.

CIS 2460. Digital Fabrication. 3 Credits.
Through hands-on experience students will practice with digital fabrication technologies (both hardware and software) that are popular with contemporary artists. Students will practice design iteration and rapid prototyping and experiment iwht art-making practices such as tessellation, 3D imaging, generative design, artificial life and interaction design. Prerequisites: ARTS 1010, ARTS 1011, ARTS 1014, ARTS 1100, or ARTS 1400; or Computer Science major or College of Engineering & Mathematical Science student; minimum Junior standing. Cross-listed with: ARTS 2620.

CIS 2990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CIS 2991. Internship. 1-18 Credits.
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.

CIS 2993. 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.

CIS 2994. 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.

CIS 2995. 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.

CIS 3990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CIS 3991. Internship. 1-18 Credits.
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.

CIS 3993. 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.

CIS 3994. 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.

CIS 3995. 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.

Computer Science Courses

CS 1060. Exploring Cybersecurity. 3 Credits.
Fundamental concepts and tools utilized by cybersecurity professionals to assess and detect software and network vulnerabilities; best practices in physical and data security through the use of appropriate risk management methodologies. No credit if taken after CS 2660 or CS 3660.

CS 1080. Intro to Web Site Dev. 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 in a team based final project. Catamount Core: QR.

CS 1210. Computer Programming I. 3 Credits.
Introduction to algorithmic problem solving and computer programming. Designed to provide a foundation for further studies in computer science. Catamount Core: QD, QR.

CS 1320. Puzzles, Games & Algorithms. 3 Credits.
Introductory computer science through exploration and analysis of mathematical puzzles and games, and the algorithms that handle them. Prerequisite: No credit if taken after CS 2100. Catamount Core: QD.

CS 1500. 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 2100. Co-requisite: CS 1210 or CS 2100.

CS 1640. 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 awarded for both CS 1640 and MATH 2055. Prerequisites: CS 1210 or CS 2100; MATH 1234 or MATH 1242. Catamount Core: QR.

CS 1870. Intro to Data Science. 3 Credits.
Basic techniques of data harvesting and cleaning; association rules, classification and clustering; analyze, manipulate, and visualize data using programming languages. Basic principles of probability and statistical modeling/inference to make meaning out of large datasets. Credit not awarded after STAT 3000 or greater. Cross-listed with: STAT 1870. Catamount Core: QD, QR.

CS 1990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles. Prerequisite: Instructor permission.

CS 1991. Internship. 1-3 Credits.
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 1993. 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 1994. Teaching Assistantship. 1-3 Credits.
Assist in instruction of undergraduate computer science courses under the direct supervision of a faculty member. Instructor permission required.

CS 2100. Intermediate Programming. 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: CS 1210 with a grade of C- or better. Catamount Core: QR.

CS 2210. Computer Organization. 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. Includes significant semester project. Cross-listed with: CMPE 2210. Prerequisite: CS 2100. Catamount Core: QR.

CS 2240. Data Struc & 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 2100 with a grade of C- or better; minimum Sophomore standing. Catamount Core: QR.

CS 2250. Computability& Complexity. 3 Credits.
Formal languages and expressiveness. Turing completeness and Church's Thesis. Decidability and tractability. Complexity classes and theory of NP completeness. Prerequisites: CS 1640 or MATH 2055. Co-requisite: CS 2240. Catamount Core: QR.

CS 2300. Advanced Programming. 3 Credits.
Builds 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 2240. Catamount Core: QR, WIL2.

CS 2450. Web Client Programming. 3 Credits.
Covers client side programming in the web browser. Explores the JavaScript programming language to include user actions in your web site, and work with the DOM (Document Object Model). Semester project. Prerequisites: CS 1080; CS 1210. Catamount Core: QR.

CS 2480. Database Design for Web. 3 Credits.
Design and implementation of a relational database model using SQL and PHP. Open ended final team based project, examples: ecommerce site, blogging site, members only site, learning site. Prerequisites: CS 1080, CS 1210. Catamount Core: QR.

CS 2500. Intro to Database Systems. 3 Credits.
Serves as a foundational course in modern database systems. Introduces the fundamental concepts and techniques of relational database management, data modeling, relational algebra, structured query language, database design and database management. Practical experience will be gained through a series of labs and projects. Credit not awarded after CS 3040 or CS 5040. Prerequisites: CS 1210; minimum Sophomore standing. Pre/Co-requisites: CS 1210; minimum Sophomore standing.

CS 2510. Intro Artificial Intelligence. 3 Credits.
An introduction to artificial intelligence including logic and rule-based approaches, heuristic search, A*, IDA*, minimax, alpha/beta pruning, expectiminimax, Markov models and MDPs, decision tree, ensemble learning / random forest, the neural model and simple multi-layer perceptrons. Other topics, if any may vary. Prerequisite: C- or better in CS 2240.

CS 2660. Cybersecurity Principles. 3 Credits.
Introduction to cybersecurity, fundamental security design principles, programming flaws, malicious code, web and database security, cryptography algorithms and hashing functions; overview of computer networks and common network threat vectors. Prerequisites: CS 2210 with a grade of C- or better. Catamount Core: QR.

CS 2670. Cybersecurity Defense. 3 Credits.
Cyber defense policy, privacy, ethics; network threat defense, intrusion detection systems, intro to penetration testing, OS security principles, system/network admin, cloud, mobile and IoT security; overview of security planning, management and incident response. Prerequisite: CS 2660 or CS 3660.

CS 2830. Embedded Programming in C. 2-3 Credits.
Fundamental exercises in C programming for embedded systems (e.g., Arduino platform) including variable types, pointers, memory allocation, input/output, etc. and demonstration of advanced knowledge of these embedded systems concepts (second credit); with embedded systems project (third credit). Prerequisites: CS 1210. Catamount Core: QR.

CS 2870. Basics of Data Science. 3 Credits.
Basic data science techniques, from import to cleaning to visualizing and modeling, using the R language. Machine learning methods include regression, classification and clustering algorithms. Programming methods include user-defined functions. Prerequisite: STAT 1110, STAT 1410, or STAT 2430. Cross-listed with: STAT 2870. Catamount Core: QR.

CS 2880. Inclusive Computing. 3 Credits.
Introduces the concept of identity and how it manifests in the broad field of computing. Provides theoretical foundation to understand biases in computing, covers a wide range of diversity, equity, and inclusive (DEI) challenges in computing, and discusses various DEI problems in real-world computing systems (e.g., algorithms, AI, data, design). Prerequisite: Minimum Sophomore standing. Pre/Co-requisite: CS 1080 or equivalent experience. Catamount Core: D2.

CS 2920. 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 2990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles. Prerequisite: Instructor permission.

CS 2991. Internship. 1-18 Credits.
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 2993. 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 2994. 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 2995. 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 3010. Operating Systems. 3 Credits.
Supervisory and control software for multiprogrammed computer systems. Processes, threads, synchronization, interprocess communication, scheduling, memory management, resource allocation, performance evaluation, secondary storage, case studies. Prerequisites: CS 2300 and CS 2210. Catamount Core: QR.

CS 3020. Compiler Construction. 3 Credits.
Covers the design and construction of compilers and translation of high-level programming languages to assembly language. Topics include code representation, register allocation, optimization, static analysis, mutable data, garbage collection, and compilation of higher-order language features. Prerequisites: CS 2240, CS 2250.

CS 3040. Database Systems. 3 Credits.
Techniques for processing very large collections of data. Secondary storage. Database design and management. Query languages and optimization. Database recovery. Credit not awarded for both CS 3040 and CS 5040. Prerequisite: CS 2240. Catamount Core: QR.

CS 3050. Software Engineering. 3 Credits.
Treatment of software engineering problems and principles, with a focus on iterative software development. A significant part of the course is devoted to two multi-week team projects. Prerequisite: CS 2300. Catamount Core: QR.

CS 3060. 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. Credit not awarded for both CS 3060 and CS 5060. Prerequisites: Junior standing and programming experience, or Instructor permission. Catamount Core: QR.

CS 3110. Data Privacy. 3 Credits.
Explores the research field of data privacy, including privacy attacks on anonymized data, and formal approaches like k-Anonymity and differential privacy. Applies the theory of data privacy to real problems in programming projects. Credit not awarded for both CS 3110 and CS 5110 Prerequisites: CS 2240, CS 2250.

CS 3120. Secure Distributed Computation. 3 Credits.
Techniques for secure computation involving multiple distributed parties, including applied cryptography, homomorphic encryption, secure multiparty computation, and zero-knowledge proof. Applications including Bitcoin and other blockchain systems, encrypted databases, federated learning, and computing on encrypted data. Credit not awarded for both CS 3120 and CS 5120. Prerequisites: CS 2240, CS 2250.

CS 3220. Computer Architecture. 3 Credits.
Architecture of computing systems. Control unit logic, input/output processors and devices, asynchronous processing, concurrency, parallelism, and memory hierarchies. Credit not awarded for both CS 3220 and CS 5220. Cross-listed with: CMPE 3220. Prerequisite: CMPE 2210 or CS 2210. Catamount Core: QR.

CS 3240. 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. Credit not awarded for both CS 3240 and CS 5240. Prerequisite: CS 2240. Pre/co-requisites: Recommended: CS 2250; STAT 2430, or STAT 2510. Catamount Core: QR.

CS 3250. Programming Languages. 3 Credits.
Principles of programming language design and fundamental implementation concepts. Syntax, semantics, and static analysis of programs. Provable properties of programming languages such as type safety. Prerequisites: CS 2240, CS 2250. Catamount Core: QR.

CS 3280. Human-Computer Interaction. 3 Credits.
Covers the foundational theories and methods in the interdisciplinary field of human-computer interaction, focuses on the human-centered design and evaluation of user interfaces for various computing systems, as well as introduces a wide range of topics in current human-computer interaction research. Prerequisites: Minimum Junior standing. Pre/Co-requisites: CS 1080 or equivalent experience; completion of WIL1. Catamount Core: WIL2.

CS 3540. Machine Learning. 3 Credits.
Introduction to machine learning algorithms, theory, and implementation, including supervised and unsupervised learning; topics typically include linear and logistic regression, learning theory, support vector machines, decision trees, backpropagation artificial neural networks, and an introduction to deep learning. Includes a team-based project. Credit not awarded for both CS 3540 and CS 5540. Prerequisites: STAT 2510 or STAT 5510; MATH 2522 or MATH 2544. Catamount Core: QR.

CS 3559. Cryptography. 3 Credits.
A survey of classical and modern cryptography. Topics include the strengths and weaknesses of various cryptosystems, specific public-key and private-key cryptosystems such as RSA, ElGamal, and elliptic curve cryptosystems, as well as digital signatures and key exchange. Prerequisites: MATH 2055 or CS 1640; MATH 2248, MATH 2522, or MATH 2544. Cross-listed with: MATH 3559.

CS 3650. Computer Networks. 3 Credits.
Introduction to the theoretical and pragmatic principles and practices of computer networking. Topics include: the Internet; wired and wireless communications protocols; network security protocols. Prerequisite: CS 2240. Cross-listed with: CMPE 3650. Catamount Core: QR.

CS 3660. Network Secrty&Cryptography. 3 Credits.
Security and secrecy in a networked environment. Cryptography: public and private key. Authentication: trusted agents, tickets. Electronic mail and digital signatures. Privacy and national security. Prerequisite: CS 2240. Catamount Core: QR.

CS 3737. Intro to Numerical Analysis. 3 Credits.
Error analysis, root-finding, interpolation, least squares, quadrature, linear equations, numerical solution of ordinary differential equations. Credit not awarded for both CS 3737 and CS 5737 or MATH 5737 Prerequisites: MATH 2248; MATH 2522, MATH 2544, or MATH 3201; CS 1210. Cross-listed with: MATH 3737.

CS 3750. Mobile App Development. 3 Credits.
A projects-based course focusing on software development for mobile devices, including the concepts of event-driven programming, GUI design and implementation, utilization of hardware sensors, and client/server applications. A significant part of the course is devoted to a multi-month team development project. Prerequisite: CS 2300, Senior standing. Pre/co-requisites: Recommended: CS 2480 or CS 3040. Catamount Core: QR.

CS 3870. Data Science I - Pinnacle. 3 Credits.
Data harvesting, cleaning, and summarizing; working with non-traditional, non-numeric data (social network, natural language textual data, etc.); scientific visualization; advanced data pipelines; Project-based. Credit not awarded for both CS 3870 and CS 5870. Prerequisites: CS 1210; STAT 1410 or STAT 2430; CS 2100 and MATH 2522 or MATH 2544 recommended. Cross-listed with: STAT 3870. Catamount Core: QR.

CS 3880. Statistical Learning. 3 Credits.
Statistical learning methods and applications to modern problems in science, industry, and society. Topics include: linear model selection, cross-validation, lasso and ridge regression, tree-based methods, bagging and boosting, support vector machines, and unsupervised learning. Prerequisites: STAT 3210 or equivalent. Cross-listed with: STAT 3880. Catamount Core: QR.

CS 3920. Senior Seminar. 1 Credit.
Oral presentations that pertain to the ethical practice of computer science in government, industry, and academia. Topics may include computer security, copyright, and patent law. Prerequisite: Senior standing in Computer Science.

CS 3930. Computing Career Preparation. 1 Credit.
Seminar to help students develop necessary skills for becoming computing professionals and exposes them to different computing careers. Topics include job search strategies, preparation for technical interviews, networking, and developing soft skills. Several guest lectures by computing professionals and alumni. Prerequisite: CS 2240.

CS 3990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles. Subject will vary from year to year. May be repeated for credit.

CS 3991. Internship. 1-18 Credits.
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 3993. 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 3994. 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 3995. 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 4990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

CS 4996. Undergraduate Honors Thesis. 1-6 Credits.
College honors thesis or other department/program honors, under the supervision of a faculty member. Offered at department discretion. See description of Honors Thesis Program in the College of EM section of this catalog.