Computer Science

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***D*escription of the Major.** Computers permeate every aspect of our society, and the science of computing is an exciting and rapidly changing field. The faculty designed the program at Westmont to teach students how to think computationally, which will give them the best preparation for careers in computer science. They will be equipped with valuable ideas and methods, such as:

Programming: Just like one can't build a cathedral without knowing how to lay bricks, we want our students to have a strong foundation in using multiple computer languages and platforms.

Algorithmic Thinking: Regardless of which computer language one is using, learning how to create efficient and effective algorithms, and analyze the algorithms of others, is a critical skill for our students.

Handling ambiguity: Because the real world rarely gives us easy or well-defined problems on which to work, we want our graduates to be able to function in an imprecise world using research, group work, critical thinking and creativity. The modern computing environment involves professionals from many fields working together as a team to solve problems. Success in such an environment requires the ability to analyze problems from many perspectives and communicate clearly with people from other backgrounds.

Inspired Thinking: We aren't just any other place to study, we want to train **faithful** computer scientists, who are called by Jesus Christ, and can articulate and identify to what ends computational systems are changing the world. Our society desperately needs the leadership and insight of individuals who are able to combine technical knowledge with inspired ethical and moral principles.

In this way, this major introduces students to computer science and develops the requisite technical skills for work in the field, further study, or research. By focusing on foundational concepts and ideas, students are prepared to grow and adapt as the field continues to change rapidly.

Set in the context of a liberal arts college, the computer science program at Westmont offers broad opportunities for exposure to problems and ideas from other disciplines. In recognition of the increasingly interdisciplinary contexts faced by computer professionals, students may complete a B.A. or B.S. degree in computer science with an interdisciplinary emphasis in another discipline such as art, biology, psychology, business, or engineering.

***D*istinctive features.** Students enjoy the benefits of working closely with faculty in a variety of settings. Students can gain deeper understanding and develop their ability to solve novel problems by participating in research with faculty, either during the summer or the

academic year. Research also brings the opportunity for students to develop valuable communication skills by co-authoring papers with faculty and presenting their results at conferences.

The computer science program maintains a strong sense of community through weekly events shared between students and faculty, annual department retreats, meals, and social events at faculty homes. Santa Barbara has earned the nickname "Silicon Beach" by being home to a number of high-tech companies; thus opening the way for student work and/or paid internships off-campus. Students can also engage in paid work for the department as teaching assistants or for the campus information technology department performing trouble-shooting and maintenance of campus networks and computers.

Career Choices. Opportunities for careers in computer science are both numerous and diverse, and a critical shortage of well-prepared professionals is predicted to exist for many years to come. Students who choose to further their studies in graduate school will be well prepared to do so. Students who wish to join the workforce immediately also have many opportunities. Computers have become ubiquitous and permeate every facet of our society. More and more careers are integrally related to computer science such as bioinformatics, cognitive science, digital media arts, neuroscience, artificial intelligence, computer graphics, management information systems, human-computer interaction, and intellectual property law. Essentially all fields and organizations welcome the talents of those properly trained in computer science. Computing on the mission field is also a growing area in which students will be able to make significant contributions.

Requirements for the Computer Science Major

Required Core: (36)~~(32 units)~~

MA 009 Calculus I (4)

CS 010 Design and Implementation of Solutions to Computational Problems (4)
CS 015 Discrete Mathematics (4)
CS 030 Abstract Models for Concrete Problems Using Java (4)
~~CS 105 Programming Languages (4)~~CS 116 Artificial Intelligence (4)
CS 120 Space, Time, and Perfect Algorithms (4)
CS 130 Creative Software Architectures for Collaborative Projects (4)
CS 144 Computer Organization and Hardware Architecture (4)
CS 195 Senior Seminar (4)

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In addition to the core courses, students must complete elective units to satisfy one of the following two tracks. Elective units may include a total of no more than 4 units from among CS 190 Internship, CS 192 Project, or CS 198 Research, of which 190 and 192 may contribute no more than 2 units each. Students complete one of the following two tracks:

B.A. in Computer Science ~~(44 units including core)~~(48 units including core)

Additional CS courses numbered CS 100 or above to bring the total to 44 units

B.S. in Computer Science ~~(56 units including core)~~(60 units including core)

Additional CS courses numbered CS 100 or above to bring the total to 56 units

Requirements for a Computer Science Minor: 20 units

CS 010 Design and Implementation of Solutions to Computational Problems (4)
CS/MA 015 Discrete Mathematics (4)
CS 030 Abstract Models for Concrete Problems Using Java (4)
~~CS 120 Space, Time, and Perfect Algorithms (4)~~

Courses from the following*:* for a minimum of 84 units
CS 105 Programming Languages (4)
CS 116 Artificial Intelligence (4)
CS 120 Space, Time, and Perfect Algorithms (4)

CS 125 Database Design (4)
CS 130 Creative Software Architectures for Collaborative Projects (4)
CS/MA 135 Formal Languages and Automata (4)
CS 140 Networks (4)
CS 144 Computer Organization and Hardware Architecture (4)
CS 150 Topics in Computer Science (4)

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Lower-Division Course Descriptions

CS 010 Design and Implementation of Solutions to Computational Problems (4) No prior computer or programming experience required. What are the general principles for designing solutions to problems? In particular, how can we employ such principles to implement computer programs that solve practical problems? This course covers the basics of programming including language features, disciplined programming style, and documentation, algorithm design, and the software development process. Discussion of ethical issues arising from the creation and use of computer programs. Note: a laptop is required for this course.

CS/MA 015 Discrete Mathematics (4) Prerequisite: Admissions Math Requirement. If calculus is analog, then discrete mathematics is digital; it is the study of things that you count, rather than things that you measure. Topics include logic (organizing thought), set theory (organizing objects), graph theory (representing relationships), combinatorics (clever ways of counting), and algorithms (analyzing processes). Students will learn how mathematicians prove theorems and how computer scientists solve problems.

CS 030 Abstract Models for Concrete Problems Using Java (4) Prerequisite: CS 010. This class introduces abstract data types (ADTs) and their implementations in Java. ADTs considered include: lists, stacks, queues, maps, trees and graphs. Sorting and searching algorithms. Big-O notation. Software testing and program verification. Discussion of ethical issues arising from the creation and use of computer programs. Note: a laptop is required for this course.

Upper-Division Course Descriptions

CS 105 Programming Languages (4) Prerequisite: CS 030. Language processors; data; binding time; operations; sequence control; referencing environments; scope of a variable; storage management; operating environment, syntax; translation.

CS 116 Artificial Intelligence (4) Prerequisite: MA 009 and CS 030. An introduction to the field of AI/ML, that includes topics such as computational and philosophical principles of intelligence, problem solving and search, game playing, knowledge representation and reasoning, methods for designing systems that learn from data and improve with experience, uncertainty and applications of such natural language processing and computer vision. Topics vary by instructor.

CS 120 Space, Time, and Perfect Algorithms (4) Prerequisite: MA 009, MA/CS 015, and CS 030. How fast is a fast algorithm? How do we determine if one algorithm is faster than another? How does the amount of memory used by an algorithm trade off against the time that algorithm takes? What is a perfect algorithm and how can we find one? These and other questions about the formal properties of algorithms and the classic data structures used by algorithms are the focus of this course.

CS/MA 121 Introduction to Numerical Analysis (4) Prerequisite: MA 010 or 10H, Recommended: CS 010. Numerical methods in the solution of equations; polynomial approximations; integration, and the solution of differential equations. Use of computer where applicable.

CS/MA 124 Codes and Encryption (4) Prerequisites: MA/CS 015 and/or MA 020. Modern applications of computing demand that the storage and transmission of data be secure and reliable. Cryptography is the study of techniques for protecting data from adversaries, while coding theory deals with representing data robustly in digital form. This course provides an introduction to these related fields. Topics include basic number theory and modern algebra, classical and modern cryptosystems, discrete logarithms, hash functions, digital signatures, elliptic curves, and error-correcting codes.

CS 125 Database Design (4) Prerequisite: CS 030. Database system architecture; relational and object-oriented databases, the Structure Query Language (SQL), normal forms and database design; query processing and optimization; handling transactions, concurrency control, crash recovery; data warehousing and data mining.

CS 128 Information Retrieval and Big Data (4) Prerequisites: CS 030. This course traces the development of Big Data from its origins in search engines through cloud computing. The role of economic interests, adversarial forces, and user interface design in the shaping of the technology is explored. Students learn web crawling, indexing, and search ranking techniques. Recent frameworks for creating large scale data warehouses and analysis engines are introduced.

CS 130 Creative Software Architectures for Collaborative Projects (4) Prerequisites: CS 030 and junior standing. When the scope of a software project exceeds a single programmer's capacity within a given time-frame, what sorts of skills and tools become necessary to support collaboration and coordination within teams? This course introduces students to the challenges of developing large-scale software artifacts. The approach taken involves the implementation of one or more large multi-person projects. Other topics include: software life-cycle, fundamental concepts of software design, modern language features, verification and validation techniques.

CS/MA 135 Formal Languages and Automata (4) Prerequisite: CS 015 or MA 015. In his early thirties, Alan Turing cracked the Enigma code, while establishing the theoretical foundation for what is computable, and what is not. He died tragically at the age of 41. This course explores what it means to compute, what features are necessary for a machine to compute, and the respective limits on what different machines can compute.

CS 140 Networks (4) Prerequisite: CS 144 or consent of instructor. Network technologies including packet switching, framing, local and wide area technologies, network addressing, repeaters, bridges, hubs, switches, topologies, next-hop forwarding, shortest path computation, delay and throughput, and protocol layers. Internetworking including IP, TCP, UDP, datagrams, routers, and protocol ports. Network applications including client-server paradigm, and domain name system. Web technologies and protocols including HTTP, CGI, and Java.

CS 144 Computer Organization and Hardware Architecture (4) Prerequisite: CS 010. Introduction to the hardware-software interface. Digital logic, data representation, computer arithmetic, software vs. hardware tradeoffs, instruction set architecture, addressing techniques, cache, virtual memory, and pipelining.

CS 150 Topics in Computer Science (4) Prerequisites: courses vary, or consent of instructor. Special courses offered on selected advanced topics in computer science. Content as announced. May be repeated for credit in a different topic.

CS 190 Internship (1-4) Prerequisite: CS 030. Field experience arranged in conjunction with the department and supervised by professional computer scientists. (By arrangement.)

CS 190SS, 191SS Computer Science Seminar for Service Learning Internship (1,0) Prerequisite: Consent of instructor. Students will spend one (CS-191SS) or three hours (CS-190SS) per week running after-school enrichment programs in mathematics or computer science in local elementary, junior high, or high schools. Students will also attend four hours of course meetings, read assigned material, and write a reflective paper on the experience. (By arrangement.)

CS 192 Project (1-4) Prerequisite: CS 130. Participation in a multi-person computer science project. (By arrangement.)

CS 195 Senior Seminar (4) Prerequisite: senior standing as a computer science major or minor. In this capstone class, students reflect on computer science as a discipline, the connections with other disciplines, the impacts of technology upon society, and ethical considerations introduced by computers. In the process of completing a major project, students consider marketing, design, implementation, testing, and maintenance. In this class, seniors complete and present their online portfolio. As the culmination of their program, students explore the transition to graduate school or the commercial sector.

CS 198 Research (1-4) Prerequisite: CS 030. Students will work closely with faculty on original research. (By arrangement.)

CS 199 Major Honors (4-6) In consultation with their faculty mentor the Major Honors candidate will develop and execute an advanced level independent research project, produce a fully documented research paper, and pass an oral examination on the research before a committee.