COMPUTER SCIENCE MAJOR

Program Director: Alan Sussman, Ph.D.

Computer science is the study of computers and computational systems: their application, design, development and theory. Principal areas within computer science include machine learning and data science, cybersecurity and privacy, human-computer interaction, artificial intelligence, programming languages, software engineering, computer systems and networking, algorithms and theory of computing, natural language processing, high-performance and quantum computing, databases systems, bioinformatics, robotics, computer vision, information visualization, and virtual- and augmented-reality systems. A computer scientist is concerned with problem solving. Problems range from abstract questions of what problems can be solved with computers to practical matters such as the design of computer systems that are efficient, secure, and easy for people to use.

Admission to the Major

The Computer Science major is a Limited Enrollment Program. Please see the admission requirements and procedures at http://lep.umd.edu.

Placement in Courses

Much of the knowledge at the early stage of the degree program is cumulative. To ensure that transfer and new students start with the appropriate courses, the department offers exemption exams for CMSC131, CMSC132, CMSC216, and CMSC250. Students who have taken CS courses prior to starting at Maryland can visit http://undergrad.cs.umd.edu/exemption-exams/ for more information.

Program Learning Outcomes

1. Graduates will be able to create, augment, debug, and test computer software. These skills will be built progressively through the courses in the introductory sequence and in some courses beyond that.
2. Graduates will develop mathematical and reasoning skills that are needed for computer science.
3. Graduates will be able to design and implement programming projects that are similar to those seen in the real world.
4. Graduates will gain skills in communication.
5. Academic Research (Optional): Graduates will be able to work independently on a project.

REQUIREMENTS

Much of the knowledge at the early stage of the degree program is cumulative. To ensure that transfer students start with the appropriate courses, the department offers exemption exams for CMSC131, CMSC132, CMSC216 and CMSC250. Students who have had CS courses prior to starting at Maryland are encouraged to schedule and take exemption exams.

A "C-" or better must be earned in all major requirements.

Course	Title	Credits
Required Lower Level Courses (Unless Exempt)		
MATH140	Calculus I (see your advisor)	4
MATH141	Calculus II	4
CMSC131	Object-Oriented Programming I [1]	4
CMSC132	Object-Oriented Programming II [1]	4
CMSC216	Introduction to Computer Systems [1]	4
CMSC250	Discrete Structures [1]	4
Additional Required Courses		
CMSC330	Organization of Programming Languages	3
CMSC351	Algorithms	3
STAT4xx [2]		3
MATH/AMSC/STAT xxx [2]		3-4
Upper Level Computer Science Courses [3]		
Select five 400 level courses from at least three of the following areas with no more than three courses in a given area:		15
Area 1: Systems		
CMSC411	Computer Systems Architecture	
CMSC412	Operating Systems	
CMSC414	Computer and Network Security	
CMSC416	Introduction to Parallel Computing	
CMSC417	Computer Networks	
Area 2: Information Processing		
CMSC420	Advanced Data Structures	
CMSC421	Introduction to Artificial Intelligence	
CMSC422	Introduction to Machine Learning	
CMSC423	Bioinformatic Algorithms, Databases, and Tools	
CMSC424	Database Design	
CMSC426	Computer Vision	
CMSC427	Computer Graphics	
CMSC470	Introduction to Natural Language Processing	
CMSC471	Introduction to Data Visualization	
CMSC472	Introduction to Deep Learning	
Area 3: Software Engineering and Programming Languages		
CMSC430	Introduction to Compilers	
CMSC433	Programming Language Technologies and Paradigms	
CMSC434	Introduction to Human-Computer Interaction	
CMSC435	Software Engineering	
CMSC436	Programming Handheld Systems	
CMSC471	Introduction to Data Visualization	
Area 4: Theory		
CMSC451	Design and Analysis of Computer Algorithms	
CMSC452	Elementary Theory of Computation	
CMSC454	Algorithms for Data Science	
CMSC456	Cryptography	
CMSC457	Introduction to Quantum Computing	
CMSC474	Introduction to Computational Game Theory	
Area 5: Numerical Analysis		
CMSC460	Computational Methods [4]	
or CMSC466	Introduction to Numerical Analysis I	
Upper Level Concentration Requirement [5]		
Select at least 12 credits of 300-400 level courses from one discipline outside of CMSC		12
Total Credits		**63-64**

Students also have the option to complete the Cybersecurity Specialization **(**p. 2**),** Data Science Specialization **(**p. 2**),**

Machine Learning Specialization (p. 2)**, or** Quantum Information Specialization (p. 3)

1 Students may fulfill CMSC131, CMSC132, CMSC216 or CMSC250 course requirements by passing proficiency exams before they start the sequence of classes.
2 This course must have prerequisite of MATH141 or higher; cannot be cross-listed with CMSC.
3 At the upper level, students take five (5) 400 level courses from at least three different areas with no more than three courses in a given area. An additional two (2) electives, totaling 6 credits, for the general computer science degree are also required. If students take more than three courses from an area, they will be counted as electives. Students can count one credit winter courses towards the elective requirement, as well as independent research or study with a faculty member, and other courses at the 300 or 400 level.
4 Credit will only be given for CMSC460 or CMSC466.
5 Students must also take at least 12 credits of 300-400 level courses from one discipline outside of CMSC. No course in or cross-listed with CMSC can be counted. An overall 2.0 average must be earned in these courses. Each course must be a minimum of 3 credits. Only 1 special topics or independent study course may be used.

Cybersecurity Specialization

Students looking to pursue the cybersecurity specialization are required to complete the lower level courses (MATH140, MATH141, CMSC131, CMSC132, CMSC216, CMSC250), the additional required courses (CMSC330, CMSC351, MATH/STATXXX and STAT4xx beyond MATH141), and the upper level concentration requirements as detailed above. The difference in the specialization is the upper level computer science courses. Students must fulfill their computer science upper level course requirements from at least 3 areas.[1]

Students are required to take:

Course	Title	Credits
CMSC414	Computer and Network Security	3
CMSC456	Cryptography	3
Students must choose four courses from:		12-13
CMSC411	Computer Systems Architecture	
CMSC412	Operating Systems	
CMSC417	Computer Networks	
CMSC430	Introduction to Compilers	
CMSC433	Programming Language Technologies and Paradigms	
CMSC451	Design and Analysis of Computer Algorithms	
Upper Level Elective Courses: three credits from CMSC3XX or CMSC4XX excluding CMSC330 and CMSC351 [1]		3
Total Credits		**21-22**

1 Students may fulfill an area requirement under the Upper Level Elective Courses requirement. Courses that fall within each area are listed in the General Track degree requirements. The five areas are: Area 1: Systems, Area 2: Information Processing, Area 3: Software Engineering and Programming Languages, Area 4: Theory, and Area 5: Numerical Analysis.

Data Science Specialization

Students looking to pursue the data science specialization are required to complete the lower level courses (MATH140, MATH141, CMSC131, CMSC132, CMSC216, CMSC250), the additional required courses (CMSC330, CMSC351, STAT400 and MATH240), and the upper level concentration requirements as detailed above. The difference in the specialization is the upper level computer science courses. Students must fulfill their computer science upper level course requirements from at least 3 areas.[1]

Students are required to take:

Course	Title	Credits
CMSC320	Introduction to Data Science	3
CMSC422	Introduction to Machine Learning	3
CMSC424	Database Design	3
Select one of the following:		3
CMSC420	Advanced Data Structures	
CMSC421	Introduction to Artificial Intelligence	
CMSC423	Bioinformatic Algorithms, Databases, and Tools	
CMSC425	Game Programming	
CMSC426	Computer Vision	
CMSC427	Computer Graphics	
CMSC470	Introduction to Natural Language Processing	
Select one of the following:		
CMSC451	Design and Analysis of Computer Algorithms	
CMSC454	Algorithms for Data Science	
CMSC460	Computational Methods	
Select two of the following:		6-7
CMSC411	Computer Systems Architecture	
CMSC412	Operating Systems	
CMSC414	Computer and Network Security	
CMSC417	Computer Networks	
CMSC430	Introduction to Compilers	
CMSC433	Programming Language Technologies and Paradigms	
CMSC434	Introduction to Human-Computer Interaction	
CMSC435	Software Engineering	
Total Credits		**18-19**

1 Courses that fall within each area are listed in the General Track degree requirements. The five areas are: Area 1: Systems, Area 2: Information Processing, Area 3: Software Engineering and Programming Languages, Area 4: Theory, and Area 5: Numerical Analysis.

Machine Learning Specialization

Students looking to pursue the machine learning specialization are required to complete the lower level courses (MATH140, MATH141, CMSC131, CMSC132, CMSC216, CMSC250), the additional required courses (CMSC330, CMSC351, STAT4xx beyond MATH141, and MATH240), and the upper level concentration requirements as detailed above. The difference in the specialization is the upper level computer science courses. Students must fulfill their computer science upper level course requirements from at least 3 areas.[1]

Students are required to take:

Course	Title	Credits
CMSC320	Introduction to Data Science	3
CMSC421	Introduction to Artificial Intelligence	3
CMSC422	Introduction to Machine Learning	3
Select two of the following:		6
CMSC426	Computer Vision	
CMSC/AMSC460	Computational Methods	
or CMSC/AMSC466	Introduction to Numerical Analysis I	
or MATH401	Applications of Linear Algebra	
CMSC470	Introduction to Natural Language Processing	
CMSC472	Introduction to Deep Learning	
CMSC473	Capstone in Machine Learning	
CMSC474	Introduction to Computational Game Theory	
CMSC476		
Upper Level Elective Courses: six credits from CMSC3XX or CMSC4XX excluding CMSC330 and CMSC351 [1]		6
Total Credits		**21**

[1] Students may fulfill an area requirement under the Upper Level Elective Courses requirement. Courses that fall within each area are listed in the General Track degree requirements. The five areas are: Area 1: Systems, Area 2: Information Processing, Area 3: Software Engineering and Programming Languages, Area 4: Theory, and Area 5: Numerical Analysis.

Quantum Information Specialization

Students looking to pursue the quantum information specialization are required to complete the lower level courses (MATH140, MATH141, CMSC131, CMSC132, CMSC216, CMSC250), the additional required courses (CMSC330, CMSC351, STAT4xx beyond MATH141, and MATH240), and the upper level concentration requirements as detailed above. The difference in the specialization is the upper level computer science courses. Students must fulfill their computer science upper level course requirements from at least 3 areas.[1]

Students are required to take:

Course	Title	Credits
CMSC457	Introduction to Quantum Computing	3
PHYS467	Introduction to Quantum Technology	3
Select four 400 level courses from at least two of the following areas (excluding Area 4: Theory) with no more than three courses in a given area:		**12-13**
Area 1: Systems		
CMSC411	Computer Systems Architecture	
CMSC412	Operating Systems	
CMSC414	Computer and Network Security	
CMSC416	Introduction to Parallel Computing	
CMSC417	Computer Networks	
Area 2: Information Processing		
CMSC420	Advanced Data Structures	
CMSC421	Introduction to Artificial Intelligence	
CMSC422	Introduction to Machine Learning	
CMSC423	Bioinformatic Algorithms, Databases, and Tools	
CMSC424	Database Design	
CMSC426	Computer Vision	
CMSC427	Computer Graphics	
CMSC470	Introduction to Natural Language Processing	
Area 3: Software Engineering and Programming Languages		
CMSC430	Introduction to Compilers	
CMSC433	Programming Language Technologies and Paradigms	
CMSC434	Introduction to Human-Computer Interaction	
CMSC435	Software Engineering	
CMSC436	Programming Handheld Systems	
Area 4: Theory		
CMSC451	Design and Analysis of Computer Algorithms	
CMSC452	Elementary Theory of Computation	
CMSC456	Cryptography	
Area 5: Numerical Analysis		
CMSC460	Computational Methods	
or CMSC466	Introduction to Numerical Analysis I	
Upper Level Elective Courses: three credits from CMSC3XX or CMSC4XX excluding CMSC330 and CMSC351		**3**
Total Credits		**21-22**

[1] Students may fulfill an area requirement under the Upper Level Elective Courses requirement. Courses that fall within each area are listed in the General Track degree requirements. The five areas are: Area 1: Systems, Area 2: Information Processing, Area 3: Software Engineering and Programming Languages, Area 4: Theory, and Area 5: Numerical Analysis.

GRADUATION PLANS

Click here (https://cmns.umd.edu/undergraduate/advising-academic-planning/academic-planning/four-year-plans/four-year-plans-gened/) for roadmaps for graduation plans in the College of Computer, Mathematical, and Natural Sciences.

Additional information on developing a graduation plan can be found on the following pages:

- http://4yearplans.umd.edu
- the Student Academic Success-Degree Completion Policy (https://academiccatalog.umd.edu/undergraduate/registration-academic-requirements-regulations/academic-advising/#success) section of this catalog