

# Computer Science

Department Website: <https://www.cs.uchicago.edu>

## Program of Study

The computer science program prepares students for careers in computer science by offering BA and BS degrees, as well as combined BA/MS and BS/MS degrees. Students who earn the BA are prepared either for graduate study in computer science or a career in industry. Students who earn the BS degree build strength in an additional field by following an approved course of study in a related area. The department also offers a minor. Furthermore, a computer science major or minor serves as an excellent foundation for work in other areas, including but not limited to mathematics, the natural sciences, social sciences, public administration, and the arts.

## Program Requirements

Both the BA and BS in computer science require fulfillment of the mathematical sciences requirement in general education by completing an approved two-quarter calculus sequence. The physical sciences requirement in general education must be satisfied by completing an approved two-quarter sequence in either chemistry or physics. Both BA and BS students take at least fourteen computer science courses chosen from an approved program. BS students also take three courses in an approved related field outside computer science.

## Approved Programs

The computer science department counselor is responsible for approval of specific courses and sequences, and responds as needed to changing course offerings in our program and other programs. Students should consult the department counselor for details on specific courses they are considering taking to meet the requirements.

## Approved Computer Science Program

There is one approved general program for both the BA and BS degrees, comprised of introductory courses, a sequence in Theory, and a sequence in Programming Languages and Systems, followed by advanced electives. Students may substitute upper-level or graduate courses in similar topics for those on the list that follows with the approval of the department counselor. Students who matriculated prior to Autumn 2016 may choose to follow these requirements; otherwise they should consult the archived catalog from their year of matriculation for the degree requirements in computer science. All students who matriculated in Autumn 2016 or later should follow this program.

The course information in this catalog, with respect to who is teaching which course and in which quarter(s), is subject to change during the academic year. For up-to-date information on our course offerings, please consult <http://course-info.cs.uchicago.edu>.

Students considering a computer science major are strongly advised to register for an introductory sequence, starting either with CMSC 15100 or CMSC 16100, in their first year. Incoming students should note that while CMSC 12100 can be used as the first course in the major, it is not open to first-year students, and it is not intended as an entry point for students who already know they want to major in computer science. Students who decide to pursue a computer science major or minor after completing CMSC 12100 may continue with either CMSC 15200-15400 or CMSC 12200-12300-15400. Note that CMSC 12200 does not meet the prerequisites for CMSC 15400.

### 1. Introductory Sequence (three courses required):

CMSC 15100	Introduction to Computer Science I	100
or CMSC 16100	Honors Introduction to Computer Science I	
or CMSC 12100	Computer Science with Applications I	
CMSC 15200	Introduction to Computer Science II	100
or CMSC 16200	Honors Introduction to Computer Science II	
CMSC 15400	Introduction to Computer Systems	100

Students may only receive credit for one introductory programming sequence: CMSC 10500-10600 Fundamentals of Computer Programming I-II, CMSC 12100-12200 Computer Science with Applications I-II, CMSC 15100-15200 Introduction to Computer Science I-II, or CMSC 16100-16200 Honors Introduction to Computer Science I-II. Exceptions must be approved by the department counselor prior to taking the second sequence.

Students may count only one of CMSC 12100 Computer Science with Applications I, CMSC 15100 Introduction to Computer Science I, and CMSC 16100 Honors Introduction to Computer Science I towards the 4200 units of credit required for graduation. The same is true for CMSC 12200 Computer Science with Applications II, CMSC 15200 Introduction to Computer Science II, and CMSC 16200 Honors Introduction to Computer Science II. Additionally, students who have taken CMSC 15200 or 16200 may not register for CMSC 12100.

### 2. Programming Languages and Systems Sequence (three courses required):

Three of the following:

CMSC 22001	Software Construction
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CMSC 22100	Programming Languages
CMSC 22200	Computer Architecture
CMSC 22300	Functional Programming
CMSC 22600	Compilers for Computer Languages
CMSC 23000	Operating Systems
CMSC 23010	Parallel Computing
CMSC 23200	Introduction to Computer Security
CMSC 23300	Networks and Distributed Systems
CMSC 23310	Advanced Distributed Systems
CMSC 23400	Mobile Computing
CMSC 23500	Introduction to Database Systems
CMSC 23700	Introduction to Computer Graphics
CMSC 23710	Scientific Visualization
CMSC 23800	Game Construction

### 3. Theory Sequence (three courses required):

Three of the following:

CMSC 27100	Discrete Mathematics
or CMSC 27130	Honors Discrete Mathematics
CMSC 27200	Theory of Algorithms
or CMSC 27230	Honors Theory of Algorithms
CMSC 28000	Introduction to Formal Languages
or CMSC 28100	Introduction to Complexity Theory

The graduate versions of Discrete Mathematics and/or Theory of Algorithms can be substituted for their undergraduate counterparts. We strongly encourage all majors to complete their theory courses by the end of their third year.

### 4. Electives (five courses required):

The major requires five additional elective Computer Science courses numbered 20000 or above. Students may enroll in CMSC 29700 Reading and Research in Computer Science and CMSC 29900 Bachelor's Thesis for multiple quarters, but only one of each may be counted as a major elective.

### Summary of Requirements\*\*

#### GENERAL EDUCATION

MATH 13100-13200	Elementary Functions and Calculus I-II (or higher) *	200
One of the following sequences:		200
CHEM 10100 & CHEM 10200	Introductory General Chemistry I and Introductory General Chemistry II (or higher or equivalent) *	
PHYS 13100-13200	Mechanics; Electricity and Magnetism (or higher) §	
Total Units		400

\* Credit may be granted by examination.

§ Students with AP credit for PHYS 12100-12200 may use that to satisfy the general education requirement for the Physical Sciences. However, if a student is fulfilling this requirement through course enrollments, only PHYS 13100-13200 (or higher) will be accepted.

#### MAJOR

Introductory Sequence:		300
CMSC 15100	Introduction to Computer Science I	
or CMSC 16100	Honors Introduction to Computer Science I	
or CMSC 12100	Computer Science with Applications I	
CMSC 15200	Introduction to Computer Science II	
or CMSC 16200	Honors Introduction to Computer Science II	
CMSC 15400	Introduction to Computer Systems	
Programming Languages and Systems Sequence (three courses from the list above)		300
Theory Sequence (three courses from the list above)		300
Five electives numbered CMSC 20000 or above §		500

Plus the following requirements:	0-300
BA (no other courses required)	
BS (three courses in an approved program in a related field)	
Total Units	1400-1700

\*\* Students who matriculated prior to Autumn 2016 may choose to follow these requirements; otherwise they should consult the archived catalog from their year of matriculation for the degree requirements in computer science. All students who matriculated in Autumn 2016 or later should follow this program.

§ While a student may enroll in CMSC 29700 or CMSC 29900 for multiple quarters, only one instance of each may be counted toward the major.

### Grading

Computer science majors must take courses in the major for quality grades. A grade of C- or higher must be received in each course in the major. Any 20000-level computer science course taken as an elective beyond requirements for the major may, with consent of instructor, be taken for P/F grading.

Non-majors may take courses either for quality grades or, subject to College regulations and with consent of instructor, for P/F grading. A Pass grade is given only for work of C- quality or higher. Courses fulfilling general education requirements must be taken for quality grades.

Incompletes are typically given in the Department of Computer Science only to students who have done at least 60 percent of the course's work of a passing quality and who are unable to complete all course work by the end of the quarter. Other restrictions on Incompletes are the province of individual instructors, many of whom do not permit Incompletes. To receive an Incomplete, students must make arrangements in advance with the instructor; a consent form to be signed by the instructor is available from the College adviser.

### Honors

Students can earn a BA or BS degree with honors by attaining a grade of B or higher in all courses in the major and a grade of B or higher in three approved graduate computer science courses (30000-level and above). These courses may be courses taken for the major or as electives.

Students may also earn a BA or BS degree with honors by attaining the same minimum B grade in all courses in the major and by writing a successful bachelor's thesis as part of CMSC 29900 Bachelor's Thesis. This thesis must be based on an approved research project that is directed by a faculty member and approved by the department counselor.

### Recommended Introductory Sequences in Computer Science

The Department of Computer Science offers different introductory pathways into the program. In consultation with their College adviser and the Computer Science Department advisers, students should choose their introductory courses carefully. Some guidelines follow.

- Students interested in a technical introduction to computer science, without assuming prior experience or unusually strong preparation in mathematics, are encouraged to take CMSC 15100-15200 Introduction to Computer Science I-II.
- Students with programming experience and strong preparation in mathematics should consider CMSC 16100-16200 Honors Introduction to Computer Science I-II.
- Students majoring in quantitative fields other than computer science, including other sciences, mathematics, and economics, should consider CMSC 12100-12200 Computer Science with Applications I-II, possibly followed by CMSC 12300 Computer Science with Applications III.
- Students in the humanities and social sciences may consider CMSC 11000 Multimedia Programming as an Interdisciplinary Art I.
- Students interested in only one or two quarters of study should consider CMSC 12100-12200 Computer Science with Applications I-II. For students intending to pursue advanced study, we recommend CMSC 15100 Introduction to Computer Science I or CMSC 16100 Honors Introduction to Computer Science I as the first course.
- Students who are interested in web design should take CMSC 10100 Introduction to Programming for the World Wide Web I.
- Students may only receive credit for one introductory programming sequence: CMSC 12100-12200 Computer Science with Applications I-II, CMSC 15100-15200 Introduction to Computer Science I-II, or CMSC 16100-16200 Honors Introduction to Computer Science I-II. Exceptions must be approved by the department counselor *prior to taking the second sequence*.
- Students who have credit for any of the following courses (or equivalent) may not take CMSC 10200 Introduction to Programming for the World Wide Web II for credit: CMSC 10600 Fundamentals of Computer Programming II, CMSC 12100 Computer Science with Applications I, CMSC 15200 Introduction to Computer Science II, or CMSC 16200 Honors Introduction to Computer Science II.

Please be aware that course information is volatile, and the catalog does not necessarily reflect the latest changes. Students should consult <http://course-info.cs.uchicago.edu> for up-to-date information.

### Minor Program in Computer Science

The minor in computer science requires seven courses. The introductory sequence of three courses is followed by four approved upper-level courses. Courses in the minor must be taken for quality grades, with a grade of C- or higher in each course. Students may not use AP credit for computer science to meet requirements for the minor.

No courses in the minor can be double counted with the student's major(s) or with other minors; nor can they be counted toward general education requirements. More than half of the requirements for the minor must be met by registering for courses bearing University of Chicago course numbers. The minor advisor must approve the student's minor consent form and the student must submit that form to their College adviser by the end of Spring Quarter of their third year.

### Introductory Courses

Students must choose three courses from the following (one course each from Areas A, B, and C). Please note that not all possible pathways through these courses are valid; for example, CMSC 15200 is not a prerequisite for CMSC 12300. Please consult the prerequisite information below and/or talk to the minor advisor to discuss viable plans.

Area A:		100
CMSC 12100	Computer Science with Applications I	
CMSC 15100	Introduction to Computer Science I	
CMSC 16100	Honors Introduction to Computer Science I	
Area B:		100
CMSC 12200	Computer Science with Applications II	
CMSC 15200	Introduction to Computer Science II	
CMSC 16200	Honors Introduction to Computer Science II	
Area C:		100
CMSC 12300	Computer Science with Applications III	
CMSC 15400	Introduction to Computer Systems	

### Upper-Level Courses

The computer science minor must include four courses chosen from among all 20000-level CMSC courses and above. CMSC 12300 may be used as an elective if a student has used CMSC 15400 as the Area C introductory course. A 20000-level course must replace each 10000-level course in the list above that was used to meet general education requirements.

### Joint BA/MS or BS/MS Program

Outstanding undergraduates may apply to complete an MS in computer science along with a BA or BS (generalized to "Bx") during their four years at the College. Students must be admitted to the joint MS program. There are three different paths to a Bx/MS: a research-oriented program for computer science majors (Option 1 below), a professionally oriented program for computer science majors (Option 2), and a professionally oriented program for non-majors (Option 3).

Participants in the Bx/MS program must meet the requirements for the BA or BS and complete nine courses for the MS, and, if applicable, a master's project. Students may double-count up to two courses towards both their Bx and MS degrees. By the conclusion of their third year, students must have completed 3900 of the 4200 units of credit required by the College, including all general education requirements.

See [www.cs.uchicago.edu/page/department-computer-science-bxms-program-admissions-requirements](http://www.cs.uchicago.edu/page/department-computer-science-bxms-program-admissions-requirements) for details about the Bx/MS application process.

To be considered for the program, students need to have earned a 3.5 GPA and have completed one of the following:

- one of CMSC 12100, CMSC 15100, or CMSC 16100 and one of CMSC 12200, CMSC 15200, or CMSC 16200 with at least a B+ average in the two, or
- one of CMSC 12100, CMSC 15100, or CMSC 16100 and one of CMSC 27100, CMSC 27130, or CMSC 37110 with at least a B+ average in the two.

The detailed requirements of the three program options follow.

### Bx/MS Option 1: Research-Oriented Computer Science Majors

Option 1 is designed for computer science majors who are interested in research. Students pursuing a Bx with a computer science major currently have to take at least fourteen courses chosen from an approved program, while obtaining an MS requires nine courses. The research-oriented option requires students to take a total of twenty-one courses: twelve that count only towards the Bx degree, seven that count only towards the MS, and two that count towards both the Bx and MS degrees.

The nine courses required for the MS degree under Option 1 are as follows: Discrete Mathematics (CMSC 27100, CMSC 27130, or CMSC 37100); Algorithms (CMSC 27200, CMSC 27230, or CMSC 37000); one systems core course ([course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms)); Machine Learning (CMSC 25400, CMSC 35400, or TTIC 31020); Research Practicum (Autumn); Research Practicum (Winter); and three electives. A current list of approved Option 1 electives is available at [course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms).

At most two courses can be drawn from the CMSC 20000-level course list, and at most two courses can be counted towards a student's computer science major and MS degree. Option 1 students are expected to take their electives from the Computer Science Department's CMSC 30000-level offerings and selected TTIC (Toyota Technological Institute at Chicago) offerings.

Option 1 requires the completion of a master's project, as well as an accompanying written report and a public presentation. Master's projects must be overseen by a faculty member and evaluated by a committee of three faculty members, including the student's project advisor.

#### **Bx/MS Option 2: Professionally Oriented Computer Science Majors**

Option 2 is designed for computer science majors who are seeking the opportunity to build upon their foundational skills and take some industry-oriented electives. As with Option 1, computer science majors who are pursuing a joint Bx/MS are required to take a total of twenty-one courses: twelve that count only towards the Bx degree, seven that count only towards the MS, and two that count towards both the Bx and MS degrees.

The nine courses required for the MS degree under Option 2 are as follows: Discrete Mathematics (CMSC 27100, CMSC 27130, or CMSC 37100); Algorithms (CMSC 27200, CMSC 27230, or CMSC 37000); two systems core courses ([course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms)); and five electives. A current list of approved Option 2 electives is available at [course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms).

At most two courses can be drawn from the CMSC 20000-level offerings, and at most two courses can be counted towards both a student's computer science major and MS degree.

Option 2 allows students to take electives from the Computer Science Department's CMSC 30000-level and MPCS 50000-level offerings and selected TTIC offerings (see [course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms)). With prior approval, Option 2 also allows one course from a graduate program outside of the Computer Science Department.

#### **Bx/MS Option 3: Professionally Oriented Non-Computer Science Majors**

Option 3 is designed for students who are not computer science majors and wish to combine a professionally oriented MS in computer science with their undergraduate major.

Students in this option are expected to complete nine courses, two of which can be also counted towards a student's BA or BS; students wishing to use these courses in their undergraduate major *must obtain approval from their director of undergraduate studies*.

The nine courses required for the MS degree under Option 3 are as follows: Discrete Mathematics (CMSC 27100, CMSC 27130, CMSC 37100, or MPCS 50103) or Core Programming (MPCS 51036, MPCS 51040, or MPCS 51100); Algorithms (CMSC 27200, CMSC 27230, CMSC 37000, or MPCS 55001); three systems core courses ([course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms)); and four electives. A current list of approved Option 3 electives is available at [course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms).

At most two courses can be drawn from the department's CMSC 20000-level offerings.

Option 3 allows students to take electives from the Computer Science Department's CMSC 20000-level, CMSC 30000-level, and MPCS 50000-level offerings and selected TTIC offerings (see [course-info.cs.uchicago.edu/bxms](http://course-info.cs.uchicago.edu/bxms)). With prior approval, Option 3 also allows one course from a graduate program outside of the Computer Science Department.

#### **Graduate Courses**

Graduate courses and seminars offered by the Department of Computer Science are open to College students with consent of instructor and department counselor. For more information, consult the department counselor.





### Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Trajan.

Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.