



MARQUETTE  
UNIVERSITY

HELEN WAY KLINGLER  
COLLEGE OF ARTS AND SCIENCES

**Handbook**  
for  
*Computer Science  
Majors*  
*2018-2019*

*Department of Mathematics, Statistics and Computer Science*



## INTRODUCTION

The Department seeks to provide each of its majors with a broad understanding of computer science. This broad understanding serves as a coherent framework in which the student can place his or her developing knowledge and technical skill. Moreover, the Department seeks to provide each student with a solid foundation in the central ideas and methods of modern computer science. It seeks to produce computer scientists who know, understand, and can apply these central ideas and methods to real problems.

Computer science is dynamic. It grows constantly. It evolves continuously. It regularly experiences revolutionary transformation. The Department seeks, therefore, to produce computer scientists who can adapt and grow along with their chosen profession.

The Department does not seek to train its majors in any particular hardware device, software product or conceptual methodology. Rather, the goal is to provide its majors with the power to succeed in today's computer environment as well as tomorrow's. Students will, however, acquire ample specific knowledge during their education.

## PROGRAM EDUCATIONAL OBJECTIVES

Within a few years of graduation, we expect alumni of our program to be applying the skills, knowledge and values they have learned at Marquette University to solve problems and to effect positive changes in a complex world. Specifically, our graduates are:

1. Working to solve meaningful problems in computing, technology, and other fields, as employees in industry or government, students seeking advanced degrees, or merely as engaged citizens;
2. Communicating and collaborating effectively with colleagues, clients and those in other fields;
3. Pursuing excellence and continued learning as a lifelong endeavor, especially in the computing realm; and
4. Growing into ethical and informed leaders and role-models in their profession and in their community.

## ADVISING and PRE-REGISTRATION

A student planning to complete a major in computer science should enroll in COSC 1010<sup>1</sup> and MATH 1450<sup>2</sup> in the first semester of his or her freshman year and in COSC 1020 and MATH 1451<sup>3</sup> in the second semester. As soon as he or she has decided to major in the Department, the student should report to the Department office (room #340 of Cudahy Hall) to declare a major and to be assigned a departmental advisor. From this

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<sup>1</sup> Upon request, 4 credits for COSC 1010 will be awarded to those students who scored a 4 or 5 on their Advanced Placement (AP) Computer Science A test.

<sup>2</sup> Upon request, 4 credits for MATH 1450 will be awarded to those students who scored a 4 or 5 on their Advanced Placement (AP) Calculus AB test or who scored a 3, 4, or 5 on their AP Calculus BC test.

<sup>3</sup> Upon request, 4 credits for MATH 1451 will be awarded to those students who scored a 4 or 5 on their AP Calculus BC test.

time on the student meets with the advisor to discuss course selections for the next semester and general academic progress.

## STUDENT LEARNING OUTCOMES

Upon completion of all required coursework, Computer Science majors will be able to:

1. Construct software systems that satisfy users' computing needs.
2. Communicate technical ideas clearly to colleagues and clients.
3. Learn independently to use emerging technologies and computing concepts.
4. Identify matters of personal and professional ethics within typical computing scenarios.
5. Verify the correctness and efficiency of an algorithm, program, and/or system implementation.

## REQUIREMENTS FOR THE COMPUTER SCIENCE MAJOR

### REQUIRED COURSES

All students must take the following nine courses:

COSC 1010	Introduction to Computer Programming	4 sem. hrs.
COSC 1020	Object-Oriented Software Design	4 sem. hrs.
COSC 2100	Data Structures & Algorithms 1	3 sem. hrs.
COSC 2200	Hardware Systems	3 sem. hrs.
COSC 3100	Data Structures and Algorithms 2	3 sem. hrs.
COSC 3250	Operating Systems	3 sem. hrs.
COSC 3410	Programming Languages	3 sem. hrs.
COSC 4920	Principles of Design	3 sem. hrs.
COSC 4998	Senior Design Project	3 sem. hrs.

### COGNATE REQUIREMENTS

MATH 1450	Calculus 1	4 sem. hrs.
MATH 1451	Calculus 2	4 sem. hrs.
MATH 2100	Discrete Mathematics	3 sem. hrs.
MATH 3100	Linear Algebra and Matrix Theory	3 sem. hrs.

### ELECTIVES

To complete the major, 13 additional semester hours of Math and Science cognate electives are required, including at least:

- one Natural Science elective with **Laboratory** component (BIOL, CHEM or PHYS) 3-4 sem. hrs.
- one Upper-division (3000- or 4000-level) MATH elective 3 sem. hrs.

Courses that satisfy the Laboratory Science requirement are normally 4 credit-hours, and include CHEM 1001, 1002, 1013, and 1014; PHYS 1001, 1002, 1003 and 1004. These departments may also offer laboratory-only sections for students that have completed Advanced Placement Chemistry or Physics in high school. Many 3-credit BIOL courses also satisfy the Laboratory Science requirement, but these generally require prerequisite courses in Biology or Chemistry.

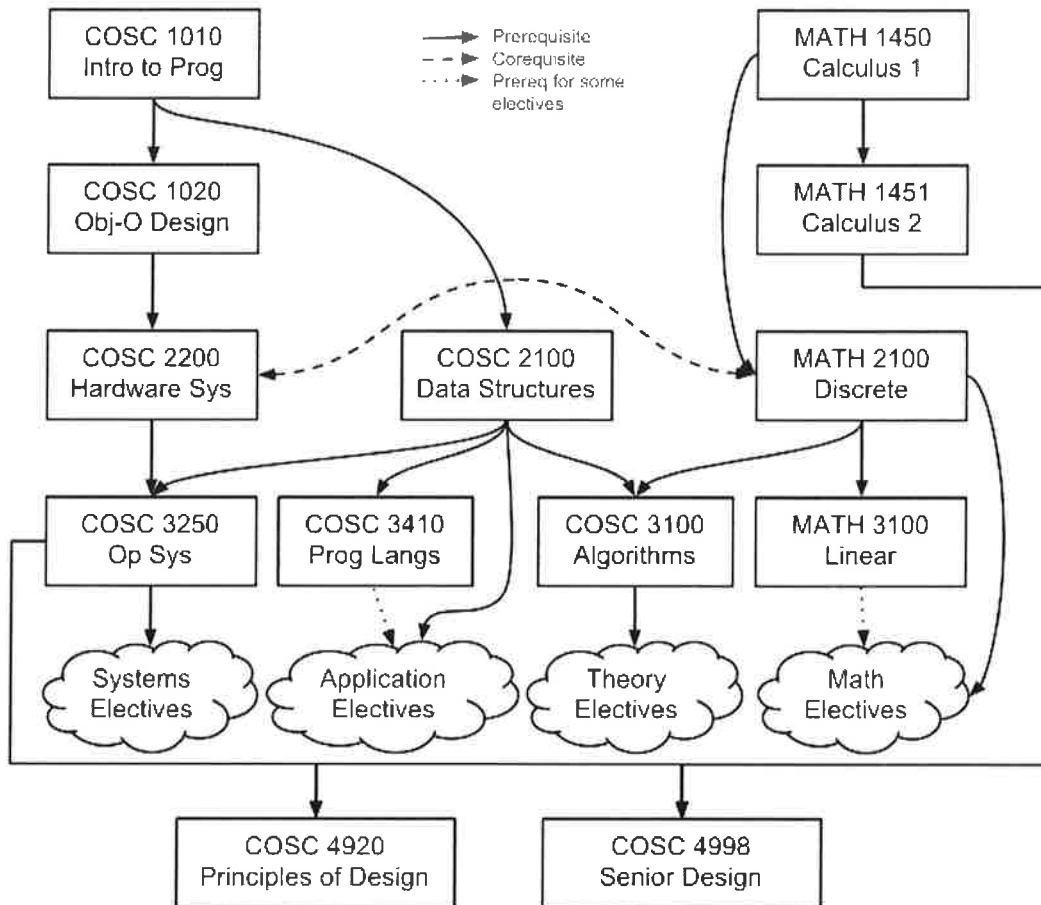
To complete the major, 12 additional semester hours of upper-division (3000- or 4000-level) COSC courses are required. A partial list of available choices is given below:

COSC 3090	Bioinformatics Algorithms	3 sem. hrs.
COSC 3550	Programming Computer Games	3 sem. hrs.
COSC 3750	Introduction to Data Science	3 sem. hrs.
COSC 4290	Real-Time and Embedded Systems	3 sem. hrs.
COSC 4300	Networks and Internets	3 sem. hrs.
COSC 4360	Computer Security	3 sem. hrs.
COSC 4400	Compiler Construction	3 sem. hrs.
COSC 4600	Fundamentals of Artificial Intelligence	3 sem. hrs.
COSC 4610	Data Mining	3 sem. hrs.
COSC 4800	Principles of Database Systems	3 sem. hrs.

Special topics courses (COSC 4931) are also routinely offered by the faculty.

In addition, Marquette's Computer Engineering (COEN) major offers upper division electives in computer architecture, graphics, intelligent systems, and other topics. Students are normally permitted to substitute up to six credits of COEN electives toward the COSC elective requirement, but must apply for a waiver from the MSCS Undergraduate Committee on a course by course basis.

The dependency tree of prerequisites is shown below:



## COURSE SELECTION

A computer science major must satisfy the requirements for the major as well as the graduation requirements of the College of Arts and Sciences and the Marquette Core Curriculum (MCC) as described in the University Undergraduate Bulletin in effect in the year in which they enter Marquette. Both the requirements for the major and the general requirements of the College are flexible enough to allow each student to select a variety of courses. The following comments are intended to aid students in making these selections.

Most elective COSC courses are offered either every other semester, or every fourth semester (once every two years) in a standard rotation. Consult your advisor for a predicted schedule of offerings. In addition, the Department occasionally offers special courses not yet part of the regular curriculum. These will be listed in the Timetable of Classes as COSC 4931 (Topics in Computer Science).

A student interested in the mathematical aspects of Computer Science, including both mathematical modeling and numerical analysis, should seriously consider a major or minor in Mathematics to go with his or her major in Computer Science, or perhaps a major in Computational Mathematics or Data Science. The requirements for combined programs are described later in this document. The MSCS department offers electives in a wide range of areas in applied mathematics, statistics, and theoretical mathematics, as well as graduate-level courses in computational sciences.

A student interested in applications of computing in media or entertainment may consider completing the requirements for the Minor in Digital Media or Minor in Fine Arts – Graphic Design. A student interested in applications of computing in business may consider completing the requirements for the Minor in Business Administration or the Minor in Innovation and Entrepreneurship. These are described in the University Undergraduate Bulletin.

Both the College of Engineering and the College of Business Administration offer a number of computer-related courses. Computer science majors may find some of these useful as electives. Courses from other colleges can sometimes be used to satisfy the elective requirements for a major in computer science, but students must apply for a waiver from the MSCS Undergraduate Committee. Consult your advisor before attempting any such cross-college substitutions.

For electives outside the Department, courses that enhance communication and reasoning skills are the most beneficial to the computer science professional. There are a number of such courses to be found in the offerings of the Departments of English and Philosophy.

## **COMBINED MAJORS AND MINORS IN COMPUTER SCIENCE AND OTHER AREAS**

### **MAJOR IN COMPUTER SCIENCE AND MINOR IN MATHEMATICS**

A student with a major in computer science needs to complete the math requirements for the minor in mathematics. There are seven additional credit hours of MATH courses including: MATH 2450, MATH 2350 (in place of MATH 2100), and one more upper division MATH elective (in addition to the MATH cognates required for the COSC major). If a COSC major decides to embark on a MATH minor after completing MATH 2100, substitutions for the MATH 2350 requirement may be allowed, but students must apply for a waiver from the MSCS Undergraduate Committee.

### **MAJOR IN COMPUTER SCIENCE AND IN MATHEMATICS**

A student majoring in both Computer Science and Mathematics must complete eighty credit hours of COSC and MATH courses. This total includes twenty-two additional credit hours of MATH course in addition to the 58 credit hour required of the computer science major. The required courses include: COSC 1010, 1020, 2100, 2200, 3100, 3250, 3410, 4920, 4998, and twelve additional hours of upper division COSC courses; MATH 1450, 1451, 2350 (in place of MATH 2100), 2450, 3100, and 21 additional hours of upper division MATH courses as outlined in the Mathematics major handbook. MATH 4550 (Numerical Analysis) may be double-counted as satisfying both a COSC elective and a MATH elective.

### **MAJOR IN COMPUTER SCIENCE AND OTHER MINOR.**

Other common minors with a major in computer science include the Minor in Business Administration or the Minor in Innovation and Entrepreneurship from the College of Business Administration, or the Minor in Digital Media from the College of Communication. A student seeking one of these minors should follow the course requirements listed in the Undergraduate Bulletin.

### **MAJOR IN DATA SCIENCE.**

Data Science is an emerging field that seeks to extract and quantify knowledge from data. The Data Science major (DTSC) integrates statistics and mathematics with computer science, allowing students to develop the knowledge and skills necessary to discover and quantify new knowledge from data. DTSC majors begin with the same sequence of MATH and COSC courses for the first two terms, and begins to diverge from Computer Science in the second year.

### **MAJOR IN BIOINFORMATICS.**

The interdisciplinary Bioinformatics major (INBI) lies at the intersection of biology, statistics and computer science and is focused on the analysis of large biological datasets. The major gives students training of sufficient depth in both biology and computer science that they are competent to approach problems in bioinformatics from the perspective of both parent fields.



## Computer Science Major SAMPLE CURRICULUM

<i>Freshman</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 1010	4	COSC 1020	4
MATH 1450	4	MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3	ENGL 1001 or ESSV1 (MCC)	3
Natural Science with Laboratory <sup>4</sup>	4	THEO 1001 or PHIL 1001 (MCC)	3
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	15		14

<i>Sophomore</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 2100	3	COSC 3100	3
COSC 2200	3	COSC 3250	3
MATH 2100	3	MATH 3100	3
CORE 1929 (MCC) or Elective	3	CORE 1929 (MCC) or Elective	3
PHIL 1001 or THEO 1001 (MCC)	3	DSCV (MCC) <sup>5,6</sup>	3
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	15		15

<i>Junior</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 3410	3	COSC 3xxx/4xxx	3
COSC 3xxx/4xxx	3	MATH 3xxx/4xxx <sup>4</sup>	3
Math/Science elective <sup>4</sup>	3	Math/Science elective <sup>4</sup>	3
DSCV (MCC) <sup>5,6</sup>	3	DSCV (MCC) <sup>5,6</sup>	3
DSCV (MCC) <sup>5,6</sup>	3	Elective	3
Elective	1		
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	16		15

<i>Senior</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 4920	3	COSC 4998	3
COSC 3xxx/4xxx	3	COSC 3xxx/4xxx	3
CORE 4929 (MCC) or Elective	3	CORE 4929 (MCC) or Elective	3
Math/Science elective <sup>4</sup>	3	Electives	6

<sup>4</sup> Must complete 16 credit hours of Math/Sciences electives, including at least:

- one 3 credit-hour upper-division (3000- or 4000-level) MATH course,
- one 3-4 credit-hour science course with a laboratory component (BIOL, CHEM or PHYS).

<sup>5</sup> The four courses in the Discovery Tier (DSCV) of the MCC must be completed in the same theme and include the following content areas: Humanities (HUM), Social Science (SSC), Natural Science and Mathematics (NSM) and one elective (ELE), which is an additional course from any of the three content areas. A maximum of two courses in the Discovery Tier can apply towards a primary major.

<sup>6</sup> Students must also complete the Writing Intensive (WRIT) and Engaging Social System and Values 2 (ESSV2) requirements of the MCC. These requirements can be fulfilled through designated courses in the Discovery Tier or other degree requirements.

Elective

3  
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15

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15

## Computer Science and Mathematics Double Major<sup>7</sup>

### SAMPLE CURRICULUM

<i>Freshman</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 1010	4	COSC 1020	4
MATH 1450	4	MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3	ENGL 1001 or ESSV1 (MCC)	3
Natural Science with Laboratory <sup>8</sup>	4	THEO 1001 or PHIL 1001 (MCC)	3
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	15		14
<i>Sophomore</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 2100	3	COSC 3100	3
COSC 2200	3	COSC 3250	3
MATH 2350	3	MATH 3100	3
MATH 2450	4	DSCV (MCC)	3
CORE 1929 (MCC)	3	PHIL 1001 or THEO 1001 (MCC)	3
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	16		15
<i>Junior</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 3410	3	COSC 3xxx/4xxx	3
COSC 3xxx/4xxx	3	MATH Group 3 (statistics)	3
MATH Sequence (part 1)	3	MATH Sequence (part 2)	3
Math/Science elective <sup>8</sup>	3	MATH 3xxx/4xxx <sup>8</sup>	3
DSCV (MCC)	3	DSCV (MCC)	3
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	15		15
<i>Senior</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 4920	3	COSC 4998	3
COSC 3xxx/4xxx	3	COSC 3xxx/4xxx <sup>9</sup>	3
MATH Group 1 (pure)	3	MATH Group 2 (applied) <sup>9</sup>	3
MATH 3xxx/4xxx <sup>8</sup>	3	MATH 3xxx/4xxx <sup>8</sup>	3
DSCV (MCC)	3	CORE 4929 (MCC)	3
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	15		15

<sup>7</sup> For a single major programs that combines aspects of both Computer Science and Mathematics with fewer course requirements, please see the Computational Mathematics major and Data Science major handbooks.

<sup>8</sup> Must complete 16 additional credit hours of Math/Sciences electives, including at least:

- two 3 credit-hour upper-division (3000- or 4000-level) MATH courses,
- one 3-4 credit hour science course with a laboratory component (BIOL, CHEM or PHYS).

<sup>9</sup> MATH 4550 (Numerical Analysis) may be double-counted as satisfying both a Computer Science elective and a Mathematics elective for double majors.

## Computer Science Major with Innovation and Entrepreneurship Minor SAMPLE CURRICULUM

<i>Freshman</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 1010	4	COSC 1020	4
MATH 1450	4	MATH 1451	4
ENGL 1001 or ESSV1 (MCC)	3	ENGL 1001 or ESSV1 (MCC)	3
Natural Science with Laboratory <sup>10</sup>	4	THEO 1001 or PHIL 1001 (MCC)	3
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	15		14

<i>Sophomore</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 2100	3	COSC 3100	3
COSC 2200	3	COSC 3250	3
MATH 2100	3	DSCV (MCC)	3
CORE 1929 (MCC)	3	PHIL 1001 or THEO 1001 (MCC)	3
ECON 1001 or ECON 1103	3	BUAD 2100 or ACCO 1030	3
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	15		15

<i>Junior</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 3410	3	COSC 3xxx/4xxx	3
COSC 3xxx/4xxx	3	MATH 4720 <sup>11</sup>	3
MATH 3100	3	Math/Science elective <sup>10</sup>	3
DSCV (MCC)	3	DSCV (MCC)	3
ENTP 3001	3	ENTP 4010	3
Elective	1		
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	16		15

<i>Senior</i>			
<u>First Term</u>	<u>Sem. Hrs.</u>	<u>Second Term</u>	<u>Sem. Hrs.</u>
COSC 4920	3	COSC 4998 <sup>12</sup>	3
COSC 3xxx/4xxx	3	COSC 3xxx/4xxx	3
Math/Science elective <sup>10</sup>	3	Math/Science elective <sup>10</sup>	3
DSCV (MCC)	3	CORE 4929	3
Entrepreneurship Elective <sup>13</sup>	3	Elective	3

<sup>10</sup> Must complete 13 more credit hours of Math/Sciences electives, including at least one 3-4 credit-hour science course with a laboratory component (BIOL, CHEM or PHYS).

<sup>11</sup> MATH 4720 satisfies both a COSC major Math requirement, and the Innovation and Entrepreneurship minor statistics requirement.

<sup>12</sup> COSC 4998 can be used to satisfy Applied Experiential Course requirement for Innovation and Entrepreneurship Minor.

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13      ENTP 4020, ENTP 4041, ENTP 4931, MANA 3034, MANA 4010, INSY 3001, OSCM 3001 or MARK  
3001.

## STUDENT COMPUTING FACILITIES

Katherine Reed Cudahy Hall houses the University's Information Technology Service (ITS) central computing facilities on the second floor, and MSCS Department computing facilities on the first, third and fourth floors.

Marquette students, faculty and staff are granted accounts on the Emarq and CheckMarq systems maintained by ITS. Authentication credentials can be obtained from the ITS Help Desk (room CU 293) and are maintained throughout a student's enrollment at Marquette. Additional information regarding University computing facilities can be obtained by calling the ITS Help Desk at 288-7799.

The MSCS Department maintains its own independent computing facilities for both teaching and research purposes. Students enrolled in MSCS courses or as department majors are granted access to general purpose laboratories in CU 101, CU 310, and CU 412. In addition, students enrolled in particular courses or involved in research projects may be granted access to special-purpose laboratories in CU 145, CU 301, CU 310, CU 368, CU 390, CU 392, CU 410 or CU 419.

The MSCS network features Gigabit internal connectivity between seven subnets with a wide variety of computing hardware and operating systems. Solaris and Linux servers provide centralized file, mail, web and print services to Windows, Linux, Solaris and Mac clients. Computer configurations range from an in-desk PC classroom to laboratories of dual-head workstations for collaborative project work.

Although students may have their own computer equipment, the MSCS Department provides sufficient facilities for all MSCS coursework. Students are encouraged to make use of department facilities; experience with heterogeneous computing environments provides a rich educational opportunity, and MSCS maintains a large body of software tailored to the needs and interests of department majors.

Additional information about MSCS department computing facilities can be obtained from the MSCS system administrator at 288-1580, or online at <http://www.mscs.mu.edu/>.