COMPUTER SCIENCE (BS)

Chair: Jeffrey J. McConnell, PhD

INTRODUCTION
A degree in computer science from Canisius College provides you with the experience and background required to continue with graduate school or to find employment in a variety of fields. Our graduates enjoy challenging and lucrative careers all over the country in many types of companies, from banking to the defense industry, from web startups to major corporations. The computer science major provides you with an essential theoretical background along with practical programming experience and knowledge about many of the important and cutting edge areas of computer science, including artificial intelligence, web development, software engineering, databases, operating systems, and distributed computing.

For a more detailed description of the program, faculty, facilities, academic and co-curricular opportunities please go to the Computer Science website (https://www.canisius.edu/academics/programs/computer-science).

QUALIFICATIONS
Students must maintain a 2.0 GPA in the major and a 2.0 overall average to graduate with a degree in Computer Science.

ADVICEMENT
All students should have an advisor in the major and should contact the department directly to have an advisor assigned if they do not already have one. Meetings with academic advisors are required prior to students receiving their PIN for course registration each semester. All majors should work closely with their advisor in discussing career expectations, choosing their major electives, developing their entire academic program and planning their co-curricular or supplemental academic experiences.

DOUBLE MAJORS
Students who wish to expand their educational opportunities may decide to declare a double major. The decision may be based on career goals or planned graduate studies. Before a student declares a double major, it is important to meet with the appropriate academic departments for advisement. Some double major combinations can be completed within the minimum 120 credit hour degree requirement, but in some cases additional coursework may be required. Students must complete the appropriate minor request form.

MINORS IN OTHER DISCIPLINES
Minors provide students the opportunity to pursue additional interests but generally do not require as many courses as a major. Minors generally range from five to eight required courses. The minors page (http://catalog.canisius.edu/undergraduate/minors) provides a complete list of minors and provides links to each minor. Some majors and minors can be completed within the minimum 120 credit hour degree requirement, but in some cases additional coursework may be required. Students must complete the appropriate minor request form.

CURRICULUM
An Ignatian Foundation
All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/core-curriculum) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/all-college-honors-program). Many schools refer to their college-wide undergraduate requirements as “general education” requirements. We believe that the core curriculum and the honors curriculum are more than a series of required classes, they provide the basis for a Jesuit education both with content and with required knowledge and skills attributes that are central to our mission.

Free Electives
Students may graduate with more but not less than 120 credit hours. Free electives are courses in addition to the Core Curriculum or Honors Curriculum and major requirements sufficient to reach the minimum of 120 credit hours required for graduation.

Major Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 111</td>
<td>Introduction to Programming</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td>and Introduction to Programming Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 112</td>
<td>Data Structures</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 112L</td>
<td>and Data Structures Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 213</td>
<td>Large Scale Programming</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 213L</td>
<td>and Large Scale Programming Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 253</td>
<td>Computer Hardware</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 253L</td>
<td>and Computer Hardware Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 281</td>
<td>Automata and Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>CSC 310</td>
<td>Information Organization and Processing</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 310L</td>
<td>and Information Organization and Processing Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 320</td>
<td>The Social Impact of Computing</td>
<td>3</td>
</tr>
<tr>
<td>CSC 330</td>
<td>Distributed Computing</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 330L</td>
<td>and Distributed Computing Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 351</td>
<td>Comparative Programming Languages</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 351L</td>
<td>and Comparative Programming Languages Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 360</td>
<td>Intelligent Systems</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 360L</td>
<td>and Intelligent Systems Laboratory</td>
<td></td>
</tr>
<tr>
<td>CSC 395</td>
<td>Software Engineering</td>
<td>4</td>
</tr>
<tr>
<td>&amp; 395L</td>
<td>and Software Engineering Lab</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits 42
MAJOR ELECTIVE

One additional course at the 300/400 level is required. These courses cover a variety of topics including web programming, advanced object oriented programming and design patterns, cryptography, app development, graphics, numerical analysis and bioinformatics. All these courses are either 3 or 4 credits. Faculty teach these courses on a rotating basis. To determine what is offered each semester consult the class schedule.

Recent electives include:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 380 &amp; 380L</td>
<td>Web Development and Web Development Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 400 &amp; 400L</td>
<td>Special Topics in Computing and Special Topics in Computing Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>MAT 341</td>
<td>Numerical Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>

REQUIRED MATHEMATICS COURSES

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 111</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MAT 191</td>
<td>Introduction to Discrete Mathematics</td>
<td>4</td>
</tr>
<tr>
<td>or MAT 230</td>
<td>Logic, Set Theory, and Proofs</td>
<td></td>
</tr>
</tbody>
</table>

TRACKS

Students must complete one of the following two tracks:

Interdisciplinary Track
Completion of an approved minor in another department or program

Science Track

Select two of the following options: 8

**Option 1:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 111 &amp; 111L</td>
<td>Introductory Biology I and Introductory Biology Laboratory I</td>
<td></td>
</tr>
<tr>
<td>BIO 112 &amp; 112L</td>
<td>Introductory Biology II and Introductory Biology Laboratory II</td>
<td></td>
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</tbody>
</table>

**Option 2:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM 111 &amp; 111L</td>
<td>General Chemistry I and General Chemistry I Laboratory</td>
<td></td>
</tr>
<tr>
<td>CHM 112 &amp; 112L</td>
<td>General Chemistry II and General Chemistry II Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

**Option 3:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY 223 &amp; 223L</td>
<td>General Physics for Physical Science Majors I and General Physics for Physical Science Majors I Laboratory</td>
<td></td>
</tr>
<tr>
<td>PHY 224 &amp; 224L</td>
<td>General Physics for Physical Science Majors II and General Physics for Physical Science Majors II Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following: 3-4

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 141</td>
<td>Inferential Statistics and Computers for Science</td>
</tr>
<tr>
<td>MAT 219</td>
<td>Linear Algebra</td>
</tr>
</tbody>
</table>

MAT 351 | Probability & Statistics I | 15-16 |

Many courses at the 200-level and above are offered every two years on a rotating schedule. Thus, some students will take, for example, CSC 330 in their junior year, while the students who entered the previous year will take CSC 330 in their senior year.

The CSC department maintains a lab for use by majors and minors that contains a number of computers that provide access to departmental and college-wide software along with a printer.

CSC majors often get part-time jobs or paid internships in the Western New York region while still taking classes, though we do not formally require an internship. CSC 497 "Internship" is a way to earn credit for an internship, but the experience must include a significant learning component that does not overlap with required coursework and must be pre-approved by the department chair. The Internship cannot count as the CSC elective.

ROADMAP

Recommended Semester Schedule for Major Course Requirements

**Freshman**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC 111</td>
<td>CSC 112</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td>&amp; 112L</td>
</tr>
<tr>
<td>MAT 111 or 109</td>
<td>Track course</td>
</tr>
<tr>
<td>or MAT 230</td>
<td>MAT 110 (if needed)</td>
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</tbody>
</table>

**Sophomore**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>CSC 213</td>
<td>CSC 213</td>
</tr>
<tr>
<td>&amp; 213L</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>Select one of the following:</td>
</tr>
<tr>
<td>CSC 253</td>
<td>CSC 253</td>
</tr>
<tr>
<td>&amp; 253L</td>
<td>&amp; 253L</td>
</tr>
<tr>
<td>CSC 281</td>
<td>CSC 281</td>
</tr>
<tr>
<td>Track course</td>
<td>Track course</td>
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</tbody>
</table>

**Junior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>CSC Elective</td>
<td>CSC 310</td>
</tr>
<tr>
<td>(take 1 elective in junior or senior year)</td>
<td>&amp; 310L</td>
</tr>
<tr>
<td>Track course</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>Select one of the following:</td>
</tr>
<tr>
<td>CSC 330</td>
<td>CSC 330</td>
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<tr>
<td>&amp; 330L</td>
<td>&amp; 330L</td>
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</tbody>
</table>

**Senior**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>CSC 360</td>
<td>CSC 320</td>
</tr>
<tr>
<td>&amp; 360L</td>
<td></td>
</tr>
<tr>
<td>Track course, if needed:</td>
<td>CSC 351</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>&amp; 351L</td>
</tr>
<tr>
<td>Track course</td>
<td></td>
</tr>
<tr>
<td>Select one of the following:</td>
<td>Select one of the following:</td>
</tr>
<tr>
<td>CSC 395</td>
<td>CSC 395</td>
</tr>
<tr>
<td>&amp; 395L</td>
<td>&amp; 395L</td>
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</tbody>
</table>
LEARNING GOALS & OBJECTIVES

Student Learning Goal 1
Majors will develop a computational solution to a problem. Students will:
• Objective A: Translate a problem description to a formal representation;
• Objective B: Implement, justify and test acceptable computational solutions;
• Objective C: Perform programming logic.

Student Learning Goal 2
Majors will know the foundations of computing. Students will:
• Objective A: Identify computational power and its limits;
• Objective B: Describe the operational details of computer systems;
• Objective C: Describe the operational details of programming languages.

Student Learning Goal 3
Majors will understand the social impact of computing. Students will:
• Objective A: Describe the social impact of computing.

MINORS

Two Minors are offered
• Computer Science Minor (http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science/computer-science-minor)
• Computer Theory Minor (http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science/computer-theory-minor)

COURSES

CSC 108 Introduction to Web Computing 3 Credits
Introduction to computer science through web sites, web pages, web page programming, HTML, XML, CSS and JavaScript. The history and social impact of computers, networks and the World Wide Web are included in the course.
Corequisite: CSC 108L.
Fulfills College Core: Ethics, Field 7 (Mathematical Sciences)
Offered: fall & spring.

CSC 108L Introduction to Web Computing Laboratory 1 Credit
Required lab for CSC 108.
Corequisite: CSC 108.

CSC 109 Robotics Introduction to Computer Science 3 Credits
Introduction to computer science through robotics, the basics of artificial intelligence and the fundamental ideas of logic, algorithms, computer systems and programming. Includes ethical issues in robotics.
Corequisite: CSC 109L.
Fulfills College Core: Field 7 (Mathematical Sciences)

CSC 109L Robotics Introduction to Computer Science Laboratory 1 Credit
Required lab for CSC 109.
Corequisite: CSC 109.
Fulfills College Core: Ethics, Field 7 (Mathematical Sciences)

CSC 111 Introduction to Programming 3 Credits
Algorithms, programming, computers, and applications to problem solving in Python.
Corequisite: CSC 111L.
Fulfills College Core: Field 7 (Mathematical Sciences)
Offered: fall.

CSC 111L Introduction to Programming Laboratory 1 Credit
Required lab for CSC 111.
Corequisite: CSC 111.

CSC 112 Data Structures 3 Credits
Basic concepts of object-oriented programming, recursion, and data structures, including lists, stacks, queues, and trees using Python.
Prerequisite: minimum grade of C- in CSC 111 & CSC 111L. Corequisite: CSC 112L.

CSC 112L Data Structures Laboratory 1 Credit
Required lab for CSC 112.
Prerequisite: minimum grade of C- in CSC 111 & CSC 111L.

CSC 127 Introduction to Game Design 3 Credits
Computer game development and underlying computer concepts necessary for game design. Game components related to the player, stories, characters, game play, graphics, the interface and audio.
Corequisite: CSC 127L.
Fulfills College Core: Field 7 (Mathematical Sciences), Oral Communication
Offered: fall 2015.

CSC 127L Intro to Game Design Laboratory 1 Credit
Required lab for CSC 127.
Corequisite: CSC 127.

CSC 213 Large Scale Programming 3 Credits
Introduction to the design, implementation, and testing of larger software systems. Intensive instruction in Java including graphics and object-oriented design.
Prerequisite: minimum grade of C- in CSC 112 & CSC 112L. Corequisite: CSC 213L.

CSC 213L Large Scale Programming Laboratory 1 Credit
Required lab for CSC 213.
Prerequisite: minimum grade of C- in CSC 112 & CSC 112L. Corequisite: CSC 213.

CSC 253 Computer Hardware 3 Credits
Introduction to digital logic, Boolean algebra, hardware and computer organization. Overview of current architectures.
Prerequisite: minimum grade of C- in CSC 111 & CSC 111L. Corequisite: CSC 253L.

CSC 253L Computer Hardware Laboratory 1 Credit
Required lab for CSC 253.
Prerequisite: minimum grade of C- in CSC 111 and CSC 111L. Corequisite: CSC 253.

CSC 281 Automata and Algorithms 3 Credits
Formal language theory including finite and pushdown automata, grammars, Turing Machines and the Halting Problem. Provides an introduction to the design and analysis of algorithms, including classes of problems and methods for analysis.
Prerequisite: minimum grade of C in CSC 112 & CSC 112L.
Offered: once a year.
CSC 281L Automata and Algorithms Lab
Optional lab for CSC 281.
**Prerequisites:** Minimum grade of C in CSC 112 and CSC 112L. **Corequisite:** CSC 281.
**Offered:** Every spring.

CSC 310 Information Organization and Processing
Databases, high-level organization and processing of information, SQL, and modern NoSQL systems.
**Prerequisite:** minimum grade of C in CSC 112 & CSC 112L. **Corequisite:** CSC 310L.
**Offered:** 2017-2018.

CSC 310L Information Organization and Processing Laboratory
Required lab for CSC 310.
**Prerequisites:** minimum grade of C in CSC 112 and CSC 112L. **Corequisite:** CSC 310L.

CSC 320 The Social Impact of Computing
Examines the societal issues involved in computing such as accessibility, ethical issues, privacy, censorship, social media, and professional responsibilities. Includes applications of information literacy techniques to the major.
**Prerequisite:** minimum grade of C in CSC 112 & CSC 112L. **Corequisite:** CSC 320L.
**Fulfills College Core:** Core Capstone
**Offered:** spring.

CSC 330 Distributed Computing
The design of operating system software, distributed applications, client/server and other models, security issues, and parallel programming on a High Performance Computing Cluster.
**Prerequisite:** CSC 253, CSC 253L, & minimum grade of C in CSC 112 & CSC 112L. **Corequisite:** CSC 330L.
**Offered:** 2017-2018.

CSC 330L Distributed Computing Laboratory
Required lab for CSC 330.
**Prerequisite:** CSC 253, CSC 253L, & minimum grade of C in CSC 112 & CSC 112L. **Corequisite:** CSC 330L.

CSC 351 Comparative Programming Languages
A study of programming languages and their implementations. Programming in logical and functional programming languages is included.
**Prerequisite:** minimum grade of C in CSC 112 & CSC 112L. **Corequisite:** CSC 351L.
**Offered:** spring 2017.

CSC 351L Comparative Programming Languages Laboratory
Required lab for CSC 351 Comparative Programming Languages.
**Prerequisites:** minimum grade of C in CSC 112 and 112L. **Corequisite:** CSC 351L.

CSC 360 Intelligent Systems
An introduction to intelligent systems including logic and rule-based systems, machine learning, and applications of AI.
**Prerequisite:** minimum grade of C in CSC 112 & CSC 112L. **Corequisite:** CSC 360L.
**Offered:** fall 2016.

CSC 360L Intelligent Systems Laboratory
Required lab for CSC 360.
**Prerequisite:** minimum grade of C in CSC 112 and 112L. **Corequisite:** CSC 360.

CSC 380 Web Development
Web design principles, programming and scripting (both client-side and server-side), client/server mechanisms, search engines, and security.
**Prerequisite:** minimum grade of C in CSC 111 & CSC 111L and junior or senior standing. **Corequisite:** CSC 380L.
**Offered:** fall 2016.

CSC 380L Web Development Laboratory
Required lab for CSC 380.
**Prerequisite:** minimum grade of C in CSC 111 and 111L. **Corequisite:** CSC 380.

CSC 391 Computer Science Junior Seminar
Topic-focused exploration involving students and faculty.
**Prerequisite:** permission of instructor.

CSC 395 Software Engineering
An examination of a variety of techniques and concepts that have been created to improve the software production process. Includes discussions of software processes, Agile software development, requirements engineering, testing, and software evolution.
**Prerequisite:** minimum grade of C in CSC 213 & CSC 213L. **Corequisite:** CSC 395L.
**Fulfills College Core:** Oral Communication
**Offered:** fall 2016.

CSC 395L Software Engineering Lab
Required lab for CSC 395.
**Prerequisite:** minimum grade of C in CSC 213 and 213L. **Corequisite:** CSC 395.

CSC 400 Special Topics in Computing
Current topics of interest to faculty and students. Possible topics: cryptography, advanced scripting languages, networking, etc.
**Prerequisites:** minimum grade of C- in either CSC 112 & CSC 112L or in CSC 212 & CSC 212L and in either MAT 111, MAT 191 or MAT 230. **Corequisite:** CSC 400L. **Restrictions:** must be junior or senior Computer Science or Bioinformatics major.
**Offered:** every spring.

CSC 400L Special Topics in Computing Laboratory
Required weekly lab for CSC 400.
**Prerequisites:** minimum grade of C- in either CSC 112 & CSC 112L or in CSC 212 & CSC 212L and in either MAT 111, MAT 191 or MAT 230. **Corequisite:** CSC 400L. **Restrictions:** must be junior or senior Computer Science or Bioinformatics major.
**Offered:** every spring.

CSC 491 Computer Science Senior Seminar
Topic-focused exploration involving students and faculty.
**Prerequisite:** permission of instructor.

CSC 497 Internship
Special projects for local institutions/businesses. Must be related to a specific focused task and involve a significant learning component. Internships require an application and approval by the associate dean. Credit is not given simply for a part-time job. Approved project proposal and results documentation required. Does not count as a CSC elective.
**Prerequisite:** permission of chair & associate dean.

CSC 498 Independent Project
A directed project course that includes research, design, and implementation of a software system.
**Prerequisite:** permission of instructor.
CSC 499 Independent Study 1-4 Credits
An in-depth study of a specific computing topic. Independent studies require an application and approval by associate dean.
Prerequisite: junior or senior standing; & permission of instructor, chair, & associate dean.