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 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, distributed computing, programming language design, and the social impact of 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.

Advisement
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. In order to declare a double major, the student must complete the appropriate double major request form and get the signature of each department chairperson and the appropriate associate dean. Please note that students will receive only one degree, regardless of the number of majors they complete.

In the past, Computer Science majors have had double majors in many other areas, including Physics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/physics), Mathematics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/mathematics-statistics), Digital Media Arts (http://catalog.canisius.edu/undergraduate/college-arts-sciences/digital-media-arts), Religious Studies (http://catalog.canisius.edu/undergraduate/college-arts-sciences/religious-studies-theology), English (http://catalog.canisius.edu/undergraduate/college-arts-sciences/english), and Classics (http://catalog.canisius.edu/undergraduate/college-arts-sciences/classics).

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/undergraduate/college-arts-sciences/digital-media-arts) 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.

Students following the Interdisciplinary Track are required to complete a minor outside of computer science. A double major also satisfies this requirement. Students in the Science Track are not required to complete a minor but may choose to do so.

Curriculum

An Ignatian Foundation
All undergraduate students must complete either the Canisius Core Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/core-curriculum) or the All-College Honors Curriculum (http://catalog.canisius.edu/undergraduate/academics/curricular-information/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>
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</thead>
<tbody>
<tr>
<td>CSC 111 &amp; 111L</td>
<td>Introduction to Programming and Introduction to Programming Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 112 &amp; 112L</td>
<td>Data Structures and Data Structures Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 213 &amp; 213L</td>
<td>Large Scale Programming and Large Scale Programming Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 253 &amp; 253L</td>
<td>Computer Hardware and Computer Hardware Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 281 &amp; 281L</td>
<td>Automata and Algorithms and Automata and Algorithms Lab</td>
<td>4</td>
</tr>
<tr>
<td>CSC 310 &amp; 310L</td>
<td>Information Organization and Processing and Information Organization and Processing Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 320</td>
<td>The Social Impact of Computing</td>
<td>3</td>
</tr>
<tr>
<td>CSC 330 &amp; 330L</td>
<td>Distributed Computing and Distributed Computing Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 351 &amp; 351L</td>
<td>Comparative Programming Languages and Comparative Programming Languages Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>CSC 360 &amp; 360L</td>
<td>Intelligent Systems and Intelligent Systems Laboratory</td>
<td>4</td>
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</tbody>
</table>
CSC 395 & 395L Software Engineering and Software Engineering Lab

Major Elective at the 300- or 400-level (see list below) 3-4

MAT 111 Calculus I 4

MAT 191 or MAT 230 Introduction to Discrete Mathematics

Logic, Set Theory, and Proofs 4

Completion of either the science track or interdisciplinary track curriculum (variable credit required) 5

Total Credits 54-55

Major Elective Options

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 major electives include:

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

Tracks

Students must complete one of the following two tracks:

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

Science Track

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAT 112</td>
<td>Calculus II</td>
<td>4</td>
</tr>
</tbody>
</table>

Select one of the following sequences: 8

Biology Sequence:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 111</td>
<td>Introductory Biology I and Introductory Biology Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO 112</td>
<td>Introductory Biology II and Introductory Biology Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>&amp; 112L</td>
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</tbody>
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Chemistry Sequence:

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<thead>
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<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CHM 111</td>
<td>General Chemistry I and General Chemistry I Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>&amp; 111L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHM 112</td>
<td>General Chemistry II and General Chemistry II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>&amp; 112L</td>
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Physics Sequence:

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>PHY 223</td>
<td>General Physics for Physical Science Majors I and General Physics for Physical Science Majors I Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>&amp; 223L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHY 224</td>
<td>General Physics for Physical Science Majors II and General Physics for Physical Science Majors II Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>&amp; 224L</td>
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</tbody>
</table>

Select one of the following math courses: 3-4

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAT 141</td>
<td>Inferential Statistics and Computers for Science</td>
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<tr>
<td>MAT 219</td>
<td>Linear Algebra</td>
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</tbody>
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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAT 351</td>
<td>Probability &amp; Statistics I</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Credits 15-16

1 Students can complete CHM 109 and CHM 110 in lieu of CHM 111.

Many courses at the 300-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>Semester</th>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Fall</td>
<td>CSC 111 &amp; 111L</td>
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<tr>
<td></td>
<td>MAT 111 or 109</td>
<td>Track course</td>
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</table>

Sophomore

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Fall</td>
<td>CSC 213 &amp; 213L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSC 253 &amp; 253L</td>
<td>Track course</td>
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</tbody>
</table>

Junior

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>Fall</td>
<td>CSC 395 &amp; 395L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MAT 191</td>
<td></td>
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<tr>
<td></td>
<td>Select one:</td>
<td>CSC elective (1 needed)</td>
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<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Fall</td>
<td>CSC 310 &amp; 310L</td>
<td>Track course</td>
</tr>
<tr>
<td></td>
<td>CSC 320</td>
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</table>

Senior

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>Fall</td>
<td>CSC 351 &amp; 351L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSC 330 &amp; 330L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Select one:</td>
<td>CSC elective (1 needed)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>CSC 310 &amp; 310L</td>
<td>Track course, if needed</td>
</tr>
<tr>
<td></td>
<td>CSC 320</td>
<td></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: Describe the basic principles of artificial intelligence (AI).

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

The following two minors are offered:
- Computer Science Minor ([link](http://catalog.canisius.edu/undergraduate/college-arts-sciences/computer-science/computer-science-minor))
- Computer Theory Minor ([link](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.
Offered: spring.

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

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.
Offered: once a year.

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.
Offered: once a year.

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.
Offered: once a year.

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.
Offered: once a year.

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. Corequisite: CSC 281L.
Offered: every spring.

CSC 281L Automata and Algorithms Lab 1 Credit
Required 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 3 Credits
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 1 Credit
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 3 Credits
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: Advanced Writing-Intensive
Offered: spring.

CSC 330 Distributed Computing 3 Credits
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 1 Credit
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 3 Credits
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 1 Credit
Required lab for CSC 351.
Prerequisites: minimum grade of C in CSC 112 and 112L. Corequisite: CSC 351L.

CSC 360 Intelligent Systems 3 Credits
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 and completion of MAT 191 or MAT 230. Corequisite: CSC 360L.
Offered: occasionally.

CSC 360L Intelligent Systems Laboratory 1 Credit
Required lab for CSC 360.
Prerequisite: minimum grade of C in CSC 112 and 112L and completion of MAT 191 or MAT 230. Corequisite: CSC 360L.
Offered: occasionally.

CSC 380 Web Development 3 Credits
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 1 Credit
Required lab for CSC 380.
Prerequisite: minimum grade of C in CSC 111 and 111L. Corequisite: CSC 380L.

CSC 391 Computer Science Junior Seminar 1 Credit
Topic-focused exploration involving students and faculty.
Prerequisite: permission of instructor.

CSC 395 Software Engineering 3 Credits
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.
Offered: fall 2016.

CSC 395L Software Engineering Lab 1 Credit
Required lab for CSC 395.
Prerequisite: minimum grade of C in CSC 213 and 213L Corequisite: CSC 395L.

CSC 400 Special Topics in Computing 3 Credits
Current topics of interest to faculty and students. Possible topics: cryptography, advanced scripting languages, networking, etc.
Prerequisite: 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. Restriction: must be junior or senior Computer Science major.
Offered: every spring.

CSC 400L Special Topics in Computing Laboratory 1 Credit
Required 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. Restriction: must be junior or senior Computer Science major.
Offered: every spring.

CSC 480 Research Experience 0 Credits
Research project done in conjunction with a faculty advisor.
Offered: every fall & spring.

CSC 481 Research Experience 1 Credit
Research project done in conjunction with a faculty advisor for credit.
Offered: every fall & spring.

CSC 491 Computer Science Senior Seminar 1 Credit
Topic-focused exploration involving students and faculty.
Prerequisite: permission of instructor.

CSC 497 Internship 1-3 Credits
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 3 Credits
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.