MAJOR IN COMPUTER SCIENCE, HUMAN-CENTERED COMPUTING CONCENTRATION

Human-centered computing (HCC) focuses on developing tools that improve the relationship between people and technology so that people can concentrate on the problem rather than the technology. The ultimate goal of HCC is to make the computer invisible.

Human-centered computing involves designing, developing, and deploying human-centric computer systems. In this concentration students will learn techniques for human-computer interaction using gestures, mobile devices, large surfaces, and virtual environments. Students will also learn how to design and conduct human-subject experiments and understand the role of HCC in developing human-centric artificial intelligence systems. The concentration provides rich interdisciplinary training in computer vision, machine learning, design and psychology.

Learning Outcomes

Upon completing this program, students will be able to:

- Design interactive systems using state-of-the-art HCC techniques.
- Design and conduct human-subject experiments.
- Build complex 3D worlds for user interaction (e.g., virtual and augmented reality).
- Confidently pursue graduate studies or professional employment in HCC and computer science.

Potential Occupations

In addition to the career opportunities open to all computer science graduates, the HCC concentration opens career paths that include:

User experience designer, virtual and augmented reality developer, and human-centric developer for intelligent systems.

Requirements

Effective Fall 2022

A minimum grade of C (2.000) is required in CO 150 and in all CS, DSCI, MATH, STAT, and Technical Elective courses which are required for graduation.

Freshman

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>AUCC</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 150</td>
<td>College Composition (GT-CO2)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MATH 156 or 160¹</td>
<td>Mathematics for Computational Science I (GT-MA1) Calculus for Physical Scientists I (GT-MA1)</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Select one group from the following:²

Group A:
- CS 150A or 150B | Culture and Coding: Java (GT-AH3)
- CS 162 or 164 | CS1—Introduction to Java Programming
- CS1—Computational Thinking with Java

Group B:
- Arts and Humanities [link]
- CS 152 | Python for STEM
- CS 162 or 164 | CS1—Introduction to Java Programming
- CS1—Computational Thinking with Java

Group C:
- Arts and Humanities [link]
- CS 163 | CS1—No Prior Programming Experience
- CS 201/PHIL 201 | Ethical Computing Systems (GT-AH3)

Select at least two courses totaling a minimum of 7 credits from the following (one course must be or include the sequenced laboratory):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA 100</td>
<td>Introduction to Astronomy (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; AA 101</td>
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<td></td>
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<tr>
<td>ANTH 120</td>
<td>Human Origins and Variation (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; ANTH 121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BZ 110</td>
<td>Principles of Animal Biology (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; BZ 111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BZ 120</td>
<td>Principles of Plant Biology (GT-SC1)</td>
<td>3A</td>
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</tbody>
</table>
### Major in Computer Science, Human-Centered Computing Concentration

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 107</td>
<td>Fundamentals of Chemistry (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; CHEM 108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM 111</td>
<td>General Chemistry I (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; CHEM 112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEOL 120</td>
<td>Exploring Earth - Physical Geology (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; GEOL 121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEOL 122</td>
<td>The Blue Planet - Geology of Our Environment (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>&amp; GEOL 121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEOL 124</td>
<td>Geology of Natural Resources (GT-SC2)</td>
<td>3A</td>
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<tr>
<td>&amp; GEOL 121</td>
<td></td>
<td></td>
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<tr>
<td>GEOL 150</td>
<td>Physical Geology for Scientists and Engineers</td>
<td>3A</td>
</tr>
<tr>
<td>HONR 292A</td>
<td>Honors Seminar: Knowing in the Sciences</td>
<td>3A</td>
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<tr>
<td>LIFE 102</td>
<td>Attributes of Living Systems (GT-SC1)</td>
<td>3A</td>
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<tr>
<td>LIFE 103</td>
<td>Biology of Organisms-Animals and Plants (GT-SC1)</td>
<td>3A</td>
</tr>
<tr>
<td>LIFE 201A</td>
<td>Introductory Genetics: Applied/Population/Conservation/Ecological (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>LIFE 201B</td>
<td>Introductory Genetics: Molecular/Immunological/Developmental (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>LIFE 220/LAND 220</td>
<td>Fundamentals of Ecology (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>NR 150</td>
<td>Oceanography (GT-SC2)</td>
<td>3A</td>
</tr>
<tr>
<td>PH 121</td>
<td>General Physics I (GT-SC1)</td>
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<tr>
<td>PH 122</td>
<td>General Physics II (GT-SC1)</td>
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<td>PH 141</td>
<td>Physics for Scientists and Engineers I (GT-SC1)</td>
<td>3A</td>
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<tr>
<td>PH 142</td>
<td>Physics for Scientists and Engineers II (GT-SC1)</td>
<td>3A</td>
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<tr>
<td>Diversity, Equity, and Inclusion (<a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion">link</a>)</td>
<td>1C</td>
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</tr>
<tr>
<td>Electives</td>
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<td>1-5</td>
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</table>

**Total Credits**: 30

### Sophomore

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CS 165</td>
<td>CS2--Data Structures</td>
<td>4</td>
</tr>
<tr>
<td>CS 220</td>
<td>Discrete Structures and their Applications</td>
<td>4</td>
</tr>
<tr>
<td>CS 253</td>
<td>Software Development with C++</td>
<td>4</td>
</tr>
<tr>
<td>CS 270</td>
<td>Computer Organization</td>
<td>4</td>
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<tr>
<td>Select one course from the following:</td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>DSCI 369</td>
<td>Linear Algebra for Data Science</td>
<td></td>
</tr>
<tr>
<td>MATH 369</td>
<td>Linear Algebra I</td>
<td></td>
</tr>
<tr>
<td>Select one course from the following:</td>
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<td>1-3</td>
</tr>
<tr>
<td>STAT 301</td>
<td>Introduction to Applied Statistical Methods</td>
<td></td>
</tr>
<tr>
<td>STAT 302A</td>
<td>Statistics Supplement: General Applications</td>
<td></td>
</tr>
<tr>
<td>STAT 307</td>
<td>Introduction to Biostatistics</td>
<td></td>
</tr>
<tr>
<td>STAT 315</td>
<td>Intro to Theory and Practice of Statistics</td>
<td></td>
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</table>

Social and Behavioral Sciences ([link](http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)) | 3C | 3

Historical Perspectives ([link](http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)) | 3D | 3

**Electives**: 1-4

**Total Credits**: 30

### Junior

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 314</td>
<td>Software Engineering</td>
<td>4A,4B</td>
</tr>
<tr>
<td>CS 320</td>
<td>Algorithms--Theory and Practice</td>
<td>3</td>
</tr>
<tr>
<td>CS 345</td>
<td>Machine Learning Foundations and Practice</td>
<td>3</td>
</tr>
<tr>
<td>CS 370</td>
<td>Operating Systems</td>
<td>3</td>
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</table>

**Total Credits**: 30
Select one course from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 310H/IDEA 310H</td>
<td>Design Thinking Toolbox: Mixed Reality Design</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 312</td>
<td>Modern Web Applications</td>
<td></td>
</tr>
<tr>
<td>Any CS course numbered 400- or above excluding CS 480-499</td>
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<td></td>
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</tbody>
</table>

Technical Electives (see list below)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Writing</td>
<td><a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing</a></td>
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</table>

Electives

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
</table>

Total Credits

30

Senior

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 464</td>
<td>Principles of Human-Computer Interaction</td>
<td>4C</td>
</tr>
</tbody>
</table>

Select two courses from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 410</td>
<td>Introduction to Computer Graphics</td>
<td></td>
</tr>
<tr>
<td>CS 440</td>
<td>Introduction to Artificial Intelligence</td>
<td></td>
</tr>
<tr>
<td>CS 445</td>
<td>Introduction to Machine Learning</td>
<td></td>
</tr>
<tr>
<td>CS 462</td>
<td>Engaging in Virtual Worlds</td>
<td></td>
</tr>
<tr>
<td>CS course numbered 300- or above, excluding 380-399 and 480-499</td>
<td>3-4</td>
<td></td>
</tr>
</tbody>
</table>

Electives

2-3

Total Credits

30

Program Total Credits:

120

1 MATH 156 recommended for computer science majors who do not already have MATH 160 credit.

2 Recommended sequence for most incoming students is Group A: CS 150B to CS 164.

3 CS 192 or other seminar course is a recommended elective for incoming, first semester, students.

4 Select enough elective credits to bring the program total to a minimum of 120 credits, of which at least 42 must be Upper-Division (300- to 400-level).

Technical Electives

Select a minimum of 9 credits, of which 6 credits must be upper-division.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
</table>

MATH 117, MATH 118, and MATH 124 must be completed by the end of Semester 1, if necessary.

Major Completion Map

Distinctive Requirements for Degree Program:

To prepare for first semester: The curriculum for the Computer Science major assumes students enter college prepared to take calculus. Entering students who are not prepared to take calculus will need to fulfill pre-calculus requirements in the first semester. Those pre-calculus requirements are listed as benchmark courses in Freshman Semester 1 below. All students must maintain a C (2.000) or better in CO 150 and in all CS, DSCI, MATH, and STAT and Technical Elective courses which are required for graduation.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
</table>

1 MATH 156 recommended for computer science majors who do not already have MATH 160 credit.

2 Recommended sequence for most incoming students is Group A: CS 150B to CS 164.

3 CS 192 or other seminar course is a recommended elective for incoming, first semester, students.

4 Select enough elective credits to bring the program total to a minimum of 120 credits, of which at least 42 must be Upper-Division (300- to 400-level).
### Semester 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Critical</th>
<th>Recommended</th>
<th>AUCC</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 201/PHIL 201 Ethical Computing Systems (GT-AH3)</td>
<td></td>
<td></td>
<td>3B</td>
<td>3</td>
</tr>
<tr>
<td>MATH 156 or Mathematics for Computational Science I (GT-MA1)</td>
<td></td>
<td></td>
<td>1B</td>
<td>4</td>
</tr>
<tr>
<td>MATH 160 Calculus for Physical Scientists I (GT-MA1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remaining course(s) from Group A, B, or C (See options in Concentration Requirements Tab)</td>
<td></td>
<td></td>
<td>2-4</td>
<td></td>
</tr>
<tr>
<td>Department Approved Science w/lab (See list on Concentration Requirements Tab)</td>
<td></td>
<td></td>
<td>3A</td>
<td>4</td>
</tr>
<tr>
<td>Electives</td>
<td></td>
<td></td>
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<td>0-2</td>
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<tr>
<td>MATH 125 and MATH 126 must be completed by the end of Semester 2, if necessary.</td>
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<tr>
<td><strong>Total Credits</strong></td>
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</table>

### Sophomore

#### Semester 3

<table>
<thead>
<tr>
<th>Course</th>
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<th>Recommended</th>
<th>AUCC</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CS 165 CS2—Data Structures</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>CS 220 Discrete Structures and their Applications</td>
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<td>X</td>
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<tr>
<td>Select one course from the following:</td>
<td></td>
<td></td>
<td></td>
<td>1-3</td>
</tr>
<tr>
<td>STAT 301 Introduction to Applied Statistical Methods</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>STAT 302A Statistics Supplement: General Applications</td>
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<td></td>
</tr>
<tr>
<td>STAT 307 Introduction to Biostatistics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAT 315 Intro to Theory and Practice of Statistics</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Social and Behavioral Sciences (<a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences</a>)</td>
<td></td>
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<td>3C</td>
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<tr>
<td>Electives</td>
<td></td>
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<td>1-3</td>
</tr>
<tr>
<td>MATH 156 or MATH 160 must be completed by the end of Semester 3.</td>
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<tr>
<td><strong>Total Credits</strong></td>
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#### Semester 4

<table>
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<tr>
<th>Course</th>
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<th>AUCC</th>
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</thead>
<tbody>
<tr>
<td>CS 253 Software Development with C++</td>
<td></td>
<td></td>
<td>X</td>
<td>4</td>
</tr>
<tr>
<td>CS 270 Computer Organization</td>
<td></td>
<td></td>
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<td>4</td>
</tr>
<tr>
<td>Select one course from the following:</td>
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<td></td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>DSCI 369 Linear Algebra for Data Science</td>
<td></td>
<td></td>
<td>X</td>
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</tr>
<tr>
<td>MATH 369 Linear Algebra I</td>
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<td></td>
</tr>
<tr>
<td>Historical Perspectives (<a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives</a>)</td>
<td></td>
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<td>3D</td>
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<tr>
<td>Electives</td>
<td></td>
<td></td>
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<tr>
<td>CS 220, CS 270, and DSCI 369 or MATH 369 must be completed by the end of Semester 4.</td>
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### Junior

#### Semester 5

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<tbody>
<tr>
<td>CS 320 Algorithms—Theory and Practice</td>
<td></td>
<td></td>
<td>X</td>
<td>3</td>
</tr>
<tr>
<td>CS 370 Operating Systems</td>
<td></td>
<td></td>
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<td>3</td>
</tr>
<tr>
<td>Technical Electives (See List on Concentration Requirements tab.)</td>
<td></td>
<td></td>
<td>X</td>
<td>6</td>
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<tr>
<td>Advanced Writing (<a href="http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing">http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing</a>)</td>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
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<tr>
<td>CS 253 must be completed by the end of Semester 5.</td>
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<td><strong>Total Credits</strong></td>
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#### Semester 6

<table>
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<tbody>
<tr>
<td>CS 314 Software Engineering</td>
<td></td>
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<td>X</td>
<td>4A,4B</td>
</tr>
<tr>
<td>CS 345 Machine Learning Foundations and Practice</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>User Interface Design Course (See List on Concentration Requirements tab.)</td>
<td></td>
<td></td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>Technical Elective Course (See List on Concentration Requirements tab.)</td>
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<tr>
<td>Elective</td>
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<td>2-3</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
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</table>
CS 320 and CS 370 must be completed by the end of Semester 6.

| Total Credits | 15 |

**Senior**

<table>
<thead>
<tr>
<th>Semester 7</th>
<th>Critical</th>
<th>Recommended</th>
<th>AUCC</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Pick Two CS Depth Courses (See List on Concentration Requirements tab.)</td>
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<tr>
<td>Electives</td>
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</table>

| Total Credits | 15 |

<table>
<thead>
<tr>
<th>Semester 8</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>CS 464 Principles of Human-Computer Interaction</td>
<td>X</td>
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<td>4C</td>
<td>4</td>
</tr>
<tr>
<td>CS*** Course numbered 300- or above</td>
<td>X</td>
<td></td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>Electives</td>
<td>X</td>
<td></td>
<td></td>
<td>7-8</td>
</tr>
<tr>
<td>The benchmark courses for the 8th semester are the remaining courses in the entire program of study.</td>
<td>X</td>
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</tr>
</tbody>
</table>

| Total Credits | 15 |

**Program Total Credits:** 120