**COMPUTER SCIENCE**

**Description**

Website: http://cse.unl.edu  
Email: info@cse.unl.edu

The University of Nebraska–Lincoln Department of Computer Science and Engineering (CSE) offers Nebraska’s only comprehensive program of higher education, research, and service outreach in computer science and computer engineering.

The CSE department offers a challenging baccalaureate degree program in computer science that prepares graduates for professional practice as computer scientists, provides the basis for advanced studies in the field, and establishes a foundation for lifelong learning and achievement. The BS degree in computer science is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

The CSE department also offers a degree of bachelor of science in computer engineering and a bachelor of science in software engineering. All students majoring in the CSE department should see their advisor during the first semester to ensure they understand the differences in the requirements among the three majors. Students should consult with their advisors each semester for registration advising.

**Introductory Courses**

Entering students may select from several introductory courses according to their interests. The Computer Science I courses (CSCE 155E Computer Science I: Systems Engineering Focus, CSCE 155H Honors: Computer Science I, and CSCE 155T Computer Science I: Informatics Focus) all provide a foundation in designing and programming computing solutions and prepare students for more advanced CSCE courses, including CSCE 156 Computer Science II. These courses are designed to meet different interests. CSCE 155E is designed for students majoring in computer science and computer engineering. CSCE 155T is for honors students. CSCE 155T focuses on data and information processing, such as document or database applications, online commerce, or bioinformatics. CSCE 155N Computer Science I: Engineering and Science Focus is for engineering majors and focuses on numerical and graphical computation in engineering and science, such as applied physics, working with time-sequenced data, and matrix applications. CSCE 101 Fundamentals of Computer Science is for students seeking a broad introduction to computer science with brief instruction in computer programming. CSCE 100 Introduction to Informatics focuses on the use of data-centric and information technologies and on issues and challenges in the application of computing in the sciences, engineering, the humanities, and the arts. CSCE 156 is for students with a background in designing and programming computing solutions, such as is provided by Computer Science I.

**Program Assessment.** In order to assist the department in evaluating the effectiveness of its programs, majors will be required in their senior year to complete a written exit survey. Results of participation in these assessment activities will in no way affect a students GPA or graduation.

**Graduate Programs.** The CSE department offers several graduate degree programs: master of science in computer science, master of science in computer science with a computer engineering specialization, master of science in computer science with a bioinformatics specialization, doctor of philosophy in computer science, doctor of philosophy in engineering with a computer engineering specialization, doctor of philosophy in computer science with a bioinformatics specialization, and joint doctor of philosophy in computer science and mathematics. See the Graduate Studies Catalog for details.

**Major Department Admission**

Students are expected to meet minimum university entrance requirements. After being admitted to the college, students desiring to pursue a degree in computer science must go through the Professional Admission process, which is automatically performed for qualifying students at the end of the sophomore year. In order to be considered for Professional Admission to the computer science program, students must receive a "P" or "C" or above in CSCE 310 Data Structures and Algorithms (RAIK 283H Honors: Software Engineering III) and have a GPA of at least 2.5 (semester and cumulative). If a student’s cumulative GPA drops below 2.4, the student may be placed on restricted status, may be removed from the College, and my not be able to graduate.

**College Requirements**

**College Admission**

**College Entrance Requirements**

**College Entrance Requirements for Computer Science majors:**

1. Mathematics – 4 units: 2 of algebra, 1 of geometry, 1 of precalculus and trigonometry
2. English – 4 units
3. Natural sciences – 3 units that must include 1 unit of physics and 1 unit of chemistry (physics and chemistry requirement waived for students in Computer Science)
4. Foreign language – 2 units of a single foreign language
5. Social studies – 3 units
6. Students having a composite ACT score of 28 or greater (or equivalent SAT score) will be admitted to the College of Engineering even if they lack any one of the following: trigonometry, chemistry, or physics.

A total of 16 units is required for admission.

Students must have an ACT (enhanced) score of 20 or greater (or equivalent SAT). Students who lack entrance requirements may be admitted based on ACT scores, high school rank and credits, or may be admitted pre-engineering status in the Exploratory and Pre-Professional Advising Center and will be advised by professional advisors in Computer Science.

Students for whom English is not their language of nurture must meet the minimum English proficiency requirements for the University.

Students should consult their advisor, their department chair, or Engineering Student Services if they have questions on current policies.

**Other Admission Requirements**

Students who transfer to the University of Nebraska–Lincoln from other accredited colleges or universities and wish to be admitted to the College of Engineering (COE) must meet the UNL General Admission Requirements and have a minimum cumulative GPA of 2.5, and be Calculus I-ready. Students transferring from UNO, UNL, or UNK to the College of Engineering must be in good academic standing with their institution.

The COE accepts courses for transfer for which a C or better grade was received. Although the University of Nebraska–Lincoln accepts D grades from the University of Nebraska at Kearney and at Omaha, not all majors in the COE accept such low grades. Students must conform to
the requirements of their intended major and, in any case, are strongly encouraged to repeat courses with a grade of C- or less.

All transfer students must adopt the curricular requirements of the undergraduate catalog current at the time of transfer to the COE—not the one in use when they entered the University of Nebraska—Lincoln. Upon admission to Nebraska, students wishing to pursue degree programs in the COE will be classified and subject to the policies defined in the subsequent section.

Students who were previously admitted to COE and are returning to the College of Engineering must demonstrate a cumulative GPA of 2.5 in order to be readmitted to COE.

**College Degree Requirements**

**Grade Rules**

**Grade Appeals**

In the event of a dispute involving any college policies or grades, the student should appeal to the instructor and appropriate department chair or school director (in that order). If a satisfactory solution is not achieved, the student may appeal the case through the College Academic Appeals Committee on their campus.

**Catalog Rule**

Students must fulfill the requirements stated in the catalog for the academic year in which they are first admitted at the University of Nebraska—Lincoln. In consultation with advisors, a student may choose to follow a subsequent catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at Nebraska in the College of Engineering. Students must complete all degree requirements from a single catalog year. The catalog which a student follows for graduation.

**Learning Outcomes**

Graduates of the computer science program will be able to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program’s discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program’s discipline.
6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

The above student outcomes have been approved by the ABET Engineering Area Delegation for use beginning with the 2019-20 academic year, and have been adopted by the faculty of the Department of Computer Science and Engineering.

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**Major Requirements (Non-Raikes)**

**Core Requirements**

**Required Computer Science Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 10</td>
<td>Introduction to CSE</td>
<td>0</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 155E</td>
<td>Computer Science I: Systems Engineering Focus</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 155H</td>
<td>Honors: Computer Science I</td>
<td></td>
</tr>
<tr>
<td>CSCE 155T</td>
<td>Computer Science I: Informatics Focus</td>
<td></td>
</tr>
<tr>
<td>CSCE 156</td>
<td>Computer Science II</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 231</td>
<td>Computer Systems Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 235</td>
<td>Introduction to Discrete Structures</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 251</td>
<td>Unix Programming Environment</td>
<td>1</td>
</tr>
<tr>
<td>CSCE 310</td>
<td>Data Structures and Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 322</td>
<td>Programming Language Concepts</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 361</td>
<td>Software Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 24

**Technical Electives**

Select 9-11 hours of technical courses from any CSCE 300- or 400-level course.

Credit Hours Subtotal: 9-11

**Senior Design Experience**

Select one of the following sequences. CSCE 486 and CSCE 487 should be taken in consecutive semesters. CSCE 401H and CSCE 402H are by special invitation and permission only.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 351</td>
<td>Operating System Kernels</td>
<td>3</td>
</tr>
<tr>
<td>or CSCE 451</td>
<td>Operating Systems Principles</td>
<td></td>
</tr>
<tr>
<td>CSCE 423</td>
<td>Design and Analysis of Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>or CSCE 428</td>
<td>Automata, Computation, and Formal Languages</td>
<td></td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 6

**Depth Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 486</td>
<td>Computer Science Professional Development</td>
<td>3</td>
</tr>
<tr>
<td>&amp; CSCE 487</td>
<td>and Computer Science Senior Design Project</td>
<td></td>
</tr>
<tr>
<td>CSCE 401H</td>
<td>Honors: RAIK Design Studio I</td>
<td>6</td>
</tr>
<tr>
<td>&amp; CSCE 402H</td>
<td>and Honors: RAIK Design Studio II</td>
<td></td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 6

Total Credit Hours: 21-23

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1. **Select from any CSCE/RAIK 300 or 400 course except CSCE 320, CSCE 391, CSCE 495, and RAIK courses lacking CSCE equivalents (except that RAIK 284H, RAIK 401H, RAIK 402H, RAIK 403H, RAIK 404H, RAIK 405H, and RAIK 406H are acceptable as technical electives).**

2. **Up to 3 hours of CSCE 495 can be used for technical courses. No more than one of MATH 428, MATH 433, MATH 439, MATH 450, MATH 452 may be used. At least 6 credit hours of technical courses must be other than CSCE 394, CSCE 399, CSCE 495, CSCE 493, CSCE 498, CSCE 399H, RAIK 401H, RAIK 402H, RAIK 403H, RAIK 404H, RAIK 405H, and RAIK 406H.**
CSCE 101 may be used to satisfy a technical elective for Computer Science majors if taken at UNL prior to taking CSCE 155, CSCE 156, CSCE 310, and CSCE 361.

Ancillary Requirements

Breadth Courses - Arts, Humanities and Social Sciences

Fulfilled by the completion of six (6) credit hours in Arts, Humanities and Social Sciences courses. At least three (3) credit hours must come from courses certified as "Diversity in US Communities."

Select from a set of approved courses in Anthropology, Art History, Classics, Communication Studies, Economics, English History, Ethnic Studies, Geography, Foreign Languages & Literature, Philosophy, Political Science, Psychology, Religious Studies, Sociology, and Women's and Gender Studies as listed in the degree audit.

Credit Hours Subtotal: 6

Technical Writing

JGEN 200 Technical Communication I or BSAD 220H Honors Business Writing

Credit Hours Subtotal: 3

Foreign Language

Fulfilled by the completion of the 6-credit-hour second-year sequence in a single foreign language in one of the following departments: Classics and religious studies or modern languages and literatures. Instruction is currently available in Arabic, Chinese, Czech, French, German, Greek, Japanese, Latin, Russian, and Spanish.

A student who has completed the fourth-year level of one foreign language in high school is exempt from the language requirement, but encouraged to continue on in their language study.

Mathematics

MATH 106 Calculus I 5
MATH 107 Calculus II 4
MATH 314 Linear Algebra 3
STAT 380 Statistics and Applications 3

Credit Hours Subtotal: 15

Science

Select 12 credit hours of courses intended for science or engineering majors including at least one laboratory. Acceptable disciplines and courses are (not an exhaustive list):

Chemistry

CHEM 109A General Chemistry I and General Chemistry I Laboratory 4
CHEM 110A General Chemistry II and General Chemistry II Laboratory 4
CHEM 221 Elementary Quantitative Analysis
CHEM 113A Fundamental Chemistry I and Fundamental Chemistry I Laboratory 4
CHEM 114 Fundamental Chemistry II

Physics and Astronomy

PHYS 141 Elementary General Physics I
PHYS 142 Elementary General Physics II
PHYS 211 General Physics I

PHYS 221 General Physics Laboratory I
PHYS 212 General Physics II
PHYS 222 General Physics Laboratory II
PHYS 213 General Physics III
PHYS 223 General Physics Laboratory III
ASTR 204 Introduction to Astronomy and Astrophysics
ASTR 224 Astronomy and Astrophysics Laboratory

Biological Sciences

BIOS 111 Introduction to Microbiology and Human Health
BIOS 205 Genetics, Molecular and Cellular Biology Laboratory
BIOS 206 General Genetics
BIOS 207 Ecology and Evolution
LIFE 120 Fundamentals of Biology I & LIFE 120L and Fundamentals of Biology I laboratory
LIFE 121 Fundamentals of Biology II & LIFE 121L and Fundamentals of Biology II Laboratory

Earth and Atmospheric Sciences

GEOG 155 Elements of Physical Geography
GEOL 101 Dynamic Earth
GEOL 103H Honors: Historical Geology
GEOL 410 Geochemistry
METR 100 Weather and Climate
METR 205 Introduction to Atmospheric Science
METR 370 Applied Climatology

Anthropology

ANTH 242 Introduction to Biological Anthropology
ANTH 242L Introduction to Biological Anthropology Laboratory

Credit Hours Subtotal: 24

Total Credit Hours 48

Minor Requirement

Complete at least one minor or a second major.

Major Requirements (Raikes School Students)

Core Requirements

Required Computer Science Courses

RAIK 183H Honors: Computer Problem Solving Essentials 4
RAIK 184H Honors: Software Development Essentials 4
RAIK 283H Honors: Software Engineering III 4
RAIK 284H Software Engineering IV 3
CSCE 231 Computer Systems Engineering 4
CSCE 251 Unix Programming Environment 1
CSCE 322 Programming Language Concepts 3

Credit Hours Subtotal: 23

Required Raikes School Requirements

RAIK 10 Raikes School Freshman Seminar 0
## Specific Major Requirements

### Depth Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 351</td>
<td>Operating System Kernels</td>
<td>3</td>
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<td>CSCE 423</td>
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<td>3</td>
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<tr>
<td>or CSCE 428</td>
<td>Automata, Computation, and Formal Languages</td>
<td></td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 6

### Technical Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAIK 370H</td>
<td>Honors: Data and Models II: Data Science Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>RAIK 403H</td>
<td>Honors: RAIK Design Studio III</td>
<td>3</td>
</tr>
<tr>
<td>Select an additional CSCE or RAIK 300- or 400-level course. 1</td>
<td>3-4</td>
<td></td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 9-10

### Senior Design Experience

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAIK 401H</td>
<td>Honors: RAIK Design Studio I</td>
<td>3</td>
</tr>
<tr>
<td>RAIK 402H</td>
<td>Honors: RAIK Design Studio II</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 6

Total Credit Hours: 21-22

1 Select from any CSCE or RAIK 300- or 400-level course except CSCE 320, CSCE 391, CSCE 399, CSCE 399H, CSCE 495, CSCE 493, CSCE 493, CSCE 493A, CSCE 498, RAIK 404H, and RAIK 406H.

## Ancillary Requirements

### Breadth Courses - Arts, Humanities and Social Sciences

Fulfilled by the completion of six (6) credit hours in Arts, Humanities and Social Sciences courses. At least three (3) credit hours must come from courses certified as "Diversity in US Communities."

Select from a set of approved courses in Anthropology, Art History, Classics, Communication Studies, Economics, English, History, Ethnic Studies, Geography, Foreign Languages & Literature, Philosophy, Political Science, Psychology, Religious Studies, Sociology, and Women's and Gender Studies as listed in the degree audit.

Credit Hours Subtotal: 6

### Technical Writing

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAIK 288H</td>
<td>Honors Business Writing</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 3

### Foreign Language

Fulfilled by the completion of the 6-credit-hour second-year sequence in a single foreign language in one of the following departments: Classics and religious studies or modern languages and literatures. Instruction is currently available in Arabic, Chinese, Czech, French, German, Greek, Japanese, Latin, Russian, and Spanish.

A student who has completed the fourth-year level of one foreign language in high school is exempt from the language requirement, but encouraged to continue on in their language study.

### Mathematics

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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 106</td>
<td>Calculus I</td>
<td>5</td>
</tr>
<tr>
<td>MATH 107</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>RAIK 270H / STAT 380 / STAT 380H</td>
<td>Statistics and Applications</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 15

### Science

Select 12 credit hours of courses intended for science or engineering majors including at least one laboratory. Acceptable disciplines and courses are (not an exhaustive list):

- Chemistry
  - CHEM 109A & CHEM 109L | General Chemistry I and General Chemistry I Laboratory | 4 |
  - CHEM 110A & CHEM 110L | General Chemistry II and General Chemistry II Laboratory | 4 |
  - CHEM 221 | Elementary Quantitative Analysis | |
  - CHEM 113A & CHEM 113L | Fundamental Chemistry I and Fundamental Chemistry I Laboratory | 4 |
  - CHEM 114 | Fundamental Chemistry II | |

- Physics and Astronomy
  - PHYS 141 | Elementary General Physics I | |
  - PHYS 142 | Elementary General Physics II | |
  - PHYS 211 | General Physics I | |
  - PHYS 221 | General Physics Laboratory I | |
  - PHYS 212 | General Physics II | |
  - PHYS 222 | General Physics Laboratory II | |
  - PHYS 213 | General Physics III | |
  - PHYS 223 | General Physics Laboratory III | |
  - ASTR 204 | Introduction to Astronomy and Astrophysics | |
  - ASTR 224 | Astronomy and Astrophysics Laboratory | |

- Biological Sciences
  - BIOS 111 | Introduction to Microbiology and Human Health | |
  - BIOS 205 | Genetics, Molecular and Cellular Biology Laboratory | |
  - BIOS 206 | General Genetics | |
  - BIOS 207 | Ecology and Evolution | |
  - LIFE 120 & LIFE 120L | Fundamentals of Biology I and Fundamentals of Biology I laboratory | |
  - LIFE 121 & LIFE 121L | Fundamentals of Biology II and Fundamentals of Biology II Laboratory | |

- Earth and Atmospheric Sciences
  - GEOG 155 | Elements of Physical Geography | |
  - GEOL 101 | Dynamic Earth | |
  - GEOL 103H | Honors: Historical Geology | |
  - GEOL 410 | Geochemistry | |
  - METR 100 | Weather and Climate | |

### Ancillary Requirements

Fulfilled by the completion of six (6) credit hours in Arts, Humanities and Social Sciences courses. At least three (3) credit hours must come from courses certified as "Diversity in US Communities."

Select from a set of approved courses in Anthropology, Art History, Classics, Communication Studies, Economics, English, History, Ethnic Studies, Geography, Foreign Languages & Literature, Philosophy, Political Science, Psychology, Religious Studies, Sociology, and Women's and Gender Studies as listed in the degree audit.

Credit Hours Subtotal: 6

### Technical Writing

<table>
<thead>
<tr>
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<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>RAIK 288H</td>
<td>Honors Business Writing</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 3

### Foreign Language

Fulfilled by the completion of the 6-credit-hour second-year sequence in a single foreign language in one of the following departments: Classics and religious studies or modern languages and literatures. Instruction is currently available in Arabic, Chinese, Czech, French, German, Greek, Japanese, Latin, Russian, and Spanish.

A student who has completed the fourth-year level of one foreign language in high school is exempt from the language requirement, but encouraged to continue on in their language study.

### Mathematics

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<td>MATH 106</td>
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<td>4</td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>RAIK 270H / STAT 380 / STAT 380H</td>
<td>Statistics and Applications</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 15

### Science

Select 12 credit hours of courses intended for science or engineering majors including at least one laboratory. Acceptable disciplines and courses are (not an exhaustive list):

- Chemistry
  - CHEM 109A & CHEM 109L | General Chemistry I and General Chemistry I Laboratory | 4 |
  - CHEM 110A & CHEM 110L | General Chemistry II and General Chemistry II Laboratory | 4 |
  - CHEM 221 | Elementary Quantitative Analysis | |
  - CHEM 113A & CHEM 113L | Fundamental Chemistry I and Fundamental Chemistry I Laboratory | 4 |
  - CHEM 114 | Fundamental Chemistry II | |

- Physics and Astronomy
  - PHYS 141 | Elementary General Physics I | |
  - PHYS 142 | Elementary General Physics II | |
  - PHYS 211 | General Physics I | |
  - PHYS 221 | General Physics Laboratory I | |
  - PHYS 212 | General Physics II | |
  - PHYS 222 | General Physics Laboratory II | |
  - PHYS 213 | General Physics III | |
  - PHYS 223 | General Physics Laboratory III | |
  - ASTR 204 | Introduction to Astronomy and Astrophysics | |
  - ASTR 224 | Astronomy and Astrophysics Laboratory | |

- Biological Sciences
  - BIOS 111 | Introduction to Microbiology and Human Health | |
  - BIOS 205 | Genetics, Molecular and Cellular Biology Laboratory | |
  - BIOS 206 | General Genetics | |
  - BIOS 207 | Ecology and Evolution | |
  - LIFE 120 & LIFE 120L | Fundamentals of Biology I and Fundamentals of Biology I laboratory | |
  - LIFE 121 & LIFE 121L | Fundamentals of Biology II and Fundamentals of Biology II Laboratory | |

- Earth and Atmospheric Sciences
  - GEOG 155 | Elements of Physical Geography | |
  - GEOL 101 | Dynamic Earth | |
  - GEOL 103H | Honors: Historical Geology | |
  - GEOL 410 | Geochemistry | |
  - METR 100 | Weather and Climate | |
Requirements for Minor Offered by Department

Minor in Computer Science – Non-Raikes School Students
Eighteen (18) hours of computer science courses as follows.

Select one of the following: 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 155H</td>
<td>Honors: Computer Science I</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 155E</td>
<td>Computer Science I: Systems Engineering Focus</td>
<td></td>
</tr>
<tr>
<td>CSCE 155T</td>
<td>Computer Science I: Informatics Focus</td>
<td></td>
</tr>
</tbody>
</table>

Select at least one of the following: 3-4

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 156</td>
<td>Computer Science II</td>
<td></td>
</tr>
<tr>
<td>CSCE 311</td>
<td>Data Structures and Algorithms for Informatics</td>
<td></td>
</tr>
<tr>
<td>CSCE 300-400-level course</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Additional CSCE courses</td>
<td></td>
<td>8-9</td>
</tr>
</tbody>
</table>

Total Credit Hours: 18

1 Excluding CSCE 100, CSCE 101L, CSCE 120, CSCE 220, or CSCE 320.

Minor in Computer Science – Raikes School Students
Eighteen (18) hours of computer science courses, including:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 183H / RAIK 183H</td>
<td>Honors: Computer Problem Solving Essentials</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 184H / RAIK 184H</td>
<td>Honors: Software Development Essentials</td>
<td>4</td>
</tr>
<tr>
<td>SOFT 260H / RAIK 283H</td>
<td>Honors: Software Engineering III</td>
<td>4</td>
</tr>
<tr>
<td>Additional CSCE courses (or RAIK courses cross-listed as CSCE) at the 200 level or above.</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Total Credit Hours: 18

2 Except CSCE 235 and courses designated as not counting toward the minor (see CSCE course list in the catalog or the degree audit).

3 No more than 3 hours for RAIK Design Studio courses RAIK 401H, RAIK 402H, RAIK 403H, RAIK 404H.

Grade Rules

C- and D Grades
A grade of C or above is required for all courses in the major and minor, excluding ancillary courses.

Pass/No Pass
Up to 3 hours of Pass/No Pass CSCE coursework may be counted toward the minor.

Restriction
Students majoring in computer science may not declare a minor in informatics or software development.

Restriction
Students minoring in computer science may not declare a minor in informatics or software development. The computer science minor is not available to students majoring in computer engineering or software engineering.
CSCE 100 Introduction to Informatics
Prerequisites: Placement in to MATH 101 or higher
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering.
Description: Introduction to the use of data-centric and information technologies and issues and challenges in today's applications in sciences, engineering, the humanities, and the arts. Exposure to computational thinking and programming, statistical thinking and research design, data analysis and database techniques, and visualization and creative thinking.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 101 Fundamentals of Computer Science
Notes: A course in the science of computation suitable for prospective CSCE majors and for non-CSCE majors who desire a deeper understanding of computers and the work of computer scientists. This course may be used to satisfy a technical elective for Computer Science and Computer Engineering majors if taken at UNL prior to CSCE 155, CSCE 156, CSCE 310 and CSCE 361, or for Software Engineering majors, if taken at UNL prior to SOFT 160, SOFT 161, SOFT 260 and SOFT 261.
Description: Introduction to problem solving with computers. Problem analysis and specification, algorithm development, program design, and implementation in a high-level programming environment. Hardware, software, software engineering, networks, and impacts of computing on society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 101L
ACE: ACE 3 Math/Stat/Reasoning

CSCE 101L Fundamentals of Computing Laboratory
Prerequisites: CSCE 101 or parallel.
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering.
Description: A variety of computer oriented exercises using many software tools is presented which supplement and are coordinated with the topics taught in CSCE 101. Students are exposed to programming, operating systems, simulation software, spreadsheets, database software, the Internet, etc. Applications software introduced in the context of tools to explore the computer science topics and as alternatives to traditional programming languages. Emphasis on learning by experiment, with a goal of developing problem solving skills. A major component is the study of a programming language-the choice of which may vary by course section.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded with Option

CSCE 120 Learning to Code
Prerequisites: Placement in to MATH 101 or higher
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering. First course in a sequence for the minor in Software Development.
Description: Introduction to coding in the context of current web development technologies (JavaScript, HTML, CSS). Basic coding skills and an introduction to computing with an emphasis on processing data: data formatting and structure, data manipulation, data presentation and the basics of an interactive program.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 155A Computer Science I
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Credit may be earned in only one CSCE 155 course. Recommended for students majoring in computer science or computer engineering.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156; CSCE 156H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 123; ECEN 224; MECH 300
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155E Computer Science I: Systems Engineering Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Credit may be earned in only one CSCE 155 course. Recommended for students interested in systems engineering, such as operating systems, mobile computing, and embedded devices.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156; CSCE 156H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 123; ECEN 224; MECH 300
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155H Honors: Computer Science I
Prerequisites: Good standing in UNL Honors Program; MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Covers the same topics as CSCE 155A, but in greater depth.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156; CSCE 156H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 224; MECH 300
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155N Computer Science I: Engineering and Science Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Recommended for students interested in numerical and graphical applications in engineering and science, such as applied physics, working with time-sequence data, and matrix applications.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: BSEN 311; CHME 312; CSCE 156; CSCE 156H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 224; MECH 300; MECH 318; MECH 330; MECH 350; MECH 381
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155T Computer Science I: Informatics Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Credit may be earned in only one CSCE 155 course. Recommended for students interested in data and information processing, such as library and database applications, online commerce, and bioinformatics.
Description: Introduction to computers and problem-solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156; CSCE 156H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 224; MECH 300
ACE: ACE 3 Math/Stat/Reasoning

CSCE 156 Computer Science II
Prerequisites: A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, or CSCE 155T; coreq: MATH 106.
Notes: Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Data structures, including linked lists, stacks, queues, and trees; algorithms, including searching, sorting, and recursion; programming language topics, including object-oriented programming; pointers, references, and memory management; design and implementation of a multilayer application with SQL database.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: CSCE 235; CSCE 310; CSCE 310H; CSCE 322; CSCE 322H; CSCE 378; CSCE 378H; SOFT 162

CSCE 156H Honors: Computer Science II
Prerequisites: Good standing UNL Honors Program. A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, or CSCE 155T; Coreq: MATH 106.
Notes: Covers the same topics as CSCE 156, but in greater depth. Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Data structures, including linked lists, stacks, queues, and trees; algorithms, including searching, sorting, and recursion; programming language topics, including object-oriented programming; pointers, references, and memory management; design and implementation of a multilayer application with SQL database.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded
Prerequisite for: CSCE 310; CSCE 310H; CSCE 322; CSCE 322H; CSCE 378; CSCE 378H; SOFT 162

CSCE 163H Honors: Innovation Processes and Software Engineering Fundamentals
Crosslisted with: RAIK 163H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management.
Description: Introduction to innovation processes for interdisciplinary and team-oriented problem solving of software engineering, business development, and industrial design problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL
CSCE 183H Honors: Computer Problem Solving Essentials
Crosslisted with: RAIK 183H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management.
Description: Introduction to problem solving with computers. Problem analysis and specification, algorithm development, program design, and implementation. JAVA in a Windows platform.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded
Prerequisite for: CSCE 235; CSCE 235H; ECON 215; RAIK 184H, CSCE 184H
ACE: ACE 3 Math/Stat/Reasoning

CSCE 184H Honors: Software Development Essentials
Crosslisted with: RAIK 184H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 183H.
Description: Problem solving with computers. Problem analysis and specification, data structures, relational databases, algorithm development, and program design and implementation. Discrete mathematics topics, propositional and predicate logic, sets, relations, functions, and proof techniques. Software Development Principles.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded
Prerequisite for: CSCE 183H

CSCE 191 Special Topics in Computer Science
Prerequisites: Permission.
Notes: Will not count towards a major or minor in computer science and computer engineering. Topics will vary.
Description: Aspects of computers and computing at the freshman level for non-computer science and computer engineering majors and/or minors.
Credit Hours: 1-3
Max credits per semester: 1
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 192 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.
Credit Hours: 1-3
Max credits per semester: 1
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 194 Independent Study in Computing
Prerequisites: Freshmen standing; permission of the instructor.
Description: Independent study of computer science topics performed under the guidance of a member of the faculty in the Department of Computer Science and Engineering.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 220 Software Development for Smart-Mobile Systems
Prerequisites: CSCE 120
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering. Second course in a sequence for the minor in Software Development.
Description: Practical experience on building larger scale applications and familiarity with the tools, environments (e.g., Android or iOS), and requirements to develop software for current smart-mobile devices such as phones and tablets.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 320

CSCE 230 Computer Organization
Prerequisites: A grade of 'P' or 'C' or better in CSCE 235, CSCE 235H, or RAIK 184H.
Notes: Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Introduction to organization and structure of computer systems. Boolean logic, digital arithmetic, processor organization, machine language programming, input/output, memory organization, system support software, communication, and ethics.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: CSCE 336; CSCE 351; ECEN 220; ECEN 370, CSCE 335

CSCE 231 Computer Systems Engineering
Prerequisites: Grade of "P" or "C" or better in CSCE 235, CSCE 235H or RAIK 184H.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: CSCE 336; CSCE 351
CSCE 235 Introduction to Discrete Structures  
**Prerequisites:** A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, SOFT 160, SOFT 160H or RAIK 183H; and MATH 106.  
**Notes:** Theoretical concepts with programming assignments. CSCE235H covers the same topics as CSCE235, but in greater depth.  
**Description:** Survey of elementary discrete mathematics. Elementary graph and tree theories, set theory, relations and functions, propositional and predicate logic, methods of proof, induction, recurrence relations, principles of counting, elementary combinatorics, and asymptotic notations.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
Grading Option: Graded with Option  
**Prerequisite for:** CSCE 230; CSCE 231; CSCE 310; CSCE 310H; SOFT 260  

CSCE 235H Honors: Introduction to Discrete Structures  
**Prerequisites:** Good standing in the University of Honors Program. A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, SOFT 160, SOFT 160H or RAIK 183H; and MATH 106.  
**Notes:** Theoretical concepts with programming assignments. CSCE235H covers the same topics as CSCE235, but in greater depth.  
**Description:** Survey of elementary discrete mathematics. Elementary graph and tree theories, set theory, relations and functions, propositional and predicate logic, methods of proof, induction, recurrence relations, principles of counting, elementary combinatorics, and asymptotic notations.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
Grading Option: Graded with Option  

CSCE 251 Unix Programming Environment  
**Notes:** Familiarity with at least one high-level programming language.  
**Description:** Introduction to the Unix operating system. Unix file system. Unix tools and utilities. Shell programming.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
Grading Option: Graded with Option  

CSCE 283H Honors: Foundations of Computer Science  
**Prerequisites:** Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 184H.  
**Notes:** CSCE/RAIK 283H is the third course in the Jeffrey S. Raikes School of Computer Science and Management core.  
**Description:** Advanced data structures and algorithms that solve common problems and standard approaches to solving new problems. Analysis and comparison of algorithms, asymptotic notation and proofs of correctness. Discrete mathematics. Induction and principles of counting and combinatorics as foundation for analysis.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
Grading Option: Graded  
**Prerequisite for:** CSCE 351; CSCE 361, CSCE 361H  

CSCE 291 Special Topics in Computer Science  
**Prerequisites:** Permission.  
**Notes:** Will not count towards a major or minor in computer science and computer engineering. Topics vary.  
**Description:** Aspects of computers and computing for non-computer science and computer engineering majors and/or minors.  
**Credit Hours:** 1-3  
**Min credits per semester:** 1  
**Max credits per semester:** 3  
**Max credits per degree:** 6  
Grading Option: Graded with Option  

CSCE 292 Special Topics in Computer Science  
**Graded with Option**  

CSCE 294 Independent Study in Computing  
**Graded with Option**  

CSCE 310 Data Structures and Algorithms  
**Graded with Option**  

CSCE 310H Honors: Data Structures and Algorithms  
**Prerequisites:** Good standing in UNL Honors Program or by invitation; grades of "P" or "C" or better in CSCE 156/156H or SOFT 161 and CSCE 235/235H.  
**Notes:** Theoretical concepts with programming assignments.  
**Description:** A review of algorithm analysis, asymptotic notation, and solving recurrence relations. Advanced data structures and their associated algorithms, heaps, priority queues, hash tables, trees, binary search trees, and graphs. Algorithmic techniques, divide and conquer, transform and conquer, space-time trade-offs, greedy algorithms, dynamic programming, randomization, and distributed algorithms. Introduction to computability and NP-completeness.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
Grading Option: Graded with Option  
**Prerequisite for:** CSCE 351; CSCE 361, CSCE 361H; CSCE 493  

CSCE 310H Honors: Data Structures and Algorithms  
**Graded with Option**  

CSCE 351; CSCE 493
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Prerequisites</th>
<th>Notes</th>
<th>Description</th>
<th>Grading Option</th>
<th>Max credits per semester</th>
<th>Max credits per degree</th>
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</thead>
<tbody>
<tr>
<td>CSCE 310</td>
<td>Data Structures and Algorithms for Informatics</td>
<td>Grade of &quot;P&quot; or &quot;C&quot; or better in CSCE 155A, CSCE 155E, CSCE 156H, CSCE 157A, CSCE 157B, or SOFT 160.</td>
<td>CSE majors must take CSCE 310. Students may not receive credit for both CSCE 310 and 311.</td>
<td>An introduction to algorithms and data structures for informatics. Foundational coverage of algorithms includes both problems (such as indexing, searching, sorting, and pattern matching) and methods (such as greedy, divide-and-conquer, and dynamic programming). Foundational coverage of data structures includes lists, tables, relational databases, regular expressions, trees, graphs, and multidimensional arrays. The topics will be studied in the context of informatics applications.</td>
<td>Graded with Option</td>
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<tr>
<td>CSCE 320</td>
<td>Data Analysis</td>
<td>A grade of &quot;P&quot; or &quot;C&quot; or better in CSCE 120 or CSCE 220.</td>
<td>Course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering. Third course in a sequence for the minor in Software Development.</td>
<td>Practical experience on how to model data through existing techniques including object-oriented and relational models. These models can then be used at the center of systems to promote efficient and effective data processing and analysis.</td>
<td>Graded with Option</td>
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<tr>
<td>CSCE 321</td>
<td>Programming Language Concepts</td>
<td>A grade of &quot;P&quot; or &quot;C&quot; or better in CSCE 316, CSCE 361, CSCE 361H, CSCE 378; CSCE 493; CSCE 493A</td>
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<td>Graded with Option</td>
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<tr>
<td>CSCE 335</td>
<td>Digital Logic Design</td>
<td>Requires participation in a group design and implementation of a software project.</td>
<td>Uses technology developed in the discipline to design and implement a software project.</td>
<td>Design and implementation of hardware circuits and microprocessor systems. Design tools, write device drivers in a high-level language, set up embedded and real-time operating systems, and develop applications for embedded systems.</td>
<td>Graded with Option</td>
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<tr>
<td>ECEN 301</td>
<td>Operating System Kernels</td>
<td>A grade of &quot;P&quot; or &quot;C&quot; or better in CSCE 230 or CSCE 2311</td>
<td></td>
<td>Introduction to designing, interfacing, configuring, and programming embedded systems. Create simple embedded microprocessor systems, control peripherals, write device drivers in a high-level language, set up embedded and real-time operating systems, and develop applications for embedded systems.</td>
<td>Graded with Option</td>
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<tr>
<td>CSCE 351</td>
<td>Digital Logic Design</td>
<td>A grade of &quot;P&quot; or &quot;C&quot; or better in CSCE 231 or CSCE 231.</td>
<td></td>
<td>Design and implementation of hardware circuits and microprocessor systems. Design tools, write device drivers in a high-level language, set up embedded and real-time operating systems, and develop applications for embedded systems.</td>
<td>Graded with Option</td>
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<tr>
<td>ECEN 307</td>
<td>Operating System Kernels</td>
<td>A grade of &quot;P&quot; or &quot;C&quot; or better in CSCE 230 or CSCE 231.</td>
<td></td>
<td>Introduction to designing, interfacing, configuring, and programming embedded systems. Create simple embedded microprocessor systems, control peripherals, write device drivers in a high-level language, set up embedded and real-time operating systems, and develop applications for embedded systems.</td>
<td>Graded with Option</td>
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<tr>
<td>CSCE 361</td>
<td>Software Engineering</td>
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<td>Graded with Option</td>
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<tr>
<td>ECEN 370</td>
<td>Operating System Kernels</td>
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<td>Graded with Option</td>
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</table>
CSCE 361H Software Engineering
Crosslisted with: CSCE 361
Prerequisites: Good standing in the University Honors Program. A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: Requires participation in a group design and implementation of a software project.
Description: Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 461, CSCE 861, SOFT 461; CSCE 486; CSCE 488

CSCE 370H Honors: Data and Models II: Data Science Fundamentals
Crosslisted with: RAIK 370H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and RAIK 270H
Description: Introduction to approaches using data for prediction and learning. Exploration of data for linear and nonlinear data modeling, machine learning, and supportive methods from statistics and numerical methods.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR

CSCE 378 Human-Computer Interaction
Prerequisites: A grade of "P" or "C" or better in CSCE 156, CSCE 156H, SOFT 161, SOFT 161H, RAIK 184H or CSCE 311.
Notes: MATH/STAT 380 or ECEN 305 recommended. Meeting ACE1 and ACE2 requirements prior to taking this course recommended.
Description: Knowledge and techniques useful in the design of computing systems for human use. Includes models of HCI, human information processing characteristics important in HCI, computer system features, such as input and output devices, dialogue techniques, and information presentation, task analysis, prototyping and the iterative design cycle, user interface implementation, interface evaluation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 378H Honors: Human-Computer Interaction
Prerequisites: Good standing in the University Honors Program; A grade of "P" or "C" or better in CSCE 156, CSCE 156H, SOFT 161, SOFT 161H, RAIK 184H or CSCE 311.
Notes: MATH/STAT 380, ECEN 305 or RAIK 270H recommended. Meeting ACE1 and ACE2 requirements prior to taking this course recommended.
Description: Knowledge and techniques useful in the design of computing systems for human use. Includes models of HCI, human information processing characteristics important in HCI, computer system features, such as input and output devices, dialogue techniques, and information presentation, task analysis, prototyping and the iterative design cycle, user interface implementation, interface evaluation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 383H Honors: Fundamentals of Software Engineering
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 284H.
Description: Proper principles and methods of engineering software. Requirements, design, implementation, management and software evolution.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 391 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for non-computer science and computer engineering majors and/or minors. Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option

CSCE 392 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option

CSCE 394 Independent Study in Computing
Prerequisites: Junior standing; permission of the instructor.
Description: Independent study of computer science topics performed under the guidance of a member of the faculty in the Department of Computer Science and Engineering.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 399 Undergraduate Thesis
Prerequisites: Permission.
Description: Independent practice and research leading to a thesis.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded

CSCE 399H Honors Undergraduate Thesis
Prerequisites: Permission.
Description: Independent practice and research leading to a thesis.

CSCE 401H Honors: RAIK Design Studio I
Crosslisted with: RAIK 401H, BSAD 401H, SOFT 401H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; RAIK 383H or equivalent.
Notes: First semester in the Jeffrey S. Raikes School of Computer Science and Management design studio
Description: Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL
Prerequisite for: RAIK 402H, BSAD 402H, CSCE 402H

CSCE 402H Honors: RAIK Design Studio II
Crosslisted with: RAIK 402H, BSAD 402H, SOFT 402H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; BSAD/CSCE/SOFT/RAIK 401H.
Notes: Second semester in the Jeffrey S. Raikes School of Computer Science and Management design studio
Description: Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: SPRING
Prerequisite for: RAIK 403H, BSAD 403H, CSCE 403H

CSCE 403H Honors: RAIK Design Studio III
Crosslisted with: RAIK 403H, BSAD 403H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; BSAD/CSCE/SOFT/RAIK 402H.
Notes: Third semester of Jeffrey S. Raikes School of Computer Science and Management design studio sequence.
Description: Application of Jeffrey S. Raikes School of Computer Science and Management core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: RAIK 404H, BSAD 404H, CSCE 404H

CSCE 404H Honors: RAIK Design Studio IV
Crosslisted with: RAIK 404H, BSAD 404H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and BSAD/CSCE/SOFT/RAIK 403H.
Notes: Fourth semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.
Description: Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: SPRING
Prerequisite for: RAIK 405H, BSAD 405H

CSCE 405H Honors: RAIK Research Studio I
Crosslisted with: RAIK 405H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; RAIK 383H or equivalent.
Notes: First semester of Jeffrey S. Raikes School of Computer Science and Management research studio experience. Students work individually with a sponsoring faculty member from the area of their research and Raikes School faculty.
Description: Application of research principles to solve complex problems through the delivery of innovative, cutting-edge solutions and to gain an understanding of the roles involved.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL
Prerequisite for: CSCE 406H, RAIK 406H

CSCE 406H Honors: RAIK Research Studio II
Crosslisted with: RAIK 406H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; RAIK 383H or equivalent.
Notes: First semester of Jeffrey S. Raikes School of Computer Science and Management research studio experience. Students work individually with a sponsoring faculty member from the area of their research and Raikes School faculty.
Description: Application of research principles to solve complex problems through the delivery of innovative, cutting-edge solutions and to gain an understanding of the roles involved.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL
Prerequisite for: CSCE 406H, RAIK 406H

ACE: ACE 8 Civic/Ethics/Stewardship

ACE: ACE 10 Integrated Product
CSCE 406H Honors: RAIK Research Studio II
Crosslisted with: RAIK 406H
Prerequisites: RAIK 405H
Notes: Second semester of Jeffrey S. Raikes School of Computer Science and Management research studio experience. Students work individually with a sponsoring faculty member from the area of their research and Raikes School faculty.
Description: Application of research principles to solve complex problems through the delivery of innovative, cutting-edge solutions and to gain an understanding of the roles involved.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: SPRING

CSCE 410 Information Retrieval Systems
Crosslisted with: CSCE 810
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: SPRING

CSCE 411 Data Modeling for Systems Development
Crosslisted with: CSCE 811
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Concepts of relational and object-oriented data modeling through the process of data model development including conceptual, logical and physical modeling. Techniques for identifying and creating relationships between discrete data members, reasoning about how data modeling and analysis are incorporated in system design and development, and specification paradigms for data models. Common tools and technologies for engineering systems and frameworks for integrating data. Design and analysis of algorithms and techniques for identification and exploration of data relationships, such as Bayesian probability and statistics, clustering, map-reduce, and web-based visualization.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 412 Data Visualization
Crosslisted with: CSCE 812
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314.
Description: Fundamentals and implementations of data visualization techniques. Programming skills and practices in interactive visualization applications. Visualization foundations, human perception for information processing, and visualization techniques for different data types, such as scalar-field data, vector-field data, geospatial data, multivariate data, graph/network data, and text/document data. Advanced visualization algorithms and topics as time permits.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPRING

CSCE 413 Database Systems
Crosslisted with: CSCE 813
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: Involves practical experience with a working database system.
Description: Data and storage models for database systems; entity/relationship, relational, and constraint models; relational databases; relational algebra and calculus; structured query language; Logical database design; normalization; integrity; distributed data storage; concurrency; security issues. Spatial databases and geographic information systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 913; CSCE 914

CSCE 421 Foundations of Constraint Processing
Crosslisted with: CSCE 821
Prerequisites: A grade of "P" or "C" or better in CSCE 235 and CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Constraint processing for articulating and solving industrial problems such as design, scheduling, and resource allocation. The foundations of constraint satisfaction, its basic mechanisms (e.g., search, backtracking, and consistency-checking algorithms), and constraint programming languages. New directions in the field, such as strategies for decomposition and for symmetry identification.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 921
CSCE 423 Design and Analysis of Algorithms
Crosslisted with: CSCE 823
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Mathematical preliminaries. Strategies for algorithm design, including divide-and-conquer, greedy, dynamic programming and backtracking. Mathematical analysis of algorithms. Introduction to NP-Completeness theory, including the classes P and NP, polynomial transformations and NP-complete problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 923; CSCE 924

CSCE 424 Computational Complexity Theory
Crosslisted with: CS 824
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 425 Compiler Construction
Crosslisted with: CSCE 825
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Review of program language structures, translation, loading, execution, and storage allocation. Compilation of simple expressions and statements. Organization of a compiler including compile-time and runtime symbol tables, lexical scan, syntax scan, object code generation, error diagnostics, object code optimization techniques, and overall design.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 428 Automata, Computation, and Formal Languages
Crosslisted with: CSCE 828
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Introduction to the classical theory of computer science. Finite state automata and regular languages, minimization of automata. Context free languages and pushdown automata, Turing machines and other models of computation, undecidable problems, introduction to computational complexity.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 430 Computer Architecture
Crosslisted with: CSCE 830
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; Coreq: MATH/STAT 380, ECEN 305 or RAIK 270H.
Description: Architecture of single-processor (von Neumann or SISD) computer systems. Evolution, design, implementation, and evaluation of state-of-the-art systems. Memory systems, including interleaving, hierarchies, virtual memory and cache implementations; Communications and I/O, including bus architectures, arbitration, I/O processors and DMA channels; and Central Processor Architectures, including RISC and Stack machines, high-speed arithmetic, fetch/execute overlap, and parallelism in a single-processor system.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 435 Cluster and Grid Computing
Crosslisted with: CSCE 835
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H, or RAIK 283H.
Notes: Designed for CSCE and non-CSCE students who have an interest in building or programming clusters to enhance their computationally-intensive research.
Description: Build and program clusters. Cluster construction, cluster administration, cluster programming, and grid computing.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 436 Advanced Embedded Systems
Crosslisted with: CSCE 836
Prerequisites: A grade of "P" or "C" or better in CSCE 231, CSCE 236 or ECEN 220.
Description: Embedded hardware design techniques; transceiver design and low-power communication techniques; sensors and distributed sampling techniques; embedded software design and embedded operating systems; driver development; embedded debugging techniques, hardware and software architectures of embedded systems; and design, development, and implementation of embedded applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 438 Internet of Things
Crosslisted with: CSCE 838
Prerequisites: CSCE 230 or CSCE 231; SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent; senior or graduate standing or instructor permission.
Description: Theoretical and practical insight into the Internet of Things (IoT). Basics of IoT, including devices and sensors, connectivity, cloud processing and storage, analytics and machine learning, security, business models as well as advanced topics such as localization, synchronization, connected vehicles, and applications of IoT. Includes a group project that provides hands-on interaction with IoT.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 439 Robotics: Algorithms and Applications
Crosslisted with: CSCE 839
Prerequisites: A grade of "P" or "C" or better in CSCE 231, CSCE 236 or ECEN 220 and CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H
Description: Fundamental theory and algorithms for real world robot systems. Design and build a robot platform and implement algorithms in C++ or other high level languages. Topics include: open and closed loop control, reactive control, localization, navigation, path planning, obstacle avoidance, dynamics, kinematics, manipulation and grasping, sensing, robot vision processing, and data fusion.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR

CSCE 440 Numerical Analysis I
Crosslisted with: CSCE 840, MATH 440, MATH 840
Prerequisites: CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; MATH 107.
Notes: Credit toward the degree may be earned in only one of the following: CSCE/MATH 440/840 and MECH 480/880.
Description: Principles of numerical computing and error analysis covering numerical error, root finding, systems of equations, interpolation, numerical differentiation and integration, and differential equations. Modeling real-world engineering problems on digital computers. Effects of floating point arithmetic.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 942, MATH 942

CSCE 441 Approximation of Functions
Crosslisted with: CSCE 841, MATH 441, MATH 841
Prerequisites: MATH 221/MATH 221H and MATH 314/MATH 314H.
Description: Polynomial interpolation, uniform approximation, orthogonal polynomials, least-first-power approximation, polynomial and spline interpolation, approximation and interpolation by rational functions.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 942, MATH 942
Groups: Advanced Mathematics Courses

CSCE 447 Numerical Linear Algebra
Crosslisted with: CSCE 847, MATH 447, MATH 847
Prerequisites: MATH 314
Description: Mathematics and algorithms for numerically stable matrix and linear algebra computations, including solution of linear systems, computation of eigenvalues and eigenvectors, singular value decomposition, and QR decomposition.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 942, MATH 942
Groups: Advanced Mathematics Courses

CSCE 451 Operating Systems Principles
Crosslisted with: CSCE 851
Prerequisites: A grade of "P" or "C" or better in CSCE 230, CSCE 230H or CSCE 310 and CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 454 Human-Robot Interaction
Crosslisted with: CSCE 854
Prerequisites: A grade of "P" or "C" or better in CSCE 156, CSCE 156H, SOFT 161, SOFT 161H, RAIK 184H or CSCE 311.
Notes: Meeting ACE1 and ACE2 requirements prior to taking this course is recommended. Non-CSCE majors may discuss qualifications with the instructor.
Description: Introduction to the area of human-robot interaction through the reading and discussion of current peer-reviewed articles on topics to include teleoperation, social robotics, and open questions with field-based or aerial robotic systems. Areas covered include: research methods, experimental design, and identification of problems/open questions.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR

CSCE 455 Distributed Operating Systems
Crosslisted with: CSCE 855
Prerequisites: CSCE 451/851.
Description: Organization and structure of distributed operating systems. Control, communication and synchronization of concurrent processes in the context of distributed systems. Processor allocation and scheduling. Deadlock avoidance, detection, recovery in distributed systems. Fault tolerance. Distributed file system concepts and structure.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 456 Parallel Programming
Crosslisted with: CSCE 856
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H, or RAIK 283H.
Description: Introduction to the fundamentals of parallel computation and applied algorithm design. Methods and models of modern parallel computation; general techniques for designing efficient parallel algorithms for distributed and shared memory multiprocessor machines; principles and practice in programming an existing parallel machine.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 457 Systems Administration
Crosslisted with: CSCE 857
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAiK 283H.
Description: Introduction to basic concepts of system administration. Operating systems and networking overview. User and resource management. Networking, systems and internet related security. System services and common applications, web services, database services, and mail servers. Basic scripting in shell, Perl, and Expect. Systems administration on UNIX® platform.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 458 Molecular and Nanoscale Communication
Crosslisted with: CSCE 858
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAiK 283H; STAT 380, ECEN 305 or RAiK 270H.
Notes: Completing CSCE 462/862 and CSCE 465/865 prior to taking this course is recommended. Exceptions can be granted on a per-student basis by the instructor.
Description: Overview of nanoscale communication options. Focus on bio-inspired communication through molecule exchange and biochemical reactions. Different techniques to realize nanomachines will be surveyed in the course, with particular attention to the tools provided by synthetic biology for the programming of biological cooperative systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR

CSCE 459 Genetically Engineered Systems
Crosslisted with: CSCE 859
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAiK 283H; STAT 380, ECEN 305 or RAiK 270H.
Notes: Completing CSCE/MATH 440/840, MATH 432/832, MATH 439/839, and CSCE 471/871 prior to taking this course is recommended. Exceptions can be granted on a per-student basis by the instructor.
Description: Introduction to the field of synthetic biology, and its interdisciplinary foundational concepts. Presents the technologies at the basis of synthetic biology, together with the engineering concepts that underlie the design, modeling, and realization of genetically engineered systems. Surveys examples of cutting edge applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR

CSCE 460 Software Engineering for Robotics
Crosslisted with: SOFT 460, CSCE 860
Prerequisites: SOFT 261 or RAiK 383H or CSCE 361
Description: Application of software engineering practices and principles to autonomous robotic systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL

CSCE 461 Advanced Topics in Software Engineering
Crosslisted with: CSCE 861, SOFT 461
Prerequisites: A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAiK 383H.
Description: Advanced or emerging techniques in software engineering. Topics include but not limited to design methodology, software dependability, and advanced software development environments.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 462 Communication Networks
Crosslisted with: CSCE 862
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAiK 283H; STAT 380, ECEN 305 or RAiK 270H.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 952; CSCE 953

CSCE 463 Data and Network Security
Crosslisted with: CSCE 863
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAiK 283H.
Description: Concepts and principles of data and network security. Focuses on practical aspects and application of crypto systems in security protocols for networks such as the Internet. Topics include: applications of cryptography and cryptosystems for digital signatures, authentication, network security protocols for wired and wireless networks, cyberattacks and countermeasures, and security in modern computing platforms.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 464 Internet Systems and Programming
Crosslisted with: CSCE 864
Prerequisites: A grade of "P" or "C" or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 311 or equivalent programming experience.
Notes: A grade of "P" or "C" or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 311 or equivalent programming experience.
Description: Paradigms, systems, and languages for Internet applications. Client-side and server-side programming, object-based and event-based distributed programming, and multi-tier applications. Coverage of specific technologies varies.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 465 Wireless Communication Networks
Crosslisted with: CSCE 865
Prerequisites: A grade of "P" or "C" or better in STAT 380, ECEN 305 or RAIK 270H
Description: Discussion of theoretical and practical insight to wireless communications and wireless networking, current practices, and future trends. Wireless network architectures, mobility management, radio propagation, modulation, power control, antennas, channel access, pricing, and standards.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 466 Software Design and Architecture
Crosslisted with: SOFT 466, CSCE 866
Prerequisites: A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 383H.
Notes: Letter grade only.
Description: Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 467 Testing, Verification and Analysis
Crosslisted with: SOFT 467, CSCE 867
Prerequisites: A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 383H.
Notes: Letter grade only.
Description: In-depth coverage of problems related to software quality, and approaches for addressing them. Topics include testing techniques, dynamic and static program analysis techniques, and other approaches for verifying software qualities. Tool support for performing testing, verification, and analysis will also be studied.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 468 Requirements Elicitation, Modeling and Analysis
Crosslisted with: SOFT 468, CSCE 868
Prerequisites: A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 383H.
Notes: Letter grade only.
Description: In-depth coverage of processes, methods and techniques for determining, or deciding, what a proposed software system should do. Topics include the requirements engineering process, identification of stakeholders, requirements elicitation techniques, methods for informal and formal requirements documentation, techniques for analyzing requirements models for consistency and completeness, and traceability of requirements across system development and evolution. Tool support for modeling functional and non-functional requirements to support elicitation and analysis will be studied.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 470 Computer Graphics
Crosslisted with: CSCE 870
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314
Description: Display and recording devices; incremental plotters; point, vector, and character generation; grey scale displays, digitizers and scanners, digital image storage; interactive and passive graphics; pattern recognition; data structures and graphics software; the mathematics of three dimensions; homogeneous coordinates; projections and the hidden-line problem.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 471 Computational Methods in Bioinformatics
Crosslisted with: CSCE 871
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Introduction to computational methods for tackling challenges in biological data analysis and modeling and understanding complex systems at the molecular and cellular level. The main topics include bio-sequence analysis, motif finding, structure prediction, phylogenetic inference, regulation network modeling, and high-throughput omics data analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

Offered: SPRING
Prerequisite for: CSCE 971
CSCE 472 Digital Image Processing
Crosslisted with: CSCE 872
Prerequisites: A grade of "Pass" or C or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 311 or equivalent programming experience.
Notes: A grade of "Pass" or C or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 311 or equivalent programming experience.
Description: Digital imaging systems, digital image processing, and low-level computer vision. Data structures, algorithms, and system analysis and modeling. Digital image formation and presentation, image statistics and descriptions, operations and transforms, and system simulation. Applications include system design, restoration and enhancement, reconstruction and geometric manipulation, compression, and low-level analysis for computer vision.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 473 Computer Vision
Crosslisted with: CSCE 873
Prerequisites: CSCE 156, SOFT 161, or CSCE 311 or equivalent programming experience.
Notes: A grade of "Pass" or C or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 311 or equivalent programming experience.
Description: High-level processing for image understanding and high-level vision. Data structures, algorithms, and modeling. Low-level representation, basic pattern-recognition and image-analysis techniques, segmentation, color, texture and motion analysis, and representation of 2-D and 3-D shape. Applications for content-based image retrieval, digital libraries, and interpretation of satellite imagery.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 474 Introduction to Data Mining
Crosslisted with: CSCE 874
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; STAT 380, ECEN 305 or RAIK 270H.
Notes: Requires the completion of a project involving the application of data mining techniques to real-world problems.
Description: Data mining and knowledge discovery methods and their application to real-world problems. Algorithmic and systems issues. Statistical foundations, association discovery, classification, prediction, clustering, spatial data mining and advanced techniques.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 475 Multiagent Systems
Crosslisted with: CSCE 875
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Distributed problem solving and planning, search algorithms for agents, distributed rational decision making, learning multiagent systems, computational organization theory, formal methods in Distributed Artificial Intelligence, multiagent negotiations, emergent behaviors (such as ants and swarms), and Robocup technologies and real-time coalition formation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 476 Introduction to Artificial Intelligence
Crosslisted with: CSCE 876
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Introduction to basic principles, techniques, and tools now being used in the area of machine intelligence. Languages for AI programming introduced with emphasis on LISP. Lecture topics include problem solving, search, game playing, knowledge representation, expert systems, and applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 976

CSCE 477 Cryptography and Computer Security
Crosslisted with: CSCE 877
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314.
Description: Introductory course on cryptography and computer security. Topics: classical cryptography (substitution, Vigenere, Hill and permutation ciphers, and the one-time pad); Block ciphers and stream ciphers; The Data Encryption Standard; Public-key cryptography, including RSA and El-Gamal systems; Signature schemes, including the Digital Signature Standard; Key exchange, key management and identification protocols.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 478 Introduction to Machine Learning
Crosslisted with: CSCE 878
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: STAT 380, ECEN 305, or RAIK 270H recommended.
Description: Introduction to the fundamentals and current trends in machine learning. Possible applications for game playing, text categorization, speech recognition, automatic system control, data mining, computational biology, and robotics. Theoretical and empirical analyses of decision trees, artificial neural networks, Bayesian classifiers, genetic algorithms, instance-based classifiers and reinforcement learning.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 479 Introduction to Deep Learning
Crosslisted with: CSCE 879
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: Completing STAT 380, ECEN 305, or RAIK 270 prior to taking this course is recommended.
Description: Fundamentals and current trends in deep learning. Backpropagation, activation functions, loss functions, choosing an optimizer, and regularization. Common architectures such as convolutional, autoencoders, and recurrent. Applications such as image analysis, text analysis, sequence analysis, and reinforcement learning.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: SPRING

CSCE 486 Computer Science Professional Development
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: Must be taken exactly one semester before CSCE 487.
Description: Preparation for the senior design project. Professional practice through familiarity with current tools, resources, and technologies. Professional standards, practices and ethics, and the oral and written report styles used specifically in the field of computer science.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 487; CSCE 487H
ACE: ACE 8 Civic/Ethics/Stewardship

CSCE 487 Computer Science Senior Design Project
Prerequisites: CSCE 486
Notes: Should be taken in the immediate next term after CSCE 486.
Description: A substantial computer science project requiring design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and software engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: SOFT 403, SOFT 403H
ACE: ACE 10 Integrated Product

CSCE 487H Honors Computer Science Senior Design Project
Prerequisites: CSCE 486 or CSCE 486H.
Notes: Should be taken in the immediate next term after CSCE 486 or CSCE 486H.
Description: A substantial computer science project requiring design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and software engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: SPRING
Prerequisite for: SOFT 403H
ACE: ACE 10 Integrated Product

CSCE 488 Computer Engineering Professional Development
Prerequisites: CSCE 236; A grade of "P" or "C" or better in CSCE 361 or CSCE 361H; formal admission to the College of Engineering; prereq or coreq: JGEN 300.
Notes: Must be taken exactly one semester before CSCE 489.
Description: Preparation for the senior design project. Professional practice through familiarity with current tools, resources, and technologies; professional standards, practices, and ethics; and oral and written report styles used in the computer engineering field.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 489; CSCE 489H
ACE: ACE 8 Civic/Ethics/Stewardship

CSCE 489 Computer Engineering Senior Design Project
Prerequisites: CSCE 488 (taken exactly one semester previous).
Description: A substantial computer engineering project requiring hardware-software co-design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and computer engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ACE: ACE 10 Integrated Product

CSCE 489H Honors Computer Engineering Senior Design Project
Prerequisites: CSCE 488 or CSCE 488H (taken exactly one semester previous).
Description: A substantial computer engineering project requiring hardware-software co-design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and computer engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: SPRING
ACE: ACE 10 Integrated Product

CSCE 492 Special Topics in Computer Science
Crosslisted with: CSCE 892
Prerequisites: Senior or graduate standing.
Description: Aspects of computers and computing not covered elsewhere in the curriculum presented as the need arises.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option

CSCE 492H Honors Special Topics in Computer Science
Prerequisites: Permission.
Description: Topics vary
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option
CSCE 493 Innovation Lab Project  
**Prerequisites:** CSCE 310, CSCE 310H, CSCE 311, or CSCE 320  
**Description:** Innovative team projects executed under the guidance of members of the faculty of the Department of Computer Science and Managing Director of the CSCE Innovation Lab. Students will work in teams and collaborate with CSE research faculty, supervising MS students, and sponsors that include private sectors and UNL faculty to design and develop real-world systems.  
**Credit Hours:** 1-3  
**Min credits per semester:** 1  
**Max credits per semester:** 3  
**Max credits per degree:** 6  
**Grading Option:** Graded with Option

CSCE 493A Interdisciplinary Capstone  
**Prerequisites:** CSCE 311  
**Notes:** Does not apply toward any requirements for the Computer Science or Computer Engineering degree. Required for the Informatics minor.  
**Description:** Innovative team projects executed under the guidance of members of the faculty of the Department of Computer Science and Managing Director of the CSCE Innovation Lab. Work in teams and collaboration with CSE research faculty and sponsors that include private sectors and UNL faculty to design and develop real-world systems to solve interdisciplinary problems.  
**Credit Hours:** 1-3  
**Min credits per semester:** 1  
**Max credits per semester:** 3  
**Max credits per degree:** 6  
**Grading Option:** Graded

CSCE 495 Internship in Computing Practice  
**Prerequisites:** Permission.  
**Notes:** Requires a detailed project proposal and final report.  
**Description:** Experiential learning in conjunction with an approved industrial or government agency under the joint supervision of an outside sponsor and a faculty advisor.  
**Credit Hours:** 1-3  
**Min credits per semester:** 1  
**Max credits per semester:** 3  
**Max credits per degree:** 6  
**Grading Option:** Graded with Option

CSCE 498 Computer Problems  
**Crosslisted with:** CSCE 898  
**Prerequisites:** Senior or graduate standing.  
**Description:** Independent project executed under the guidance of a member of the faculty of the Department of Computer Science. Solution and documentation of a computer problem demanding a thorough knowledge of either the numerical or nonnumerical aspects of computer science.  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Grading Option:** Graded with Option

Career Information  
*The following represents a sample of the internships, jobs and graduate school programs that current students and recent graduates have reported.*

### Transferable Skills
- Implement appropriate technological interventions to help solve problems
- Collaborate with a team to develop solutions
- Simplify complex information and present it to others
- Use quantitative analysis techniques
- Document and replicate processes and procedures
- Apply mathematical and scientific skills to solve real-world problems
- Make decisions carefully, using appropriate theoretical frameworks
- Make predictions using mathematical, statistical, and scientific modeling methods

### Jobs of Recent Graduates
- Mobile App Developer, Sandhills Publishing - Lincoln NE
- Software Consultant, Self Employed - Austin TX
- Programmer, Nebraska Heart Hospital - Lincoln NE
- Business Technology Support Technician, Department of Roads - Lincoln NE
- GIS Web Developer/Analyst, The North Jackson Company - Marquette MI
- Officer, United States Air Force - Cheyenne WY
- Software Developer, Experian - Lincoln NE
- Systems Application Specialist, Sandhills Publishing - Lincoln NE
- Data Engineer, Hudl - Lincoln NE
- Technology Specialist, TD Ameritrade - Omaha NE
- Software Engineer, Union Pacific - Omaha NE
- Software Engineer, Lockheed Martin - Littleton CO
- Implementation Consultant, Fast Enterprises, LLC - Atlanta GA
- Jr. Application Developer, Builder Trend - Omaha NE
- Developer, Microsoft - Redmond WA

### Internships
- System Application Developer Intern, Gallup - Lincoln NE
- Sandhills Systems Intern, Sandhills Publishing - Lincoln NE
- Data Science Intern, Hudl - Lincoln NE
- Junior Developer, NeSis - Lincoln NE
- Web Developer, Internet and Interactive Media (University Comm.) - Lincoln NE
- Web Developer Intern, Union Pacific - Council Bluffs IA
- Software Development Intern, Nelnet - Lincoln NE
- IOS Intern, OSG Corporation - Irving TX
- Programmer, GIS Workshop - Lincoln NE
- Research Intern, ABB Corporate Research Center - Raleigh NC
- Web Developer Intern, Lincoln Stars - Lincoln NE
- Functional Assurance Intern, FISERV - Lincoln NE
- Software Engineer Intern, Bosch Security System - Lincoln NE
- Application Development Intern, BuilderTREND - Omaha NE
- Software Developer Engineer Intern, Zillow - Lincoln NE

### Graduate & Professional Schools
- Master's Degree, Data Science, University of Minnesota-Twin Cities - Twin Cities MN
- Master's Degree, Computer Science, University of Nebraska-Lincoln - Lincoln NE
- Ph.D., Computer Science, University of Nebraska-Lincoln - Lincoln NE
- Master's Degree, Mathematical Science, Purdue University - West Lafayette IN
• Juris Doctorate, University of Nebraska-Lincoln - Lincoln NE
• Ph.D., Physics, University of Nebraska-Lincoln - Lincoln NE
• Ph.D., Computer Science, University of Texas at Austin - Austin TX
• Master’s Degree, Computer Science, Arizona State University - Tempe AZ
• Medical Doctor, University of Nebraska Medical Center - Omaha NE
• Ph.D., Computer Science, Ohio State University - Columbus OH