COMPUTER ENGINEERING (LINCOLN)

Description

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

The UNL 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 engineering that prepares graduates for professional practice in commerce, industry, and government, and for post-graduate education to enter careers in research and academia. The BS degree in computer engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The focus of the program is integrated hardware/software system design. Increasingly, diverse systems, products, and processes depend on computers for design, control, data acquisition, and other functions. The computer engineer possesses the range of expertise to have an integrated view of computer-based systems and to make global design decisions.

Consistent with this focus, the computer engineering baccalaureate program develops:

- The ability to view computer systems as an integrated continuum of technologies and to engage in integrated system-level design. Studies include mathematical foundations, digital logic and technologies, programming and software design, system components and design, application of theory, experimentation, design tools and techniques, and documentation and maintenance.
- The ability to work with professionals in related fields over the spectrum of system design. Studies include natural sciences, electricity/electronics, and programming and software design.
- Skills to quickly adapt to new work environments, assimilate new information, and solve new problems. Studies develop skills in the application of theory, experimentation, design tools and techniques, documentation and maintenance, and technical communications.
- The background and perspective for post-graduate education. Studies develop skills in the application of theory, experimentation, and life-long learning/professional development.
- Abilities to work in conformance with societal needs and expectations. Studies include liberal arts and ethical/social issues.
- Insight into the world of practicing professionals, for collaborations, mutual support, and representing the profession to government and society. Studies include teamwork and life-long learning/professional development, plus students are provided multiple opportunities for involvement in organizations such as ACM, UPE, and IEEE.

The CSE department also offers a degree of bachelor of science in computer science through the College of Arts and Sciences. All students majoring in the CSE department should see their advisors during their first semester to make sure they understand the differences in the requirements of the two programs. Majors should consult with their advisors each semester for registration advising.

Introductory Courses. Entering students may select from several introductory courses according to their interests and as indicated by the CSE Placement Examination. The Computer Science I courses (CSCE 155A Computer Science I, CSCE 155H Honors: Computer Science I, CSCE 155E Computer Science I: Systems Engineering Focus, CSCE 155N Computer Science I: Engineering and Science Focus, 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 155A is designed for students majoring in computer science. CSCE 155H is for honors students. CSCE 155E emphasizes computing for systems engineering, such as control systems, mobile computing, and embedded devices and is designed for students majoring in computer engineering. CSCE 155N focuses on numerical and graphical computation in engineering and science, such as applied physics, working with time-sequence data, and matrix applications. CSCE 155T focuses on data and information processing, such as document or database applications, online commerce, or bioinformatics. CSCE 156 is for students with a background in designing and programming computing solutions, such as is provided by Computer Science I. CSCE 101 Fundamentals of Computer Science is for students seeking a broad introduction to computer science with brief instruction in computer programming.

Graduate Programs. The CSE department offers several graduate degree programs: master of science in computer science, master of science in computer science with computer engineering specialization, master of science in computer science with bioinformatics specialization, doctor of philosophy in computer science, doctor of philosophy in engineering with computer engineering specialization, doctor of philosophy in computer science with 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 college entrance requirements. After being admitted to the college, students wishing to pursue a degree in computer engineering 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 engineering program, students must receive at least a C+ in CSCE 155A, CSCE 155H, CSCE 155E, CSCE 155N, or CSCE 155T; CSCE 156; CSCE 230 Computer Organization; CSCE 235 Introduction to Discrete Structures; ECEN 215 Electronics and Circuits I; ECEN 235 Introductory Electrical Laboratory I; MATH 106 Calculus I; MATH 107 Calculus II; MATH 208 Calculus III; PHYS 210 General Physics I; PHYS 212 General Physics II and a GPA of at least 2.5 (semester and cumulative). If a student’s cumulative GPA drops below 2.4, a student may be placed on restricted status, may be removed from the College, and may not be able to graduate.

College Requirements

College Admission

College Entrance Requirements

Students must have high school credit for (one unit is equal to one high school year):

1. 4 units of mathematics: 2 of algebra, 1 of geometry, 1 of precalculus and trigonometry.
2. 4 units of English.
3. 3 units of natural science that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management).
4. 2 units of a single foreign language.
5. 3 units of social studies.
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.
7. Students having an ACT score of 19 or less in English (or equivalent SAT score) must take ENGL 150 Writing and Inquiry or ENGL 151 Writing and Argument.

A total of 16 units is required for admission.

Students must have an ACT (enhanced) score of 24 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 to pre-engineering status in the Exploratory and Pre-Professional Advising Center. Pre-engineering students are advised within the College of Engineering.

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

Students who lack entrance units may complete precollege training by Independent Study through the UNL Office of On-line and Distance Education, in summer courses, or as a part of their first or second semester course loads while in the Exploratory and Pre-Professional Advising Center or other Colleges at UNL.

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 COE freshman entrance requirements and have a minimum cumulative GPA of 2.5 for Nebraska residents or 3.0 for non-residents, and be calculus-ready. Students not meeting either of these requirements must enroll in the Explore Center or another UNL college until they meet COE admission requirements.

The COE accepts courses for transfer for which a C or better grade was received. Although UNL 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 that in use when they entered UNL. Upon admission to UNL, students wishing to pursue degree programs in the COE will be classified and subject to the policies defined in the subsequent section.

**College Degree Requirements**

**Grade Rules**

**Grade Appeals**

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

**Catalog Rule**

Students must fulfill the requirements stated in the catalog for the academic year in which they are first admitted at UNL. 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 UNL in the College of Engineering. Students must complete all degree requirements from a single catalog year. The catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

**Learning Outcomes**

Majors in computer engineering will be able to:

1. View computer systems as an integrated continuum of technologies and to engage in integrated system-level design. Studies include mathematical foundations, digital logic and technologies, programming and software design, system components and design, application of theory, experimentation, design tools and techniques, and documentation and maintenance.
2. Work with professionals in related fields over the spectrum of system design. Studies include natural sciences, electricity/electronics, and programming and software design.
3. Quickly adapt to new work environments, assimilate new information, and solve new problems. Studies develop skills in the application of theory, experimentation, design tools and techniques, documentation and maintenance, and technical communications.
4. Have the background and perspective for post-graduate education. Studies develop skills in the application of theory, experimentation, and life-long learning/professional development.
5. Work in conformance with societal needs and expectations. Studies include liberal arts and ethical/social issues.
6. Understand the world of practicing professionals, for collaborations, mutual support, and representing the profession to government and society. Studies include teamwork and life-long learning/professional development, plus students are provided multiple opportunities for involvement in organizations such as ACM, UPE, and IEEE.

**Major Requirements**

The computer engineering degree requires 126 hours of course work. There is a set of required core courses and technical elective courses in computer science and engineering (57 credit hours), electrical engineering (17 credit hours), mathematics (19 credit hours), physics and chemistry (12-13 credit hours), and other supporting courses (21 credit hours) as described below.

**Computer Science and Engineering (57 hours) CSE Core (36 hours)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</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</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 155E</td>
<td>Computer Science I: Systems Engineering Focus</td>
</tr>
<tr>
<td>CSCE 155H</td>
<td>Honors: Computer Science I</td>
</tr>
<tr>
<td>CSCE 155A</td>
<td>Computer Science I</td>
</tr>
<tr>
<td>CSCE 155N</td>
<td>Computer Science I: Engineering and Science Focus</td>
</tr>
<tr>
<td>Course</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>CSCE 155T</td>
<td>Computer Science I: Informatics Focus</td>
</tr>
<tr>
<td>CSCE 156</td>
<td>Computer Science II</td>
</tr>
<tr>
<td>CSCE 230</td>
<td>Computer Organization</td>
</tr>
<tr>
<td>CSCE 235</td>
<td>Introduction to Discrete Structures</td>
</tr>
<tr>
<td>CSCE 236</td>
<td>Embedded Systems</td>
</tr>
<tr>
<td>CSCE 251</td>
<td>Unix Programming Environment</td>
</tr>
<tr>
<td>CSCE 310</td>
<td>Data Structures and Algorithms</td>
</tr>
<tr>
<td>CSCE 335</td>
<td>Digital Logic Design</td>
</tr>
<tr>
<td>CSCE 440</td>
<td>Numerical Analysis I</td>
</tr>
<tr>
<td>CSCE 351</td>
<td>Operating System Kernels</td>
</tr>
<tr>
<td>CSCE 361</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>CSCE 462</td>
<td>Communication Networks</td>
</tr>
<tr>
<td></td>
<td>Total Credit Hours</td>
</tr>
</tbody>
</table>

Or for students in the J. S. Raikes School of Computer Science and Management:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAIK 183H</td>
<td>Honors: Computer Problem Solving Essentials</td>
<td>4</td>
</tr>
<tr>
<td>RAIK 184H</td>
<td>Honors: Software Development Essentials</td>
<td>4</td>
</tr>
<tr>
<td>RAIK 283H</td>
<td>Honors: Foundations of Computer Science</td>
<td>3</td>
</tr>
<tr>
<td>RAIK 383H</td>
<td>Honors: Fundamentals of Software Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 230</td>
<td>Computer Organization</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 236</td>
<td>Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 251</td>
<td>Unix Programming Environment</td>
<td>1</td>
</tr>
<tr>
<td>CSCE 335</td>
<td>Digital Logic Design</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 440</td>
<td>Numerical Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 351</td>
<td>Operating System Kernels</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 462</td>
<td>Communication Networks</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total Credit Hours</td>
<td>34</td>
</tr>
</tbody>
</table>

### Senior Design Experience (6 hrs)

CSCE 488 Computer Engineering Professional Development (or RAIK 381H Honors: Advanced Topics in Business I or RAIK 382H Honors: Advanced Topics in Business II), and CSCE 489 Computer Engineering Senior Design Project (or RAIK 402H Honors: RAIK Design Studio II or RAIK 404H Honors: RAIK Design Studio IV). CSCE 488 and CSCE 489 are to be taken in consecutive semesters. Taking CSCE 488 also satisfies ACE outcome 8.

Double majors in electrical engineering may elect to take either of the senior design course sequences (CSCE 488 then CSCE 489 or ECEN 494 Capstone I then ECEN 495 Capstone II). Students not taking CSCE 488 must satisfy ACE outcome 8 with another course(s).

### Technical Electives (15 hours)

In addition, students select 15 credit hours of technical electives with the focus areas option as described below.

A computer engineering major has the option of declaring a focus in one of the areas listed below. Students who, in addition to completing all computer engineering required courses listed above, receive a grade of C or better in each of the three technical elective courses from one focus area below, will receive a notice from the Department of Computer Science and Engineering stating that they received the degree bachelor of science in computer engineering with a focus in their chosen area(s). The focus areas are:

#### Embedded Systems and Robotics

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 436</td>
<td>Advanced Embedded Systems (required)</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 439</td>
<td>Robotics: Algorithms and Applications</td>
<td>3</td>
</tr>
<tr>
<td>or MECH 453</td>
<td>Robotics: Kinematics and Design</td>
<td></td>
</tr>
<tr>
<td>CSCE 430</td>
<td>Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 438</td>
<td>Sensor Networks</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 476</td>
<td>Introduction to Artificial Intelligence</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 477</td>
<td>Digital Systems Organization and Design</td>
<td>3</td>
</tr>
</tbody>
</table>

#### VLSI Design

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 434</td>
<td>VLSI Design (required)</td>
<td>3</td>
</tr>
<tr>
<td>or ECEN 470</td>
<td>Digital and Analog VLSI Design</td>
<td></td>
</tr>
<tr>
<td>CSCE 421</td>
<td>Foundations of Constraint Processing</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 430</td>
<td>Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 416</td>
<td>Materials and Devices for Computer</td>
<td>3</td>
</tr>
<tr>
<td>Memory, Logic, and Display</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ECEN 421</td>
<td>Principles of Semiconductor Materials and Devices I</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 474</td>
<td>Digital Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

Students choosing this focus area must take PHYS 213 General Physics III and PHYS 223 General Physics Laboratory III as the science requirement.

#### Signal Processing and Communications

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 462</td>
<td>Communication Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 463</td>
<td>Digital Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 464</td>
<td>Digital Communication Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 465</td>
<td>Introduction to Data Compression</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 438</td>
<td>Sensor Networks</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 463</td>
<td>Data and Network Security</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 465</td>
<td>Wireless Communication Networks</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 472</td>
<td>Digital Image Processing</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 473</td>
<td>Computer Vision</td>
<td>3</td>
</tr>
</tbody>
</table>

#### High-Performance Computing

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 430</td>
<td>Computer Architecture (required)</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 432</td>
<td>High-Performance Processor Architectures</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 435</td>
<td>Cluster and Grid Computing</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 437</td>
<td>File and Storage Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 455</td>
<td>Distributed Operating Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 456</td>
<td>Parallel Programming</td>
<td>3</td>
</tr>
</tbody>
</table>

The 15 credit hours can be taken from exactly one focus area or from any combination of the focus areas courses plus 300- or 400-level CSCE, ECEN, and RAIK courses, but subject to the following restrictions:

1. At least 9 hours must be taken from CSCE and/or cross-listed courses in RAIK (namely, RAIK 384H Honors: Applied Numerical Analysis, RAIK 401H Honors: RAIK Design Studio I, RAIK 402H Honors: RAIK Design Studio II, RAIK 403H Honors: RAIK Design Studio III, and RAIK 404H Honors: RAIK Design Studio IV).
2. At least 9 hours must be taken at the 400 level.
3. CSCE 390 Special Topics in Computer Science and CSCE 490 Special Topics in Computer Science have been pre-designated as not applying to the major and cannot count as technical electives.

4. At most, 3 hours of independent study (CSCE 498 Computer Problems, ECEN 399 Undergraduate Research, ECEN 499 Capstone II) may apply.

5. At most, 6 hours of internship/practicum courses (CSCE 491 Internship in Computing Practice, CSCE 493 Innovation Lab Project, RAIK 401H, RAIK 402H, RAIK 403H, RAIK 404H) may apply.

6. ECEN 494 Capstone I and ECEN 495 Capstone II may not apply (however, these may be substituted for CSCE 488 Computer Engineering Professional Development and CSCE 489 Computer Engineering Senior Design Project).

**Electrical Engineering (17 hours)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 215</td>
<td>Electronics and Circuits I</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 216</td>
<td>Electronics and Circuits II</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 235</td>
<td>Introductory Electrical Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>ECEN 236</td>
<td>Introductory Electrical Laboratory II</td>
<td>1</td>
</tr>
<tr>
<td>ECEN 304</td>
<td>Signals and Systems I</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 305</td>
<td>Probability and Statistics for Electrical and Computer Engineers</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 316</td>
<td>Electronics and Circuits III</td>
<td>3</td>
</tr>
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</table>

Total Credit Hours: 17

**Mathematics (19 hours)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</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 208</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 221</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours: 19

**Science (12-13 hours)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>PHYS 211</td>
<td>General Physics I</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 109</td>
<td>General Chemistry I</td>
<td>4-5</td>
</tr>
<tr>
<td>or PHYS 213 &amp; PHYS 223</td>
<td>General Physics III and General Physics Laboratory III</td>
<td>12</td>
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Total Credit Hours: 12-13

**Other Supporting Courses (21 hours)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Elective</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>ENGR 20</td>
<td>Sophomore Engineering Seminar</td>
<td>0</td>
</tr>
<tr>
<td>JGEN 200</td>
<td>Technical Communication I</td>
<td>3</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>ENGR 100</td>
<td>Interpersonal Skills for Engineering Leaders</td>
<td></td>
</tr>
<tr>
<td>JGEN 300</td>
<td>Technical Communication II</td>
<td>3</td>
</tr>
<tr>
<td>COMM 286</td>
<td>Business and Professional Communication</td>
<td>3</td>
</tr>
<tr>
<td>ACE 5, 6, 7, 9</td>
<td></td>
<td>12</td>
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</table>

Total Credit Hours: 21

**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 that participation will in no way affect a student's GPA or graduation.

**Additional Major Requirements**

**Grade Rules**

**C- and D Grades**

Applicants for formal admission to computer engineering must meet the usual college requirements plus a minimum grade rule on the following core courses (or their equivalents).

**Grades of C+ or higher in:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 155A</td>
<td>Computer Science I</td>
<td>3</td>
</tr>
<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>3</td>
</tr>
<tr>
<td>CSCE 155N</td>
<td>Computer Science I: Engineering and Science Focus</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 155T</td>
<td>Computer Science I: Informatics Focus</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 156</td>
<td>Computer Science II</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 230</td>
<td>Computer Organization</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 235</td>
<td>Introduction to Discrete Structures</td>
<td>3</td>
</tr>
<tr>
<td>MATH 106</td>
<td>Calculus I</td>
<td>5</td>
</tr>
<tr>
<td>ECEN 215</td>
<td>Electronics and Circuits I</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 235</td>
<td>Introductory Electrical Laboratory I</td>
<td>1</td>
</tr>
<tr>
<td>MATH 107</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 208</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics I</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>General Physics II</td>
<td>4</td>
</tr>
</tbody>
</table>

**Requirements for Minor Offered by Department**

**Minor in Software Development**

For non-CSCE majors: 15 hours of the following sequence of CSCE courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 120</td>
<td>Learning to Code</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 220</td>
<td>Software Development for Smart-Mobile Systems</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 320</td>
<td>Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 311</td>
<td>Data Structures and Algorithms for Informatics</td>
<td>3</td>
</tr>
<tr>
<td>or CSCE 464</td>
<td>Internet Systems and Programming</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 493</td>
<td>Innovation Lab Project</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credit Hours: 15

For more information, contact CSE advisors.

**Grade Rules**

**Pass/No Pass**

Credits earned using the Pass/No Pass options do not count toward this minor.

**Restrictions**

A course taken to meet the requirement of a major cannot be counted towards this minor.
This minor is not open to computer science or computer engineering majors.

**CSCE 100 Introduction to Informatics**
**Prerequisites:** Placement in to MATH 101 or higher
**Notes:** This course should not be taken by majors in Computer Science or Computer 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
**Format:** LEC

**CSCE 101 Fundamentals of Computer Science**
**Prerequisites:** High School algebra and use of computing applications
**Notes:** CSCE 101 is intended for non-CSCE majors who desire a deeper understanding of computers and the work of computer scientists. CSCE 101 is a course in the science of computation and is suitable for non-CSCE majors and prospective CSCE majors.
**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
**Format:** LEC
**ACE:** ACE 3 Math/Stat/Reasoning

**CSCE 101L Fundamentals of Computing Laboratory**
**Prerequisites:** CSCE 101 or parallel.
**Notes:** Will not count towards the requirements for a major or minor in computer science and computer 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
**Format:** LAB

**CSCE 120 Learning to Code**
**Prerequisites:** Placement in to MATH 101 or higher
**Notes:** This course should not be taken by majors in Computer Science or Computer 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
**Format:** LEC

**CSCE 155A Computer Science I**
**Prerequisites:** Appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
**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
**Format:** LEC
**Prerequisite for:** CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
**ACE:** ACE 3 Math/Stat/Reasoning

**CSCE 155E Computer Science I: Systems Engineering Focus**
**Prerequisites:** Appropriate score on the CSE Placement Exam or CSCE 101; MATH 103 or equivalent
**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
**Format:** LEC
**Prerequisite for:** CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
**ACE:** ACE 3 Math/Stat/Reasoning

**CSCE 155H Honors: Computer Science I**
**Prerequisites:** Good standing in the University Honors Program or by invitation; appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
**Notes:** CSCE 155H covers the same topics as CSCE 155A, but in greater depth.
**Description:** For course description, see CSCE 155A.
**Credit Hours:** 3
**Max credits per semester:** 3
**Max credits per degree:** 3
**Format:** LEC
**Prerequisite for:** CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
**ACE:** ACE 3 Math/Stat/Reasoning
CSCE 155N Computer Science I: Engineering and Science Focus
Prerequisites: Appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
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
Format: LEC
Prerequisite for: CHME 223; CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350; MECH 381; METR 223; METR 312; METR 323
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155T Computer Science I: Informatics Focus
Prerequisites: Appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
Notes: Recommended for students interested in data and information processing, such as library and database applications, online commerce, and bioinformatics. Credit may be earned in only one CSCE 155 course.
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
Format: LEC
Prerequisite for: CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
ACE: ACE 3 Math/Stat/Reasoning
CSCE 156 Computer Science II
Prerequisites: Appropriate score on the CSE Placement Exam or a grade of "P" or "C" or better in CSCE 155A, CSCE155E, CSCE 155H, CSCE 155N, or CSCE 155T; Math 106 or parallel
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
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; CSCE 322; CSCE 378; SOFT 162
CSCE 156H Honors: Computer Science II
Prerequisites: Good standing in the University Honors Program or by invitation; appropriate score on CSE Placement Exam or a grade of "P" or "C" or better in CSCE 155 or 155H; MATH 106 or parallel
Notes: CSCE 156H covers the same topics as CSCE 156, but in greater depth. Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: For course description, see CSCE 156.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; CSCE 322; CSCE 378; SOFT 162
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
Format: LEC
Prerequisite for: ECON 215; MATH 380, MATH 380H, STAT 380, STAT 380H, RAIK 270H; MRKT 350; SCMA 250
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
Format: LEC
CSCE 190 Special Topics in Computer Science
Prerequisites: Permission.
Notes: CSCE 190 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
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC
CSCE 196 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
Format: LEC

CSCE 220 Software Development for Smart-Mobile Systems
Prerequisites: CSCE 120
Notes: Second course in a sequence for the minor in Software Development. This course should not be taken by majors in Computer Science or Computer Engineering.
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
Format: LEC

CSCE 230 Computer Organization
Prerequisites: A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160 or equivalent knowledge of a high-level programming language.
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
Format: LEC
Prerequisite for: CSCE 322; CSCE 438, CSCE 838; ECEN 220

CSCE 230H Honors: Computer Organization
Prerequisites: Good standing in the University Honors Program or by invitation; a grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160 or equivalent knowledge of a high-level programming language.
Notes: CSCE 230H covers the same topics as CSCE 230, but in greater depth. Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: For course description, see CSCE 230.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CSCE 322; CSCE 438, CSCE 838; ECEN 220

CSCE 231 Computer Systems Engineering
Prerequisites: Grade of "Pass" or "C" or better in CSCE 235 or CSCE 235H.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC

CSCE 235 Introduction to Discrete Structures
Crosslisted with: CSCE 235H
Prerequisites: A grade of "Pass" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; Math 106.
Description: For course description, see CSCE235.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; SOFT 260

CSCE 235H Introduction to Discrete Structures
Crosslisted with: CSCE 235
Prerequisites: A grade of "Pass" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; Math 106.
Description: For course description, see CSCE235.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; SOFT 260

CSCE 236 Embedded Systems
Prerequisites: CSCE 230
Description: Introduction to designing, interfacing, configuring, and programming embedded systems. Configure 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.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 251 Unix Programming Environment
Prerequisites: 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
Format: LEC

CSCE 251K C Programming
Prerequisites: Familiarity with one high-level programming language.
Description: Introduction to the C programming language.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB
CSCE 252A FORTRAN Programming  
**Prerequisites:** Familiarity with one high-level programming language.  
**Notes:** Credit towards the degree maybe earned in only one of: CSCE 155E or CSCE 155N or CSCE 155T or CSCE 252A.  
**Description:** Principles and practice of FORTRAN programming.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Format:** LEC

CSCE 283H Honors: Foundations of Computer Science  
**Crosslisted with:** RAIK 283H  
**Prerequisites:** Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 184H.  
**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  
**Format:** LEC  
**Prerequisite for:** CSCE 411H, RAIK 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 284H Honors: Foundations of Computer Systems  
**Crosslisted with:** RAIK 284H  
**Prerequisites:** Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 283H.  
**Description:** Introduction to fundamental organization and structure of computer systems. Boolean logic, data representation, processor organization, input/output, memory organization, system support software and communication.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Format:** LEC

CSCE 290 Special Topics in Computer Science  
**Prerequisites:** Permission.  
**Notes:** Topics vary. CSCE 290 will not count towards a major or minor in computer science and computer engineering.  
**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  
**Format:** LEC

CSCE 296 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  
**Format:** LEC

CSCE 310 Data Structures and Algorithms  
**Crosslisted with:** CSCE 310H  
**Prerequisites:** Grades of "Pass" or "C" or better in CSCE 156/156H or SOFT 161 and 235/235H.  
**Description:** For course description, see CSCE310.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIK 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 310H Data Structures and Algorithms  
**Crosslisted with:** CSCE 310  
**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 235/235H.  
**Description:** For course description, see CSCE310.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIK 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 311 Data Structures and Algorithms for Informatics  
**Prerequisites:** Grade of "Pass" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160.  
**Notes:** CSE majors must take CSCE 310. Students may not receive credit for both CSCE310 and 311.  
**Description:** 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.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  
**Prerequisite for:** CSCE 322; CSCE 378; CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIK 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 320 Data Analysis  
**Prerequisites:** CSCE 220  
**Notes:** This course should not be taken by majors in Computer Science or Computer Engineering. Third course in a sequence for the minor in Software Development.  
**Description:** 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.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC
CSCE 322 Programming Language Concepts  
Prerequisites: CSCE 156, SOFT 161 or CSCE 311; CSCE 230.  
Description: List-processing, string-processing, and other types of high-level programming languages. Fundamental concepts of data types, control structures, operations, and programming environments of various programming languages. Analysis, formal specification, and comparison of language features.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

CSCE 322H Honors: Programming Language Concepts  
Prerequisites: Good Standing in UNL Honors Program or by invitation; CSCE156/CSCE156H or CSCE311, CSCE230/CSCE230H  
Description: List-processing, string-processing, and other types of high-level programming languages. Fundamental concepts of data types, control structures, operations, and programming environments of various programming languages. Analysis, formal specification, and comparison of language features.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

CSCE 335 Digital Logic Design  
Crosslisted with: ECEN 370  
Prerequisites: ECEN 121/(UNO) ECEN 1210 or CSCE 230.  
Description: Combinational and sequential logic circuits. MSI chips, programmable logic devices (PAL, ROM, PLA) used to design combinational and sequential circuits. CAD tools. LSI and PLD components and their use. Hardware design experience.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

Prerequisite for: ECEN 307

CSCE 351 Operating System Kernels  
Prerequisites: CSCE 230; CSCE 310 or CSCE 311  
Notes: Lab content reinforces concepts through practice.  
Description: Design and implementation of operating system kernels. Bootstrapping and system initialization, process context switching, I/O hardware and software, DMA, I/O polling, interrupt handlers, device drivers, clock management. Substantial programming implementing or extending an instructional operating system kernel.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

CSCE 361 Software Engineering  
Crosslisted with: CSCE 361H  
Prerequisites: A grade of "Pass" or "C" or better in CSCE 310, CSCE 310H, CSCE 311 or SOFT 260.  
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  
Format: LEC

Prerequisite for: CSCE 486

CSCE 361H Software Engineering  
Crosslisted with: CSCE 361  
Prerequisites: Good Standing in UNL Honors Program or by invitation; A grade of "Pass" or "C" or better in CSCE 310, CSCE 310H, CSCE 311 or SOFT 260.  
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  
Format: LEC

Offered: FALL/SPR

CSCE 370H 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  
Format: LEC

CSCE 378 Human-Computer Interaction  
Prerequisites: CSCE 156, SOFT 161, or CSCE 311.  
Notes: MATH/STAT 380 or ELEC 305 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  
Format: LEC
CSCE 378H Honors: Human-Computer Interaction
Prerequisites: CSCE 310, CSCE 311, SOFT 260, or CSCE 283H; Good standing in the University Honors Program or by instructor permission.
Notes: CSCE 378H covers the same topics as CSCE 378, but in greater depth.
Description: For course description, see CSCE 378.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 383H Honors: Fundamentals of Software Engineering
Crosslisted with: RAIK 383H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; 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
Format: LEC

CSCE 384H Honors: Applied Numerical Analysis
Crosslisted with: RAIK 384H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 284H; parallel BSAD/RAIK 382H.
Description: Application of established numerical analysis techniques to selected business and finance problems, finite difference applied to standard options or stochastic processes in modeling financial markets.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 390 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
Format: LEC

CSCE 396 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
Format: LEC

CSCE 399H Honors Thesis
Prerequisites: Open to students in the honors program and to candidates for degrees with distinction, with high distinction, and with highest distinction.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: IND

CSCE 401H Honors: RAIK Design Studio I
Crosslisted with: 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; BSAD/RAIK 282H; and CSCE/RAIK 284H.
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
Format: LEC
ACE: ACE 8 Civic/Ethics/Stewardship

CSCE 402H Honors: RAIK Design Studio II
Crosslisted with: 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; and BSAD/CSCE/SOFT/RAIK 401H.
Notes: Second 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
Format: LEC
ACE: ACE 10 Integrated Product

CSCE 403H Honors: RAIK Design Studio III
Crosslisted with: RAIK 403H, BSAD 403H, SOFT 403H
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 402H.
Notes: Third semester of Jeffrey S. Raikes School of Computer Science and Management design studio sequence. 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
Format: LEC
CSCE 404H Honors: RAIK Design Studio IV
Crosslisted with: RAIK 404H, BSAD 404H, SOFT 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
Format: LEC

CSCE 410 Information Retrieval Systems
Crosslisted with: CSCE 810
Prerequisites: CSCE 310, SOFT 260, or CSCE 311.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 411 Data Modeling for Systems Development
Crosslisted with: CSCE 811
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
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
Format: LEC

CSCE 411H Honors: Data Modeling for Systems Development
Crosslisted with: RAIK 411H
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, CSCE 311, or CSCE 283H. Good standing in the University Honors Program.
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
Format: LEC

CSCE 412 Data Visualization
Crosslisted with: CSCE 812
Prerequisites: CSCE 310, CSCE 310H or CSCE 311; 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
Format: LEC

CSCE 413 Database Systems
Crosslisted with: CSCE 813
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311
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
Format: LEC

CSCE 421 Foundations of Constraint Processing
Crosslisted with: CSCE 821
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311
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
Format: LEC
CSCE 423 Design and Analysis of Algorithms
Crosslisted with: CSCE 823
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
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
Format: LEC

CSCE 424 Computational Complexity Theory
Crosslisted with: CSCE 824
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 425 Compiler Construction
Crosslisted with: CSCE 825
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
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
Format: LEC

CSCE 428 Automata, Computation, and Formal Languages
Crosslisted with: CSCE 828
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
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
Format: LEC

CSCE 430 Computer Architecture
Crosslisted with: CSCE 830
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; Prereq or Coreq: MATH/STAT 380 or ELEC 305.
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
Format: LEC

CSCE 432 High-Performance Processor Architectures
Crosslisted with: CSCE 832
Prerequisites: CSCE 430; MATH 314; MATH/STAT 380 or ELEC 305
Notes: CSCE 432 assumes knowledge of computer architecture, pipelining, memory hierarchy, instruction level parallelism, and compiler principles.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 433 VLSI Design
Crosslisted with: CSCE 833
Prerequisites: CSCE 335 or permission.
Description: Introduction to VLSI design using metal-oxide semiconductor (MOS) devices primarily aimed at computer science majors with little or no background in the physics or circuitry of such devices. Includes design of nMOS and CMOS logic, data-path, control unit, and highly concurrent systems as well as topics in design automation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 434 VLSI Design
Crosslisted with: CSCE 834
Prerequisites: CSCE 335 or permission.
Description: Introduction to VLSI design using metal-oxide semiconductor (MOS) devices primarily aimed at computer science majors with little or no background in the physics or circuitry of such devices. Includes design of nMOS and CMOS logic, data-path, control unit, and highly concurrent systems as well as topics in design automation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 435 Cluster and Grid Computing
Crosslisted with: CSCE 835
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311 or equivalent programming experience.
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
Format: LEC
CSCE 436 Advanced Embedded Systems
Crosslisted with: CSCE 836
Prerequisites: CSCE 236; SOFT 260, CSCE 310, CSCE 310H, CSCE 311, or equivalent; senior/graduate standing.
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
Format: LEC

CSCE 437 File and Storage Systems
Crosslisted with: CSCE 837
Prerequisites: CSCE 351 or 451/851; CSCE 430/830.
Description: System-level and device-level topics in the design, implementation, and use of file and storage systems. Components and organization of storage systems, disk drive hardware and firmware, multiskit systems, RAID’s, local distributed and P2P file systems, and low-power design.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 438 Sensor Networks
Crosslisted with: CSCE 838
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent; senior or graduate standing or instructor permission.
Description: Basics of sensor networks; theoretical and practical insight into wireless sensor networks, including low-power hardware and wireless communication principles; networking in wireless sensor networks; and applications of sensor networks, such as multimedia, underwater, and underground. A group project that provides hands-on interaction with a wireless sensor network testbed.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 439 Robotics: Algorithms and Applications
Crosslisted with: CSCE 839
Prerequisites: CSCE 236 or ELEC 222; SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent programming experience; MATH 314; senior/graduate standing or instructor permission.
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
Format: LEC

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
Format: LEC

CSCE 441 Approximation of Functions
Crosslisted with: CSCE 841, MATH 441, MATH 841
Prerequisites: A programming language, MATH 221 and 314.
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
Format: LEC
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
Format: LEC
Groups: Advanced Mathematics Courses

CSCE 451 Operating Systems Principles
Crosslisted with: CSCE 851
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
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
Format: LEC

CSCE 456 Parallel Programming
Crosslisted with: CSCE 856
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent programming experience.
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
Format: LEC

CSCE 457 Systems Administration
Crosslisted with: CSCE 857
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent programming experience.
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
Format: LEC

CSCE 461 Advanced Topics in Software Engineering
Crosslisted with: CSCE 861, SOFT 461
Prerequisites: CSCE 361, CSCE 361H or SOFT 261
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
Format: LEC

CSCE 462 Communication Networks
Crosslisted with: CSCE 862
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380 or ELEC 305.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 463 Data and Network Security
Crosslisted with: CSCE 863
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
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
Format: LEC

CSCE 464 Internet Systems and Programming
Crosslisted with: CSCE 864
Prerequisites: CSCE 156, SOFT 161, CSCE 311, or CSCE 320 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
Format: LEC

CSCE 465 Wireless Communication Networks
Crosslisted with: CSCE 865
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380 or ELEC 305; or instructor permission
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
Format: LEC
CSCE 466 Software Design and Architecture
Crosslisted with: SOFT 466, CSCE 866
Prerequisites: SOFT 261 or CSCE 361 or equivalent
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
Format: LEC

CSCE 467 Testing, Verification and Analysis
Crosslisted with: SOFT 467, CSCE 867
Prerequisites: SOFT 261 or CSCE 361 or equivalent
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
Format: LEC

CSCE 468 Requirements Elicitation, Modeling and Analysis
Crosslisted with: SOFT 468, CSCE 868
Prerequisites: SOFT 261 or CSCE 361 or equivalent
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
Format: LEC

CSCE 470 Computer Graphics
Crosslisted with: CSCE 870
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 330
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
Format: LEC

CSCE 471 Introduction to Bioinformatics
Crosslisted with: CSCE 871
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380
Description: Fundamentals and trends in bioinformatics. Scoring matrices and pairwise sequence alignments via dynamic programming, BLAST, and other heuristics. Multiple sequence alignments. Applications of machine learning methods such as hidden Markov models and support vector machines to biological problems such as family modeling and phylogeny.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 472 Digital Image Processing
Crosslisted with: CSCE 872
Prerequisites: SOFT 161, 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
Format: LEC

CSCE 473 Computer Vision
Crosslisted with: CSCE 873
Prerequisites: CSCE 156, SOFT 161, 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
Format: LEC

CSCE 474 Introduction to Data Mining
Crosslisted with: CSCE 874
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380
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
Format: LEC
CSCE 475 Multiagent Systems
Crosslisted with: CSCE 875
Prerequisites: CSCE 156, SOFT 161, or CSCE 311
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
Format: LEC

CSCE 476 Introduction to Artificial Intelligence
Crosslisted with: CSCE 876
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311
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
Format: LEC

CSCE 476H Honors: Introduction to Artificial Intelligence
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, CSCE 311, or CSCE 283H; Good standing in the University Honors Program or by instructor permission.
Notes: CSCE 476H covers the same topics as CSCE 476, but in greater depth.
Description: For course description, see CSCE 476.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 477 Cryptography and Computer Security
Crosslisted with: CSCE 877
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; 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
Format: LEC

CSCE 478 Introduction to Machine Learning
Crosslisted with: CSCE 878
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Description: Introduction to the fundamentals and current trends in machine learning. Possible applications for game playing, text categorization, speech recognition, automatic system control, date 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
Format: LEC

CSCE 479 Introduction to Neural Networks
Crosslisted with: CSCE 879
Prerequisites: CSCE 310 or CSCE 311
Description: Introduction to the concepts, design and application of connection-based computing begins by simulating neural networks, focusing on competing alternative network architectures, including sparse distributed memories, Hopfield networks, and the multilayered feed-forward systems. Construction and improvement of algorithms used for training of neural networks addressed to reduce training time and improve generalization. Algorithms for training and synthesizing effective networks implemented in high level language programs running on conventional computers. Emphasis on methods for synthesizing and simplifying network architectures for improved generalization. Application areas include: pattern recognition, computer vision, robotics medical diagnosis, weather and economic forecasting.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 486 Computer Science Professional Development
Prerequisites: A grade of "Pass" or "C" or better in SOFT 261, CSCE 361 or CSCE 361H
Notes: CSCE 486 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
Format: LEC
ACE: ACE 8 Civic/Ethics/Stewardship

CSCE 487 Computer Science Senior Design Project
Prerequisites: CSCE 486 (taken exactly one semester previous)
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
Format: LEC
ACE: ACE 10 Integrated Product
CSCE 488 Computer Engineering Professional Development
Prerequisites: CSCE 236; A grade of "Pass" or "C" or better in CSCE 361 or CSCE 361H; formal admission to the College of Engineering; prereq or coreq: JGEN 300.
Description: Preparation for the senior design project. Professional practice through familiarity and practice 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
Format: LEC
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
Format: LEC
ACE: ACE 10 Integrated Product
CSCE 490 Special Topics in Computer Science
Crosslisted with: CSCE 890
Prerequisites: Permission.
Notes: CSCE 490/890 will not count toward 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
Format: LEC
CSCE 491 Internship in Computing Practice
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311
Notes: CSCE 491 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
Format: FLD
CSCE 493 Innovation Lab Project
Prerequisites: CSCE310, CSCE310H, CSCE311, or CSCE320
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
Format: LEC
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
Format: LEC
CSCE 496 Special Topics in Computer Science
Crosslisted with: CSCE 896
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
Format: LEC
CSCE 496H Honors: Special Topics in Computer Science
Prerequisites: Good standing in the University Honors Program or by invitation; specific course prerequisites will vary depending on the topic.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
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
Format: IND

PLEASE NOTE
This document represents a sample 4-year plan for degree completion with this major. Actual course selection and sequence may vary and should be discussed individually with your college or department academic advisor. Advisors also can help you plan other experiences to enrich your undergraduate education such as internships, education abroad, undergraduate research, learning communities, and service learning and community-based learning.

**Icon Legend: Critical**

**15 HR TERM 1**

**Systems Engineering**

complete CSCE 155E

CSCE 155E becomes critical to your success in the major if not completed by the end of the first term of enrollment.

**Calculus I**

complete MATH 106

MATH 106 becomes critical to your success in the major if not completed by the end of the second term of enrollment.

**ACE 3/4 Math/Science**

complete PHYS 211

**ACE 5 Humanities**

complete 1 from ACE5

**Freshman Seminar**

complete CSCE10#

CSCE 10 becomes critical to your success in the major if not completed by the end of the first term of enrollment.

**16 HR TERM 2**

**Engineering Topics**

complete CSCE 156, CSCE251#

**Engineering Topics**

complete CSCE 235

CSCE 235 is not a critical course, but it is a prerequisite for CSCE 310 which is a critical course.

**Calculus II**

complete MATH 107

**17 HR TERM 3**

**Engineering Topics**

complete CSCE 230, ECEN 235

**Electronics and Circuits**

complete ECEN 215

ECEN 215 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

**Sophomore Seminar**

complete ENGR20#

ENGR 20 becomes critical to your success in the major if not completed by the end of the fifth term of enrollment.

**ACE 3/4 Math/Science**

complete MATH 208

**Science - Physics**

complete either PHYS 213 or PHYS 223

CHEM 109 is also acceptable to fulfill this requirement.

**16 HR TERM 4**
Engineering Topics
complete CSCE 236, ECEN 216, ECEN 236

7hr

Engineering Topics
complete CSCE 310

3hr

CSCE 310 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

ACE 1 Written
complete JGEN 200

3hr

ACE 3/4 Math/Science
complete MATH 221

3hr

18 HR TERM 5
Engineering Topics
complete CSCE 351, CSCE 361, ECEN 304, ECEN 316

12hr

Engr Topics Electives
recommend 1 or more courses

3hr

Open Elective.


ACE 6 Social Sciences
complete 1 from ACE6

3hr

Milestones
1. Professional Admission into College.

15 HR TERM 6
Engineering Topics
complete CSCE 335, CSCE 462, ECEN 305

9hr

ACE 3/4 Math/Science
complete MATH 314

3hr

Technical Electives
recommend 1 or more courses

3hr

See advisor for list.

15 HR TERM 7
Engineering Topics
complete CSCE 440

3hr

Senior Design Experience
complete CSCE 488

3hr

Technical Electives
recommend 1 or more courses

3hr

See advisor for list.

ACE 7 Arts
complete 1 from ACE7

3hr

ACE 2 Oral Comm
complete either JGEN 300 or COMM 286

3hr

15 HR TERM 8
Senior Design Experience
complete CSCE 489

3hr

CSCE 489 becomes critical to your success in the major if not completed by the end of the eighth term of enrollment.

Technical Electives
recommend 1 or more courses

9hr

ACE 3/4 Math/Science
See advisor for list.

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**ACE 9 Global/Human Divers**

*complete 1 from ACE9*

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**Graduation Requirements**

1. 126 hours required for graduation.
2. 2.40 GPA required for graduation.
3. 30 of the last 36 hours must be taken at UNL/UNO.

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**Career Information**

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

### Jobs of Recent Graduates

- Software Engineer 1, Garmin - Olathe KS
- Software Developer, Spreetail - Lincoln NE
- Jr. Project Engineer, Union Pacific - Omaha NE
- Product Manager, Hudl - Lincoln NE
- Embedded Systems Engineer, Lockheed Martin - Denver CO
- Software Developer, IBM - Rochester MN
- Computer Engineer, United States Department of Defense - San Antonio TX
- Software Developer in Test, Amazon - Seattle WA
- Software Developer Engineer, Microsoft - Seattle WA
- System Integration Specialist, Sandhills Publishing - Lincoln NE

### Internships

- System Intern, Sandhills Publishing - Lincoln NE
- Software Engineering Intern, Garmin International - Olathe KS
- Software Engineer Intern, Microsoft - Redmond WA
- Simulation Lab Intern, University of Nebraska Medical Center - Omaha NE
- Hardware Engineer, Springbok Inc - Omaha NE
- Software Development Intern, Epic Systems - Madison WI
- Software Engineering Intern, Firespring - Lincoln NE
- Applications Developer Intern, Gallup - Omaha NE
- Design Engineering Intern, Communication Systems Solutions - Lincoln NE
- Network Design Intern, Union Pacific - Omaha NE

### Grad Schools

- Master of Computer Science, University of Nebraska-Lincoln - Lincoln NE
- Ph.D. in Computer Science, University of Colorado - CO
- Robotics Engineering, Northwestern University - Evanston IL
- Masters of Science in Visualization, Texas A&M University - College Station TX
- Electrical Engineering, University of Nebraska - Lincoln - Lincoln NE
- Masters in Information Technology, University of Texas-Austin - Austin TX
- Medical Sciences Interdepartmental Areas, University of Nebraska Medical Center - Omaha NE