COMPUTER SCIENCE

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

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 Computer Science I is designed for students majoring in computer science. CSCE 155H Honors: Computer Science I is for honors students. CSCE 155E Computer Science I: Systems Engineering Focus 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 Computer Science I: Engineering and Science Focus focuses on numerical and graphical computation in engineering and science, such as applied physics, working with time-sequence data, and matrix applications. CSCE 155T Computer Science I: Informatics Focus focuses on data and information processing, such as document or database applications, online commerce, or bioinformatics. CSCE 156 Computer Science II 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.

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.

College Requirements

College Admission

College Admission
The entrance requirements for the College of Arts and Sciences are the same as the UNL General Admission Requirements. Students who are admitted through the Admission by Review process may have certain conditions attached to their enrollment at UNL. These conditions are explained under “Removal of Deficiencies.”

In addition to these requirements, the College of Arts and Sciences strongly recommends a third and fourth year of languages. Four years of high school language will exempt students from the College of Arts and Sciences’ language requirement. It will also allow students to continue language study at a more advanced level, and give more opportunity to study abroad.

Transfer Students
To be considered for admission as a transfer student, Nebraska resident or nonresident, students must have an accumulated average of C (2.0 on a 4.0 scale) and a minimum C average in the last semester of attendance at another college. Transfer students who graduated from high school January 1997 and after must also meet the UNL General Admissions Requirements. Those transfer students who graduated before January 1997 must have completed in high school 3 years of English, 2 years of the same foreign language, 2 years of algebra, and 1 year of geometry. Transfer students who have completed less than 12 credit hours of college study must submit either the ACT or SAT scores.

Ordinarily, hours earned at an accredited college are accepted by the University. The College, however, will evaluate all hours submitted on an application for transfer and reserves the right to accept or reject any of them. Sixty is the maximum number of hours the University will accept on transfer from a two-year college or international institution. Transfer credit in the major or minor must be approved by the departmental advisor on a Request for Substitution Form to meet specific course requirements, group requirements, or course level requirements in the major or minor. At least half of the hours in the major field must be completed at the University regardless of the number of hours transferred.

The College of Arts and Sciences will accept no more than 15 semester hours of C- and D grades from other schools. The C- and D grades cannot be applied toward requirements for a major or minor. This policy does not apply to the transfer of grades from UNO or UNK to UNL. All D grades may be transferred from UNO or UNK, but they are not applicable to a major or minor.

Readmitted Students
Students readmitted to the College of Arts and Sciences will follow the requirements stated in the bulletin for the academic year of readmission and reenrollment as a degree-seeking student in Arts and Sciences. In consultation with advisors, a student may choose to follow a bulletin for any academic year in which they are admitted to and enrolled as a degree-seeking student at UNL in the College of Arts and Sciences. Students must complete all degree requirements from a single bulletin year. Beginning in 1990-1991, the bulletin which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Admission Deficiencies/Removal of Deficiencies
Students must remove entrance deficiencies in geometry and foreign language before graduating from the College of Arts and Sciences and should consult a college advisor in the Academic and Career Advising Center in 107 Oldfather Hall for questions about admission deficiencies.

Removing Foreign Language Deficiencies
Students must complete the second semester of the first year language sequence to clear the deficiency and the second semester of the second year language sequence to complete the college graduation requirement in language.

Removing Geometry Deficiencies
A deficiency of one year of geometry can be removed by taking two high school geometry courses by Independent Study or by completing
a geometry course from an accredited community college or a four-year institution. Neither of these options count for college credit.

### College Degree Requirements

#### College General Education Requirements

The College of Arts and Sciences distribution requirements are designed to further the purposes of liberal education by encouraging study in several different areas. Courses satisfying these requirements may impart specialized knowledge or broadly connect the subject matter to other areas of knowledge.

All requirements are in addition to University ACE requirements. A student may not use a single course to satisfy more than one of the following five distribution requirements. A student cannot use a single course to satisfy both an ACE outcome and a College distribution requirement. A student cannot use a course from their major to satisfy the Breadth Requirement (F), but may apply an ancillary requirement of the primary major or a course from their second major toward this requirement. Independent study or reading courses and internships cannot be used to satisfy distribution requirements. To see a complete list of excluded courses, run a degree audit through MyRED.

Courses from interdisciplinary programs will count in the same area as courses from the home/cross-listed department(s).

#### Bachelor of Arts or Bachelor of Science (16 credits + Language)

**A. Written Communication: 3 hours**

To be selected from courses approved for ACE outcome 1.

**B. Natural, Physical and Mathematical Sciences: 4 hours**

Select from biochemistry, biological sciences, chemistry, computer science, geology, meteorology, mathematics, physics and statistics. Must include one lab in the natural or physical sciences. Lab courses may be selected from biochemistry, biological sciences, chemistry, geology, meteorology and physics. Select courses from geography\(^1\) and anthropology\(^*\) may also be used to satisfy the lab requirement.

**C. Humanities: 3 hours**

Select from: classics\(^2\), English, history, modern languages and literatures\(^2\), philosophy, and religious studies\(^2\).

**D. Social Sciences: 3 hours**

Select from: anthropology\(^3\), communication studies, geography\(^3\), political science, psychology\(^3\), or sociology.

**E. Languages Classical and Modern: 0-6 hours**

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, modern languages and literatures, or anthropology. Instruction is currently available in Arabic, Chinese, Czech, French, German, Greek, Japanese, Latin, Omaha, Russian, and Spanish. A student who has completed the fourth-year level of one foreign language in high school is exempt from the languages requirement.

**F. Additional Breadth Requirement (may not be used toward the primary major; may apply toward ancillary requirements and second majors): 3 hours**

Select from: natural, physical and mathematical sciences (Area B), humanities (Area C), or social sciences (Area D).

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\(^1\) See your degree audit or College of Arts and Sciences advisor for approved geography and anthropology courses that apply as natural science.

\(^2\) Language courses numbered 210 or below apply only for the foreign language requirement.

\(^3\) See degree audit or College of Arts and Sciences advisor for list of natural/physical science courses in anthropology, geography, and psychology that do not apply as social science.

#### Scientific Base

The bachelor of science degree requires students to complete 60 hours in mathematical, physical and natural sciences. Approved courses for scientific base credit come from the following College of Arts and Sciences disciplines: actuarial science, anthropology (selected courses), astronomy, biochemistry (excluding BIOL 101 Career Opportunities in Biochemistry), biological sciences (excluding CASC 160 Introduction to Dentistry and Dental Hygiene, BIOS 160 Introduction to Clinical Laboratory Science, BIOS 203 Bioethics), chemistry (excluding CHEM 101 Career Opportunities in Chemistry), computer science (excluding CSCE 10 Introduction to CSE), geography (selected courses), geology, life sciences, mathematics (excluding courses below MATH 104 Applied Calculus), meteorology, physics and statistics.

See your degree audit or a College of Arts and Sciences advisor for a complete list including individual classes that fall outside of the disciplines listed above. Up to 12 hours of scientific and technical courses offered by other colleges may be accepted toward this requirement with approval of a college advisor.

#### Foreign Languages/Language Requirement

**Languages Exemption Policy**

UNL and the College of Arts and Sciences will exempt or waive students from the UNL entrance requirement of two years of the same foreign language or from the College’s language distribution requirement based on documentation only. The following are the options and procedures for documentation:

**High School Transcripts**

1. For the University entrance requirements, students must show an official high school transcript with two or more years of the same foreign language in high school.

2. For the College of Arts and Sciences College Distribution Requirement E-Language, students must show an official high school transcript with four or more years of the same foreign language in high school, or show evidence of graduation from a non-English-speaking foreign high school.

3. For the College of Arts and Sciences College Distribution Requirement E-Language, students whose native language is not English must show English as a Second Language study on an official high school transcript. Four years of ESL at the high school level (9th, 10th, 11th and 12th grades) will be the basis for a waiver of the CDR E Language requirement.

**Proficiency Examination at UNL**

1. For the University entrance requirement, students who do not have transcript documentation can request to take a proficiency exam in the language. (This is not the same test as the Modern Languages Placement Exam.) However, UNL will provide testing only in the languages it teaches. Currently, these languages are:

- Arabic
- French
- German
- Spanish
- Russian
- Czech
- Japanese
- Chinese
The Department of Modern Languages will oversee the test and provide written documentation to the Arts and Sciences Advising Center that the student has passed the proficiency test at the 102 level.

2. For the College of Arts and Sciences College Distribution Requirement E-Language, the Department of Modern Languages will oversee the test at the 202 level. If the student passes the test, the department will sign the College Request for Waiver form and indicate the level of proficiency. The form is then forwarded to the Arts and Sciences Advising Center for approval.

**Distance Education**

1. For the University entrance requirement, students without transcript documentation who claim proficiency in a language not taught at UNL, have the option of seeking out a distance education program in languages. If the student completes the equivalent of 102 from an approved distance education program, the student will meet the UNL entrance requirement. The student must have the course work approved before he/she takes/completes the course as equivalent to 102 by a College advisor. The student then completes the course and has the distance education program send the transcript to the Admissions Office.

2. For the College of Arts and Sciences College Distribution Requirement E-Language, the student can seek out a distance education program and complete the equivalent of the 202-level course. The student must submit the request on the College Request for Substitution form and have the course work approved by a College advisor. The student then completes the course and has the distance education program send the transcript to the Admissions Office.

**Third Language Option**

If a student demonstrates knowledge of two foreign languages at the 102 level, the College of Arts and Sciences may consider waiving two semesters of the four semester College Distribution Requirements E-Language requirement. If this waiver were granted, the student would then be required to complete 101 and 102 in another (3rd language) at UNL.

**Minimum Hours Required for Graduation**

A minimum of 120 semester hours of credit is required for graduation from the College of Arts and Sciences. A total grade point average of at least 2.0 is required.

**Grade Rules**

**Restrictions on C- and D Grades**

The College will accept no more than 15 semester hours of C- and D grades from other schools except for UNO and UNK. No transfer C- and D grades can be applied toward requirements in a major or a minor. No UNL C- and D grades can be applied toward requirements in a major or a minor.

**Pass/No Pass Privilege**

University regulations for the Pass/No Pass (P/N) privilege state:

- The Pass/No Pass option is designed for your use by seeking to expand your intellectual horizons by taking courses in areas where you may have had minimal preparation.

For students in Arts and Sciences, the University regulations for Pass/No Pass apply as follows:

- Neither the P nor the N grade contribute to your GPA.
- P is interpreted to mean C or above.

- A change to or from a Pass/No Pass may be made until mid-term (1/2 of the course).
- The Pass/No Pass or grade registration cannot conflict with the policy of the professor, department, college, or University governing the grading option.
- Changing to or from Pass/No Pass requires using the MyRED system to change the grading option or filing a Drop/Add form with the Office of the University Registrar, 107 Canfield Administration Building. After mid-term of the course, a student registered for Pass/No Pass cannot change to a grade registration unless the Pass/No Pass registration is in conflict with the policy of the professor, department, college, or University governing Pass/No Pass.
- The Pass/No Pass grading option cannot be used for the removal of C- or D or F grades.

**Pass/No Pass privileges in the College of Arts and Sciences are extended to students according to the following additional regulations:**

- Pass/No Pass hours can count toward fulfillment of University ACE requirements and college distribution requirements up to the 24-hour maximum.
- Many Arts and Sciences departments and programs do not allow courses in the major or minor to be taken Pass/No Pass; students should refer to the department’s or program’s section of the bulletin for clarification. By college rule, departments can allow up to 6 hours of Pass/No Pass in the major or minor.
- Departments may specify that certain courses of theirs can be taken only on a P/N basis.
- The college will permit no more than a total of 24 semester hours of P/N grades to be applied toward degree requirements. This total includes all Pass grades earned at UNL and other U.S. schools. **NOTE:** This 24-hour limit is more restrictive than the University regulation.

Students who wish to apply P/N hours to their major and minor(s) must obtain approval on a form that is available in the Arts and Sciences Advising Center, 107 Oldfather Hall.

**Grading Appeals**

A student who feels that he/she has been unfairly graded must ordinarily take the following sequential steps in a timely manner, usually by initiating the appeal in the semester following the awarding of the grade:

1. Talk with the instructor concerned. Most problems are resolved at this point.
2. Talk to the instructor’s department chairperson.
3. Take the case to the Grading Appeal Committee of the department concerned. The Committee should be contacted through the department chairperson.
4. Take the case to the College Grading Appeals Committee by contacting the Dean’s Office, 1223 Oldfather Hall.

**Course Level Requirements**

**Courses Numbered above 299**

Thirty of the 120 semester hours of credit must be in courses numbered above 299. Of the 30 hours above 299, 15 hours (1/2) must be completed in residence at UNL. **NOTE:** ALEC 397E and ALEC 397K do not count toward these 30 hours.

**Graduate Courses**

Seniors in the University who have obtained in advance the approval of the dean for Graduate Studies may receive up to 12 hours credit for graduate courses taken in addition to the courses necessary to complete
their undergraduate work, provided that such credits are earned within the calendar year prior to receipt of the baccalaureate. For procedures, inquire at the Office of Graduate Studies.

Course work taken prior to receipt of the baccalaureate may not always be accepted for transfer to other institutions as graduate work.

Residency

Residency Requirement and Open Enrollment and Summer Independent Study Courses

Students must complete at least 30 of the 120 total hours for their degree at UNL. Students must complete at least 1/2 of their major course work including 6 hours above 299 in their major, and 15 of the 30 hours required above 299 in residence. Credit earned during education abroad may be used toward the residency requirement if students register through UNL and participate in prior-approved education abroad programs. UNL open enrollment and summer independent study courses count toward residence.

ACE Requirements

Consistent with the mission and values of the University, ACE is based on a shared set of four institutional objectives and 10 student learning outcomes. The ACE program was approved by faculty in all eight undergraduate colleges and endorsed by the Faculty Senate, the student government, and the Academic Planning Committee in January 2008 for implementation in the fall 2009. ACE aligns with current national initiatives in general education.

Key characteristics of ACE demonstrate the benefits of the program to students:

- Students receive a broad education with exposure to multiple disciplines, critical life skills and important reasoning, inquiry, and civic capacities.
- ACE is simple and transparent for students, faculty and advisors. Students complete the equivalent of 3 credit hours for each of the ten student learning outcomes.
- Students connect and integrate their ACE experiences with their selected major.
- Students can transfer all ACE certified courses across colleges within the institution to meet the ACE requirement and any course from outside the institution that is directly equivalent to a UNL ACE-certified course. Courses from outside institutions without direct equivalents may be considered with appropriate documentation for ACE credit (see academic advisor).

ACE allows faculty to assess and improve their effectiveness and facilitate students’ learning.

ACE Institutional Objectives and Student Learning Outcomes

To meet the ACE Program requirement, a student will complete a minimum of 3 credit hours for each of the ten ACE Student Learning Outcomes (a total of 30 ACE credit hours). See the ACE website at: http://ace.unl.edu for the most current information and the most recently certified courses.

Bulletin Rule

Students must fulfill the requirements stated in the bulletin for the academic year in which they are first admitted to and enrolled as a degree-seeking student at UNL. In consultation with advisors, a student may choose to follow a subsequent bulletin for any academic year in which they are admitted to and enrolled as a degree-seeking student at UNL in the College of Arts and Sciences. Students must complete all degree requirements from a single bulletin year. Beginning in 1990-1991 the bulletin 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 science will be able to:

1. Demonstrate mastery of the mathematical foundations and familiarity of the scientific foundations of computer science.
3. Demonstrate familiarity with the fundamentals of natural science in at least one field, such as chemistry, physics, or geology.
4. Demonstrate familiarity with advanced concepts in automata and/or algorithm design and analysis.

Major Requirements

Core Requirements

Required Computer Science Courses - Non Raikes

<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>
<tr>
<td>Select one of the following:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSCE 156</td>
<td>Computer Science I</td>
<td>4</td>
</tr>
<tr>
<td>or CSCE 155</td>
<td>Computer Science I: Systems Engineering Focus</td>
<td>3</td>
</tr>
<tr>
<td>or CSCE 155</td>
<td>Honors: Computer Science I</td>
<td></td>
</tr>
<tr>
<td>or CSCE 155</td>
<td>Computer Science I: Engineering and Science Focus</td>
<td></td>
</tr>
<tr>
<td>or CSCE 155</td>
<td>Computer Science I: Informatics Focus</td>
<td></td>
</tr>
<tr>
<td>CSCE 156</td>
<td>Computer Science II</td>
<td></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>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

Required Courses for students in the J. S. Raikes School

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</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></td>
</tr>
<tr>
<td>CSCE 251</td>
<td>Unix Programming Environment</td>
<td></td>
</tr>
<tr>
<td>CSCE 322</td>
<td>Programming Language Concepts</td>
<td>3</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 22

Specific Major Requirements

Depth Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</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

Technical Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select 9-11 hours of technical courses</td>
<td></td>
<td>9-11</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 9-11
## Senior Design Experience

Select one of the following: 3

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 486</td>
<td>Computer Science Professional Development</td>
</tr>
<tr>
<td>RAIK 381H</td>
<td>Honors: Advanced Topics in Business I</td>
</tr>
<tr>
<td>RAIK 382H</td>
<td>Honors: Advanced Topics in Business II</td>
</tr>
</tbody>
</table>

Select one of the following: 3

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 487</td>
<td>Computer Science Senior Design Project</td>
</tr>
<tr>
<td>RAIK 402H</td>
<td>Honors: RAIK Design Studio II</td>
</tr>
<tr>
<td>RAIK 404H</td>
<td>Honors: RAIK Design Studio IV</td>
</tr>
</tbody>
</table>

Credit Hours Subtotal: 6

Total Credit Hours: 21-23

1. Select from any CSCE/RAIK 300 or 400 course except CSCE 390, CSCE 490, and RAIK courses lacking CSCE equivalents (except that RAIK 384H, RAIK 401H, RAIK 402H, RAIK 403H and RAIK 404H are acceptable as technical electives).

2. Up to 3 hours of CSCE 491 can be used for technical courses. No more than one of MATH 428, MATH 432, MATH 433, MATH 439, MATH 450, MATH 452 may be used. At least 6 credit hours of technical courses must be other than CSCE 399H, CSCE 491, CSCE 493, CSCE 498, RAIK 401H, RAIK 402H, RAIK 403H, and RAIK 404H.

3. CSCE 486 and CSCE 487 are to be taken in consecutive semesters.

## Recommended Courses for Specific Interests

Talk with your advisor about documenting a focus in one of the following through additional and optional course work:

- **Informatics**: CSCE 410, CSCE 411, CSCE 413, CSCE 464, CSCE 470, CSCE 471, CSCE 472, CSCE 473, CSCE 474
- **Artificial Intelligence**: CSCE 421, CSCE 475, CSCE 476, CSCE 478, CSCE 479
- **Computer and Networking Systems**: CSCE 430, CSCE 432, CSCE 434, CSCE 435, CSCE 455, CSCE 456, CSCE 462, CSCE 465
- **Foundations**: CSCE 421, CSCE 423, CSCE 424, CSCE 428, CSCE 440, CSCE 477

## Ancillary Courses

### Mathematics

<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 314</td>
<td>Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>STAT 380</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:

- **Chemistry**
  - CHEM 109 General Chemistry I
  - CHEM 110 General Chemistry II
  - CHEM 221 Elementary Quantitative Analysis
  - CHEM 113 Fundamental Chemistry I
  - CHEM 114 Fundamental Chemistry II
  - CHEM 116 Quantitative Chemistry Laboratory

- **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

- **Biology**
  - BIOS 109 General Botany
  - BIOS 111 The Biology of Microorganisms
  - BIOS 112 Introduction to Zoology
  - BIOS 112L Introduction to Zoology Lab
  - 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 Fundamentals of Biology I Laboratory
  - LIFE 121 Fundamentals of Biology II
  - LIFE 121L 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 210 Earth Materials: Rocks and Minerals
  - GEOL 410 Geochemistry
  - METR 100 Weather and Climate
  - METR 205 Introduction to Atmospheric Science
  - METR 370 Basic and Applied Climatology

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

Credit Hours Subtotal: 12

Total Credit Hours: 27

### Minor Requirement

The Plan A minor is required. By completing MATH 208 Calculus III (in addition to the major requirements) the Plan A minor requirements for mathematics can be met. You must declare a minor through the College of Arts and Sciences Advising Center in 107 Oldfather Hall.

## Additional Major Requirements

### 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

No course taken Pass/No Pass will be counted toward the major or minor.
Course Level Requirement
Thirteen (13) hours of the CSCE courses must be at the 400 level for students not completing the J. S. Raikes School of Computer Science and Management.

Requirements for Minor Offered by Department

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

Select one of the following: 3
- 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
- CSCE 155T Computer Science I: Informatics Focus

Select at least one of the following: 3-4
- CSCE 156 Computer Science II
- CSCE 311 Data Structures and Algorithms for Informatics
- CSCE 300 or 400 level course
- Additional CSCE courses

Total Credit Hours 18

1 Excluding courses explicitly designated as not counting toward the minor. See CSCE course list in the catalog or the degree audit to identify these.

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

- CSCE 183H / RAIK 183H Honors: Computer Problem Solving Essentials 4
- CSCE 184H / RAIK 184H Honors: Software Development Essentials 4
- CSCE 283H / RAIK 283H Honors: Foundations of Computer Science 3
- Additional CSCE courses (or RAIK courses cross-listed as CSCE) at the 200 level or above. 2 3 7

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
No course taken Pass/No Pass will be counted toward the major or minor.

Restriction
This minor is not open to computer engineering or software engineering majors.

CSCE 100 Introduction to Informatics
Prerequisites: Placement in to MATH 101 or higher
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. This course should not be taken by majors in Computer Science or Computer Engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 101 Fundamentals of Computer Science
Crosslisted with: CSCE 101H
Prerequisites: High school algebra and use of computing applications
Description: Introduction to problem solving with computers. Problem analysis and specifications, algorithm development, program design, and implementation in a high-level programming environment. Hardware, software, software engineering, networks, and impacts of computing on society. 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.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 3 Math/Stat/Reasoning

CSCE 101H Fundamentals of Computer Science
Crosslisted with: CSCE 101
Prerequisites: High school algebra and use of computing applications
Description: Introduction to problem solving with computers. Problem analysis and specifications, algorithm development, program design, and implementation in a high-level programming environment. Hardware, software, software engineering, networks, and impacts of computing on society. 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.
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

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. Will not count towards the requirements for a major or minor in computer science and computer engineering.

Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB

CSCE 120 Learning to Code

Prerequisites: Placement into MATH 101 or higher

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. First course in a sequence for the minor in Software Development. This course should not be taken by majors in Computer Science or Computer Engineering.

Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LAB

CSCE 155A Computer Science I

Prerequisites: Appropriate score on the CSE Placement Exam or CSCE 101; MATH 103 or equivalent

Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society. Recommended for students majoring in computer science or computer engineering. Credit may be earned in only one CSCE 155 course.

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, MECH 350H
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155N Computer Science I: Engineering and Science Focus

Prerequisites: Appropriate score on the CSE Placement Exam or CSCE 101; MATH 103 or equivalent

Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society. 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.

Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

Prerequisite for: CHME 223, CHME 223H; CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350, MECH 350H; MECH 381; METR 223, METR 312, METR 323
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 CSCE 101; MATH 103 or equivalent

Description: For course description, see CSCE 155A. CSCE 155H covers the same topics as CSCE 155A, but in greater depth.

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, MECH 350H
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155SE Computer Science I: Systems Engineering Focus

Prerequisites: Appropriate score on the CSE Placement Exam or CSCE 101; MATH 103 or equivalent

Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society. Recommended for students interested in systems engineering, such as operating systems, mobile computing, and embedded devices. Credit may be earned in only one CSCE 155 course.

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 220, ECEN 220H; ECEN 224; MECH 300; MECH 350, MECH 350H
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
Description: Introduction to computers and problem-solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society. 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.
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, MECH 350H
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
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. Laboratories supplement the lecture material and give an opportunity to practice concepts.
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
ACE: ACE 3 Math/Stat/Reasoning

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
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. Laboratories supplement the lecture material and give an opportunity to practice concepts.
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
ACE: ACE 3 Math/Stat/Reasoning

CSCE 183H Honors: Computer Problem Solving Essentials
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
ACE: ACE 3 Math/Stat/Reasoning

CSCE 184H Honors: Software Development Essentials
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
Description: Aspects of computers and computing at the freshman level for non-computer science and computer engineering majors and/or minors. Topics will vary. CSCE 190 will not count towards a major or minor in computer science and computer engineering.
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, or CSCE 155T 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, ECEN 220H
ACE: ACE 8 Civic/Ethics/Stewardship
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, ECEN 220H
ACE: ACE 8 Civic/Ethics/Stewardship

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: 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
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: 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
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
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: LAB

CSCE 251K C Programming
Crosslisted with: CSCE 251H
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 283H Honors: Foundations of Computer Science
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 378H; CSCE 411H, RAIK 411H; CSCE 476H
CSCE 284H Honors: Foundations of Computer Systems
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
Prerequisite for: RAIS 401H

CSCE 290 Special Topics in Computer Science
Description: Aspects of computers and computing for non-computer science and computer engineering majors and/or minors. Topics vary.
CSCE 290 will not count towards a major or minor in computer science and computer engineering.
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
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: 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
Format: LEC
Prerequisite for: CSCE 361, CSCE 361H; CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIS 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 311H 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: 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
Format: LEC
Prerequisite for: CSCE 361, CSCE 361H; CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIS 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: 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
Format: LEC
Prerequisite for: CSCE 361, CSCE 361H; CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIS 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 361, CSCE 361H; CSCE 378; CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIS 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 320 Data Analysis
Prerequisites: CSCE 220
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. This course should not be taken by majors in Computer Science or Computer Engineering.
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: CSCE 335H
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

CSCE 335H Digital Logic Design
Crosslisted with: CSCE 335
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

CSCE 351 Operating System Kernels
Prerequisites: CSCE 230; CSCE 310 or CSCE 311
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. Lab content reinforces concepts through practice.
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: 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 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
Offered: FALL/SPR

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 HCl, human information processing characteristics important in HCl, 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:** 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 383H Honors: Fundamentals of Software Engineering  
**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  
**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  
**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  
**Crosslisted with:** CSCE 396H  
**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 396H Special Topics in Computer Science  
**Crosslisted with:** CSCE 396  
**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  
**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.  
**Description:** Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients. First semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  

**Prerequisite for:** RAIK 402H  
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.  
**Description:** Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients. Second semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  

**Prerequisite for:** RAIK 403H  

CSCE 403H RAIK Design Studio III  
**Crosslisted with:** 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; BSAD/CSCE/SOFT/RAIK 402H.  
**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. Third semester of Jeffrey S. Raikes School of Computer Science and Management design studio sequence.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC  

**Prerequisite for:** RAIK 404H
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<td>Crosslisted with: SOFT 404H</td>
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<td>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.</td>
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<td>Description: Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients. Fourth semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.</td>
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<tr>
<td>CSCE 410</td>
<td>Information Retrieval Systems</td>
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<td>CSCE 810</td>
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<td>Prerequisites: CSCE 310, SOFT 260, or CSCE 311.</td>
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<td>CSCE 411</td>
<td>Data Modeling for Systems Development</td>
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<td>CSCE 811</td>
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<td>Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.</td>
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<td>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.</td>
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<tr>
<td>CSCE 412</td>
<td>Data Visualization</td>
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<td>CSCE 812</td>
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<td>Prerequisites: CSCE 310, CSCE 310H or CSCE 311; MATH 314</td>
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<td>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.</td>
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<tr>
<td>CSCE 413</td>
<td>Database Systems</td>
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<td>CSCE 813</td>
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<td>Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
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<td>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.</td>
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<tr>
<td>CSCE 421</td>
<td>Foundations of Constraint Processing</td>
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<td>LEC</td>
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<td>Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.</td>
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<td>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.</td>
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<td>CSCE 423</td>
<td>Design and Analysis of Algorithms</td>
<td>CSCE 823</td>
<td>CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<td>CSCE 425</td>
<td>Compiler Construction</td>
<td>CSCE 825</td>
<td>CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<td>CSCE 428</td>
<td>Automata, Computation, and Formal Languages</td>
<td>CSCE 828</td>
<td>CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<td>CSCE 430</td>
<td>Computer Architecture</td>
<td>CSCE 430H</td>
<td>CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<td>CSCE 432</td>
<td>High-Performance Processor Architectures</td>
<td>CSCE 832</td>
<td>CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; Prereq or Coreq: MATH/STAT 380 or ELEC 305.</td>
<td>High performance computing at the processor level. The underlying principles and micro-architectures of contemporary high-performance processors and systems. State-of-the-art architectural approaches to exploiting instruction level parallelism for performance enhancements. Case studies of actual systems highlight real-world trade-offs and theories. CSCE 432 assumes knowledge of computer architecture, pipelining, memory hierarchy, instruction level parallelism, and compiler principles.</td>
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<td>CSCE 434</td>
<td>VLSI Design</td>
<td>CSCE 834</td>
<td>Prerequisites: CSCE 430; MATH 314; MATH/STAT 380 or ELEC 305.</td>
<td>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.</td>
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</table>
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: Techniques in embedded hardware and software design. Transceiver design and low-power communication, sensors, and distributed sampling techniques. Operating systems, driver development, and debugging. Architectures of embedded systems such as wireless sensors and design. Development and implementation of these 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
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, multi-disk 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 440H, CSCE 840, MATH 440, MATH 440H, MATH 840
Prerequisites: CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; MATH 107.
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 440H Numerical Analysis I
Crosslisted with: CSCE 440, CSCE 840, MATH 440, MATH 440H, MATH 840
Prerequisites: CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; MATH 107.
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: 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 451H, 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 451H Operating Systems Principles
Crosslisted with: CSCE 451, 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
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 462H, 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 462H Communication Networks
Crosslisted with: CSCE 462, 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 cryptographic systems in network 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
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. Letter grade only.
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
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. Letter grade only.
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
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. Letter grade only.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 470 Computer Graphics
Crosslisted with: CSCE 470H, CSCE 870
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; 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
Format: LEC
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<th>Course Code</th>
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<tbody>
<tr>
<td>CSCE 470H</td>
<td>Computer Graphics</td>
<td>CSCE 470, CSCE 870</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH 314.</td>
<td>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.</td>
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<td>CSCE 471</td>
<td>Introduction to Bioinformatics</td>
<td>CSCE 871</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380</td>
<td>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.</td>
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<td>CSCE 472</td>
<td>Digital Image Processing</td>
<td>CSCE 872</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311 or equivalent programming experience.</td>
<td>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.</td>
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<td>CSCE 473</td>
<td>Computer Vision</td>
<td>CSCE 873</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<td>CSCE 474</td>
<td>Introduction to Data Mining</td>
<td>CSCE 874</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380</td>
<td>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.</td>
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<tr>
<td>CSCE 475</td>
<td>Multiagent Systems</td>
<td>CSCE 875</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<tr>
<td>CSCE 476</td>
<td>Introduction to Artificial Intelligence</td>
<td>CSCE 876</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311</td>
<td>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.</td>
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<tr>
<td>CSCE 476H</td>
<td>Honors: Introduction to Artificial Intelligence</td>
<td>CSCE 876</td>
<td>SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380; Good standing in the University Honors Program or by instructor permission.</td>
<td>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.</td>
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CSCE 477 Cryptography and Computer Security  
Crosslisted with: CSCE 477H, 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 477H Cryptography and Computer Security  
Crosslisted with: CSCE 477, 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, 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  
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 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  
Crosslisted with: CSCE 488H  
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: 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 488H Computer Engineering Professional Development
Crosslisted with: CSCE 488
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
Crosslisted with: CSCE 489H
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 489H Computer Engineering Senior Design Project
Crosslisted with: CSCE 489
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
Description: Prereq: Permission. CSCE 490/890 will not count toward a major or minor in Computer Science and Computer Engineering. 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 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
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. Does not apply toward any requirements for the Computer Science or Computer Engineering degree. Required for the Informatics minor.
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
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
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 498 Computer Problems
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.

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
- Comprehend and critically evaluate complex information
- Use quantitative analytical computational techniques
- Make predictions using mathematical, statistical, and scientific modeling methods
- Understand and use proper laboratory and technical skills and instruments
- Define problems and identifying causes
- More...
  - Support and communicate claims using clear evidence
  - Simplify complex information and present it to others
  - Apply mathematical and scientific skills to solve real-world problems
  - Document and replicate processes and procedures
  - Design and implement research experiments

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
- More...
  - 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

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
- Student Web Developer, Internet and Interactive Media (University Comm.) - Lincoln NE
- More...
  - Year Round PC Build 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

Grad Schools
- M.S. in Data Science, University of Minnesota-Twin Cities - Twin Cities MN
- Masters of Science in Computer Science, University of Nebraska-Lincoln - Lincoln NE
- Ph.D. in Computer Science, University of Nebraska-Lincoln - Lincoln NE
- Mathematical Sciences, Purdue University - West Lafayette IN
- J.D. Degree, University of Nebraska-Lincoln - Lincoln NE
- More...
  - Physics, Ph.D., University of Nebraska-Lincoln - Lincoln NE
  - Computer Science, Ph.D., University of Texas at Austin - Austin TX
  - Computer Science, Arizona State University - Tempe AZ
  - M.D., University of Nebraska Medical Center - Omaha NE
  - Ph.D., Ohio State University - Columbus OH