**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 lifelong 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 and 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 documents 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 student’s 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 one foreign language. Four years of high school coursework in the same language will fulfill the College of Arts and Sciences’ language requirement. It will also allow students to continue language study at a more advanced level at UNL, and provide 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 Admission 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 also submit either their ACT or SAT scores.

Ordinarily, hours earned at a similarly accredited college or university are applicable to the UNL degree. The College, however, will evaluate all hours submitted on an application for transfer, and reserves the right to accept or reject any of them, based upon its exclusion and restriction policies. 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**

UNL students who choose not to take courses for more than 2 consecutive terms, must reapply to UNL. Students readmitted to the College of Arts and Sciences will follow the requirements stated in the catalog for the academic year of readmission and re-enrollment as a degree-seeking student in Arts and Sciences. In consultation with advisors, a student may choose to follow a catalog 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 catalog year. Beginning in 1990-1991, the catalog 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 as soon as possible, and before graduating from the College of Arts and Sciences. For questions and more information, students should consult a college advisor in the Academic and Career Advising Center in 107 Oldfather Hall.

**Removing Foreign Language Deficiencies**

Students must complete the second semester of a 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 high school geometry courses through an approved independent study program, or by completing a geometry course from an accredited community college or a four-year institution. Neither of these options will count for college credit.

College Degree Requirements
College Distribution Requirements

Bachelor of Arts or Bachelor of Science (16 hours + Language)

The College of Arts and Sciences distribution requirements are designed to further the purposes of liberal education by encouraging study in several different areas within the College. 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 primary major to satisfy the Breadth Requirement (F), but may apply an ancillary requirement of the primary major or a course from their primary 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).

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td></td>
<td>College Distribution Requirements</td>
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</tr>
<tr>
<td>CDR A - Written Communication</td>
<td>3</td>
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<tr>
<td>Select from courses approved for ACE outcome 1.</td>
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<tr>
<td>CDR B and BL - Natural, Physical, and Mathematical Sciences with Lab</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
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<tr>
<td>Some courses from geography and anthropology may also be used to satisfy the lab requirement above.</td>
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<tr>
<td>CDR C - Humanities</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Select from classics, English, history, modern languages and literatures, philosophy, and religious studies.</td>
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<tr>
<td>CDR D - Social Science</td>
<td>3</td>
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<tr>
<td>Select from: anthropology, communication studies, geography, political science, psychology, or sociology.</td>
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<tr>
<td>CDR E - Language</td>
<td>0-16</td>
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<tr>
<td>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.</td>
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<tr>
<td>CDR F - Additional Breadth</td>
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</tbody>
</table>

Select from: natural, physical and mathematical sciences (Area B), humanities (Area C), or social sciences (Area D). Cannot be a course from the primary major.

Credit Hours Subtotal: 16-32

1. See degree audit or a 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
Bachelor of Science Only (60 hours)

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), biological sciences (excluding BIOS 203), chemistry (excluding CHEM 101), computer science (excluding CSCE 10), geography (selected courses), geology, life sciences, mathematics (excluding courses below MATH 104), meteorology, microbiology, physics and statistics.

See your degree audit or a College of Arts and Sciences advisor for a complete list including individual classes that fail 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
For the University entrance requirement, students must show an official high school transcript with two or more years of the same foreign language.

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. 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
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.

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.

The Department of Modern Languages will oversee the test and provide written documentation to the Arts and Sciences Advising Center the level of proficiency passed.

Distance Education
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.

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 Requirement E-Languages requirement. If this waiver were granted, the student would then be required to complete 101 and 102 in another, 3rd foreign 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.
- 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 (see academic calendar for specific dates per term).
- 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.
- Most Arts and Sciences departments and programs do not allow courses graded Pass/No Pass to apply to the major or minor. Students should refer to the department's or program's section of the catalog 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.

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.

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 ten 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.

Catalog Rule
Students must fulfill the requirements stated in the catalog 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 catalog 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 catalog year. Beginning in 1990-1991 the catalog which a student follows for degree requirements may not be more than 10 years old at the time of graduation.

Learning Outcomes
Majors in computer science will be able to:
1. Demonstrate mastery of the mathematical foundations and familiarity with the scientific foundations of Computer Science. These include:
   b. Natural Sciences: Familiarity with the fundamentals of natural science in at least one field, such as chemistry, physics, or geology; and
   c. Computer Science Theory: Familiarity with advanced concepts in automata and/or algorithm design and analysis.
2. Demonstrate a depth of knowledge in topics critical to analyzing and solving computer science problems. These include:
   a. Programming and Software Design: Mastery of computer programming, including data structures and algorithms using representative programming languages; and
   b. Systems Components and Design: Mastery of the topics necessary to design software systems, including computer organization, operating systems, programming language concepts, and software engineering.
3. Demonstrate the ability to envision, analyze, design, and implement maintainable, practicable, software solutions within realistic constraints to advanced computer science problems, which involves:
   a. Application of Theory: Application of theoretical knowledge;
   b. Experimentation: Design and execution of experiments with analysis and interpretation of data;
   c. Design Tools and Techniques: Use of current design tools and techniques; and
   d. Documentation and Maintenance: Generation of documentation and means for system maintenance.
4. Demonstrate proficiency at communicating their technical knowledge and accomplishments in both written and oral forms to a range of audiences and in styles consistent with industry norms.
5. Demonstrate an understanding of contemporary social, political, cultural, organizational and ethical issues and the implications for a computer scientist over his/her professional lifetime. These include:
   a. Liberal Arts: A broad education in the humanities, fine arts, and social sciences;
   b. Ethical/Social Issues: A focused education of the range of ethical, legal, environmental, security, and safety issues relevant to computer science;
   c. Teamwork: The ability to work with others, including interdisciplinary teams; and
   d. Life-Long Learning/Professional Development: An understanding of the importance of and opportunities to engage in life-long learning and professional development, as demonstrated through involvement in professional organizations, extra-curricular and elective activities.

Major Requirements
Core Requirements

Required Computer Science Courses - Non Raikes

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<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CSCE 10</td>
<td>Introduction to CSE</td>
<td>3</td>
</tr>
</tbody>
</table>

Select one of the following: 3
Specific Major Requirements

Depth Courses
- CSCE 351 Operating System Kernels 3
- or CSCE 451 Operating Systems Principles 3
- CSCE 423 Design and Analysis of Algorithms 3
- or CSCE 428 Automata, Computation, and Formal Languages 3

Credit Hours Subtotal: 6

Technical Courses
Select 9-11 hours of technical courses 1 2

Credit Hours Subtotal: 9-11

Senior Design Experience
Select one of the following:
- CSCE 486 Computer Science Professional Development 3
- RAIK 381H Honors: Advanced Topics in Business I
- RAIK 382H Honors: Advanced Topics in Business II

Select one of the following:
- CSCE 487 Computer Science Senior Design Project 3
- RAIK 402H Honors: RAIK Design Studio II
- RAIK 404H Honors: RAIK Design Studio IV

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

Credit Hours Subtotal: 15

Science
Select 12 credit hours of courses intended for science or engineering majors including at least one laboratory.

Acceptable disciplines and courses are:

- 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

- Astronomical Sciences
  - ASTR 224 Astronomy and Astrophysics Laboratory

- Biological Sciences
  - BIOS 109 General Botany
  - BIOS 111 The Biology of Microorganisms
  - BIOS 112 Introduction to Zoology
  - BIOS 112L Introduction to Zoology Lab
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

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

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
Notes: This course should not be taken by majors in Computer Science or Computer Engineering.
Description: Introduction to the use of data-centric and information technologies-and issues and challenges-in today's applications in sciences, engineering, the humanities, and the arts. Exposure to computational thinking and programming, statistical thinking and research design, data analysis and database techniques, and visualization and creative thinking.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 101 Fundamentals of Computer Science
Prerequisites: High School algebra and use of computing applications
Notes: CSCE 101 is intended for non-CSCE majors who desire a deeper understanding of computers and the work of computer scientists.
CSCE 101 is a course in the science of computation and is suitable for non-CSCE majors and prospective CSCE majors.
Description: Introduction to problem solving with computers. Problem analysis and specification, algorithm development, program design, and implementation in a high-level programming environment. Hardware, software, software engineering, networks, and impacts of computing on society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 3 Math/Stat/Reasoning

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

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

CSCE 155A Computer Science I
Prerequisites: Appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
Notes: Credit may be earned in only one CSCE 155 course.
Recommended for students majoring in computer science or computer engineering.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155E Computer Science I: Systems Engineering Focus
Prerequisites: Appropriate score on the CSE Placement Exam or CSCE 101; MATH 103 or equivalent
Notes: Credit may be earned in only one CSCE 155 course.
Recommended for students interested in systems engineering, such as operating systems, mobile computing, and embedded devices.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155H Honors: Computer Science I
Prerequisites: Good standing in the University Honors Program or by invitation; appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
Notes: CSCE 155H covers the same topics as CSCE 155A, but in greater depth.
Description: For course description, see CSCE 155A.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155N Computer Science I: Engineering and Science Focus
Prerequisites: Appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
Notes: Recommended for students interested in numerical and graphical applications in engineering and science, such as applied physics, working with time-sequence data, and matrix applications.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CHME 223; CSCE 230; CSCE 230H; CSCE 235; CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350; MECH 381; METR 223; METR 312; METR 323
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155T Computer Science I: Informatics Focus
Prerequisites: Appropriate score on the CSE Placement Exam or CSCE101; MATH 103 or equivalent
Notes: Recommended for students interested in data and information processing, such as library and database applications, online commerce, and bioinformatics. Credit may be earned in only one CSCE 155 course.
Description: Introduction to computers and problem-solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 230; CSCE 230H; CSCE 235; CSCE 235H; CSCE 311; ECEN 224; MECH 300; MECH 350
ACE: ACE 3 Math/Stat/Reasoning
CSCE 156 Computer Science II
Prerequisites: Appropriate score on the CSE Placement Exam or a grade of "P" or "C" or better in CSCE 155A, CSCE155E, CSCE 155H, CSCE 155N, or CSCE 155T; Math 106 or parallel
Notes: Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Data structures, including linked lists, stacks, queues, and trees; algorithms, including searching, sorting, and recursion; programming language topics, including object-oriented programming; pointers, references, and memory management; design and implementation of a multilayer application with SQL database.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; CSCE 322; CSCE 378; SOFT 162
CSCE 156H Honors: Computer Science II
Prerequisites: Good standing in the University Honors Program or by invitation; appropriate score on CSE Placement Exam or a grade of "P" or "C" or better in CSCE 155 or 155H; MATH 106 or parallel
Notes: CSCE 156H covers the same topics as CSCE 156, but in greater depth. Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: For course description, see CSCE 156.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; CSCE 322; CSCE 378; SOFT 162
CSCE 183H Honors: Computer Problem Solving Essentials
Crosslisted with: RAIK 183H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management.
Description: Introduction to problem solving with computers. Problem analysis and specification, algorithm development, program design, and implementation. JAVA in a Windows platform.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: ECON 215; MATH 380, MATH 380H, STAT 380, STAT 380H, RAIK 270H; MRKT 350; SCMA 250
ACE: ACE 3 Math/Stat/Reasoning
CSCE 184H Honors: Software Development Essentials
Crosslisted with: RAIK 184H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 183H.
Description: Problem solving with computers. Problem analysis and specification, data structures, relational databases, algorithm development, and program design and implementation. Discrete mathematics topics, propositional and predicate logic, sets, relations, functions, and proof techniques. Software Development Principles.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CSCE 310, CSCE 310H; CSCE 322; CSCE 378; SOFT 162
CSCE 190 Special Topics in Computer Science
Prerequisites: Permission.
Notes: CSCE 190 will not count towards a major or minor in computer science and computer engineering. Topics will vary.
Description: Aspects of computers and computing at the freshman level for non-computer science and computer engineering majors and/or minors.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC
CSCE 196 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC

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

CSCE 230 Computer Organization
Prerequisites: A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160 or equivalent knowledge of a high-level programming language.
Notes: Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Introduction to organization and structure of computer systems. Boolean logic, digital arithmetic, processor organization, machine language programming, input/output, memory organization, system support software, communication, and ethics.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: CSCE 322; CSCE 438, CSCE 838; ECEN 220

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

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

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

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

CSCE 236 Embedded Systems
Prerequisites: CSCE 230
Description: Introduction to designing, interfacing, configuring, and programming embedded systems. Configure simple embedded microprocessor systems, control peripherals, write device drivers in a high-level language, set up embedded and real-time operating systems, and develop applications for embedded systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

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

CSCE 283H Honors: Foundations of Computer Science
Crosslisted with: RAIK 283H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 184H.
Description: Advanced data structures and algorithms that solve common problems and standard approaches to solving new problems. Analysis and comparison of algorithms, asymptotic notation and proofs of correctness. Discrete mathematics. Induction and principles of counting and combinatorics as foundation for analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 411H, RAIK 411H; CSCE 476H

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

CSCE 290 Special Topics in Computer Science
Prerequisites: Permission.
Notes: Topics vary. CSCE 290 will not count towards a major or minor in computer science and computer engineering.
Description: Aspects of computers and computing for non-computer science and computer engineering majors and/or minors.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC

CSCE 296 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC

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

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

CSCE 311 Data Structures and Algorithms for Informatics
Prerequisites: Grade of "Pass" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160.
Notes: CSE majors must take CSCE 310. Students may not receive credit for both CSCE310 and 311.
Description: An introduction to algorithms and data structures for informatics. Foundational coverage of algorithms includes both problems (such as indexing, searching, sorting, and pattern matching) and methods (such as greedy, divide-and-conquer, and dynamic programming). Foundational coverage of data structures includes lists, tables, relational databases, regular expressions, trees, graphs, and multidimensional arrays. The topics will be studied in the context of informatics applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: CSCE 322; CSCE 378; CSCE 378H; CSCE 410, CSCE 810; CSCE 411H, RAIK 411H; CSCE 413, CSCE 813; CSCE 438, CSCE 838; CSCE 476H; CSCE 491

CSCE 320 Data Analysis
Prerequisites: CSCE 220
Notes: This course should not be taken by majors in Computer Science or Computer Engineering. Third course in a sequence for the minor in Software Development.
Description: Practical experience on how to model data through existing techniques including object-oriented and relational models. These models can then be used at the center of systems to promote efficient and effective data processing and analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 322 Programming Language Concepts
Prerequisites: CSCE 156, SOFT 161 or CSCE 311; CSCE 230.
Description: List-processing, string-processing, and other types of high-level programming languages. Fundamental concepts of data types, control structures, operations, and programming environments of various programming languages. Analysis, formal specification, and comparison of language features.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

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

Prerequisite for: ECEN 307

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

CSCE 361 Software Engineering
Crosslisted with: CSCE 361H
Prerequisites: A grade of "Pass" or "C" or better in CSCE 310, CSCE 310H, CSCE 311 or SOFT 260.
Description: Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

Prerequisite for: CSCE 486

CSCE 361H Software Engineering
Crosslisted with: CSCE 361
Prerequisites: Good Standing in UNL Honors Program or by invitation; A grade of "Pass" or "C" or better in CSCE 310, CSCE 310H, CSCE 311 or SOFT 260.
Description: Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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 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
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Crosslisted</th>
<th>Prerequisites</th>
<th>Notes</th>
<th>Description</th>
<th>Credit Hours</th>
<th>Max credits per semester</th>
<th>Max credits per degree</th>
<th>Format</th>
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<tbody>
<tr>
<td>CSCE 378H</td>
<td>Honors: Human-Computer Interaction</td>
<td></td>
<td>CSCE 310, CSCE 311, SOFT 260, or CSCE 283H; Good standing in the University Honors Program or by instructor permission.</td>
<td>Notes: CSCE 378H covers the same topics as CSCE 378, but in greater depth.</td>
<td>Description: For course description, see CSCE 378.</td>
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<tr>
<td>CSCE 383H</td>
<td>Honors: Fundamentals of Software Engineering</td>
<td>RAIK 383H</td>
<td>CSCE 310, CSCE 311, SOFT 260, or CSCE 283H; 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.</td>
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<td>Description: Proper principles and methods of engineering software. Requirements, design, implementation, management and software evolution.</td>
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<td>LEC</td>
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<td>CSCE 384H</td>
<td>Honors: Applied Numerical Analysis</td>
<td>RAIK 384H</td>
<td>CSCE 310, CSCE 311, SOFT 260, or CSCE 283H; Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 284H; parallel BSAD/RAIK 382H.</td>
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<td>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.</td>
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<tr>
<td>CSCE 390</td>
<td>Special Topics in Computer Science</td>
<td></td>
<td>Permission.</td>
<td></td>
<td>Description: Aspects of computers and computing for non-computer science and computer engineering majors and/or minors. Topics vary.</td>
<td>1-3</td>
<td>1</td>
<td>6</td>
<td>LEC</td>
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<tr>
<td>CSCE 396</td>
<td>Special Topics in Computer Science</td>
<td></td>
<td>Permission.</td>
<td></td>
<td>Description: Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.</td>
<td>1-3</td>
<td>1</td>
<td>6</td>
<td>LEC</td>
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<tr>
<td>CSCE 401H</td>
<td>Honors: RAIK Design Studio I</td>
<td>SOFT 401H</td>
<td>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.</td>
<td>Notes: First semester in the Jeffrey S. Raikes School of Computer Science and Management design studio</td>
<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.</td>
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<td>LEC</td>
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<tr>
<td>CSCE 402H</td>
<td>Honors: RAIK Design Studio II</td>
<td>SOFT 402H</td>
<td>Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and BSAD/CSCE/SOFT/RAIK 401H.</td>
<td>Notes: Second semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.</td>
<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.</td>
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<td>LEC</td>
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<tr>
<td>CSCE 403H</td>
<td>Honors: RAIK Design Studio III</td>
<td>RAIK 403H, BSAD 403H, SOFT 403H</td>
<td>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.</td>
<td>Notes: Third semester of Jeffrey S. Raikes School of Computer Science and Management design studio sequence. Third semester of Jeffrey S. Raikes School of Computer Science and Management design studio sequence.</td>
<td>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.</td>
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<td>3</td>
<td>3</td>
<td>LEC</td>
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</table>
CSCE 404H Honors: RAIK Design Studio IV  
**Crosslisted with:** RAIK 404H, BSAD 404H, SOFT 404H  
**Prerequisites:** Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; BSAD/CSCE/SOFT/RAIK 403H.  
**Notes:** Fourth semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.  
**Description:** Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

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

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

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

CSCE 412 Data Visualization  
**Crosslisted with:** CSCE 812  
**Prerequisites:** CSCE 310, CSCE 310H or CSCE 311; MATH 314  
**Description:** Fundamentals and implementations of data visualization techniques. Programming skills and practices in interactive visualization applications. Visualization foundations, human perception for information processing, and visualization techniques for different data types, such as scalar-field data, vector-field data, geospatial data, multivariate data, graph/network data, and text/document data. Advanced visualization algorithms and topics as time permits.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

CSCE 413 Database Systems  
**Crosslisted with:** CSCE 813  
**Prerequisites:** SOFT 260, CSCE 310, CSCE 310H, or CSCE 311  
**Description:** Data and storage models for database systems; entity/relationship, relational, and constraint models; relational databases; relational algebra and calculus; structured query language; Logical database design: normalization; integrity; distributed data storage; concurrency; security issues. Spatial databases and geographic information systems.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Format:** LEC

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

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

CSCE 425 Compiler Construction
Crosslisted with: CSCE 825
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Description: Review of program language structures, translation, loading, execution, and storage allocation. Compilation of simple expressions and statements. Organization of a compiler including compile-time and run-time symbol tables, lexical scan, syntax scan, object code generation, error diagnostics, object code optimization techniques, and overall design.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 428 Automata, Computation, and Formal Languages
Crosslisted with: CSCE 828
Prerequisites: CSCE 235; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Description: Introduction to the classical theory of computer science. Finite state automata and regular languages, minimization of automata. Context free languages and pushdown automata, Turing machines and other models of computation, undecidable problems, introduction to computational complexity.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 430 Computer Architecture
Crosslisted with: CSCE 830
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; Prereq or Coreq: MATH/STAT 380 or ELEC 305.
Description: Architecture of single-processor (Von Neumann or SISD) computer systems. Evolution, design, implementation, and evaluation of state-of-the-art systems. Memory Systems, including interleaving, hierarchies, virtual memory and cache implementations; Communications and I/O, including bus architectures, arbitration, I/O processors and DMA channels; and Central Processor Architectures, including RISC and Stack machines, high-speed arithmetic, fetch/execute overlap, and parallelism in a single-processor system.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

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

CSCE 435 Cluster and Grid Computing
Crosslisted with: CSCE 835
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311 or equivalent programming experience.
Description: Build and program clusters. Cluster construction, cluster administration, cluster programming, and grid computing.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 436 Advanced Embedded Systems
Crosslisted with: CSCE 836
Prerequisites: CSCE 236; SOFT 260, CSCE 310, CSCE 310H, CSCE 311, or equivalent; senior/graduate standing.
Description: Embedded hardware design techniques; transceiver design and low-power communication techniques; sensors and distributed sampling techniques; embedded software design and embedded operating systems; driver development; embedded debugging techniques; hardware and software architectures of embedded systems; and design, development, and implementation of embedded applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 437 File and Storage Systems
Crosslisted with: CSCE 837
Prerequisites: CSCE 351 or 451/851; CSCE 430/830.
Description: System-level and device-level topics in the design, implementation, and use of file and storage systems. Components and organization of storage systems, disk drive hardware and firmware, 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 840, MATH 440, MATH 840
Prerequisites: CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; Math 107.
Notes: Credit toward the degree may be earned in only one of the following: CSCE/MATH 440/840 and MECH 480/880.
Description: Principles of numerical computing and error analysis covering numerical error, root finding, systems of equations, interpolation, numerical differentiation and integration, and differential equations. Modeling real-world engineering problems on digital computers. Effects of floating point arithmetic.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 441 Approximation of Functions
Crosslisted with: CSCE 841, MATH 441, MATH 841
Prerequisites: A programming language, MATH 221 and 314.
Description: Polynomial interpolation, uniform approximation, orthogonal polynomials, least-first-power approximation, polynomial and spline interpolation, approximation and interpolation by rational functions.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Groups: Advanced Mathematics Courses

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

CSCE 451 Operating Systems Principles
Crosslisted with: CSCE 851
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 455 Distributed Operating Systems
Crosslisted with: CSCE 855
Prerequisites: CSCE 451/851.
Description: Organization and structure of distributed operating systems. Control, communication and synchronization of concurrent processes in the context of distributed systems. Processor allocation and scheduling. Deadlock avoidance, detection, recovery in distributed systems. Fault tolerance. Distributed file system concepts and structure.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 456 Parallel Programming
Crosslisted with: CSCE 856
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent programming experience.
Description: Introduction to the fundamentals of parallel computation and applied algorithm design. Methods and models of modern parallel computation; general techniques for designing efficient parallel algorithms for distributed and shared memory multiprocessor machines; principles and practice in programming an existing parallel machine.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 457 Systems Administration
Crosslisted with: CSCE 857
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, CSCE 311 or equivalent programming experience.
Description: Introduction to basic concepts of system administration. Operating systems and networking overview. User and resource management. Networking, systems and internet related security. System services and common applications, web services, database services, and mail servers. Basic scripting in shell, Perl, and Expect. Systems administration on UNIX® platform.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 461 Advanced Topics in Software Engineering
Crosslisted with: CSCE 861, SOFT 461
Prerequisites: CSCE 361, CSCE 361H or SOFT 261
Description: Advanced or emerging techniques in software engineering. Topics include but not limited to design methodology, software dependability, and advanced software development environments.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

CSCE 463 Data and Network Security
Crosslisted with: CSCE 863
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Description: Concepts and principles of data and network security. Focuses on practical aspects and application of crypto systems in security protocols for networks such as the Internet. Topics include: applications of cryptography and cryptosystems for digital signatures, authentication, network security protocols for wired and wireless networks, cyberattacks and countermeasures, and security in modern computing platforms.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 464 Internet Systems and Programming
Crosslisted with: CSCE 864
Prerequisites: CSCE 156, SOFT 161, CSCE 311, or CSCE 320 or equivalent programming experience.
Description: Paradigms, systems, and languages for Internet applications. Client-side and server-side programming, object-based and event-based distributed programming, and multi-tier applications. Coverage of specific technologies varies.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 465 Wireless Communication Networks
Crosslisted with: CSCE 865
Prerequisites: CSCE 230; SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380 or ELEC 305; or instructor permission
Description: Discussion of theoretical and practical insight to wireless communications and wireless networking, current practices, and future trends. Wireless network architectures, mobility management, radio propagation, modulation, power control, antennas, channel access, pricing, and standards.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 466 Software Design and Architecture
Crosslisted with: SOFT 466, CSCE 866
Prerequisites: SOFT 261 or CSCE 361 or equivalent
Notes: Letter grade only.
Description: Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

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

CSCE 470 Computer Graphics
Crosslisted with: CSCE 870
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH 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

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

CSCE 472 Digital Image Processing
Crosslisted with: CSCE 872
Prerequisites: CSCE 156, SOFT 161, or CSCE 311 or equivalent programming experience.
Description: Digital imaging systems, digital image processing, and low-level computer vision. Data structures, algorithms, and system analysis and modeling. Digital image formation and presentation, image statistics and descriptions, operations and transforms, and system simulation. Applications include system design, restoration and enhancement, reconstruction and geometric manipulation, compression, and low-level analysis for computer vision.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

CSCE 474 Introduction to Data Mining
Crosslisted with: CSCE 874
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311; MATH/STAT 380
Description: Data mining and knowledge discovery methods and their application to real-world problems. Algorithmic and systems issues. Statistical foundations, association discovery, classification, prediction, clustering, spatial data mining and advanced techniques.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
CSCE 475 Multiagent Systems
Crosslisted with: CSCE 875
Prerequisites: CSCE 156, SOFT 161, or CSCE 311
Description: Distributed problem solving and planning, search algorithms for agents, distributed rational decision making, learning multiagent systems, computational organization theory, formal methods in Distributed Artificial Intelligence, multiagent negotiations, emergent behaviors (such as ants and swarms), and Robocup technologies and real-time coalition formation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

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

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

CSCE 478 Introduction to Machine Learning
Crosslisted with: CSCE 878
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311.
Description: Introduction to the fundamentals and current trends in machine learning. Possible applications for game playing, text categorization, speech recognition, automatic system control, 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: ACE 8 Civic/Ethics/Stewardship

CSCE 487 Computer Science Senior Design Project
Prerequisites: CSCE 486 (taken exactly one semester previous)
Description: A substantial computer science project requiring design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and software engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 10 Integrated Product
CSCE 488 Computer Engineering Professional Development
Prerequisites: CSCE 236; A grade of "Pass" or "C" or better in CSCE 361 or CSCE 361H; formal admission to the College of Engineering; prereq or coreq: JGEN 300.
Description: Preparation for the senior design project. Professional practice through familiarity and practice with current tools, resources, and technologies; professional standards, practices, and ethics; and oral and written report styles used in the computer engineering field.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
ACE: ACE 8 Civic/Ethics/Stewardship

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

CSCE 490 Special Topics in Computer Science
Crosslisted with: CSCE 890
Prerequisites: Permission.
Notes: CSCE 490/890 will not count toward a major or minor in Computer Science and Computer Engineering. Topics vary.
Description: Aspects of computers and computing for non-Computer Science and Computer Engineering majors and/or minors.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC

CSCE 491 Internship in Computing Practice
Prerequisites: SOFT 260, CSCE 310, CSCE 310H, or CSCE 311
Notes: CSCE 491 requires a detailed project proposal and final report.
Description: Experiential learning in conjunction with an approved industrial or government agency under the joint supervision of an outside sponsor and a faculty advisor.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: FLD

CSCE 493 Innovation Lab Project
Prerequisites: CSCE310, CSCE310H, CSCE311, or CSCE320
Description: Innovative team projects executed under the guidance of members of the faculty of the Department of Computer Science and Managing Director of the CSCE Innovation Lab. Students will work in teams and collaborate with CSE research faculty, supervising MS students, and sponsors that include private sectors and UNL faculty to design and develop real-world systems.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC

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

CSCE 496 Special Topics in Computer Science
Crosslisted with: CSCE 896
Prerequisites: Senior or graduate standing.
Description: Aspects of computers and computing not covered elsewhere in the curriculum presented as the need arises.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Format: LEC

CSCE 496H Honors: Special Topics in Computer Science
Prerequisites: Good standing in the University Honors Program or by invitation; specific course prerequisites will vary depending on the topic.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

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

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

**Computer Science (B.S.)**

**16 HR TERM 1**

**Computer Science Core**

- complete CSCE10#, CSCE 155A

**Calculus I**

- complete MATH 106

MATH 106 is ideally completed in the first term of enrollment. It becomes critical to your success in the major if not completed by the second term of enrollment.

**ACE 1 Written Texts**

- complete 1 from ACE1

**CDR E: Language**

- recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

**Electives**

- complete Any Course

MATH 208 is recommended in the term.

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<th>Course Name</th>
<th>Credits</th>
<th>Grade</th>
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<td>16</td>
<td><strong>Computer Science Core</strong></td>
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<tr>
<td>3</td>
<td>complete CSCE10#, CSCE 155A</td>
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<td>5</td>
<td>Calculus I</td>
<td>complete MATH 106</td>
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<tr>
<td>3</td>
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<td>recommend 1 or more courses</td>
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<tr>
<td>3</td>
<td>Electives</td>
<td>complete Any Course</td>
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**16 HR TERM 2**

**Computer Science Core**

- complete CSCE156#, CSCE 235

**Calculus II**

- complete MATH 107

**Computer Science Core**

- complete CSCE 310

CSCE 310 is ideally completed in the third term of enrollment. It becomes critical to your success in the major if not completed by the fourth term of enrollment.

**CDR E: Language**

- recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

**Electives**

- complete Any Course

MATH 208 is recommended in the term.

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**15 HR TERM 3**

**Computer Science Core**

- complete either CSCE230# or CSCE251#

**CDR E: Language**

- recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

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**15 HR TERM 4**

**Computer Science Core**

- complete CSCE 361

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Computer Science

Linear Algebra
complete MATH 314

Statistics
complete STAT 380

CDR E: Language
recommend 1 or more courses

If not complete, choose a language course according to your placement and proficiency. CDR E is met after 4th level (202) of most languages.

16 HR TERM 5

Senior Design Experience
complete CSCE 486

CSCE 486 will fulfill the ACE 8 requirement.

Technical Course
complete either Any Computer Science Course at the 300 Level or Any Computer Science Course at the 400 Level

Complete an approved CSCE course at the 300 or 400 level.

Science Courses
complete 1 from ANTH 242L, ANTH 242, ASTR 204, ASTR 224, BIOS 109, BIOS 111, BIOS 112L, BIOS 112, BIOS 205, BIOS 206, BIOS 207, CHEM 109, CHEM 110, CHEM 113, CHEM 114, CHEM 116, CHEM 221, GEOG 155, GEOI 101, GEOL 103H, GEOL 103, GEOL 210, GEOL 410, LIFE 120L, LIFE 120, LIFE 121L, LIFE 121, LIFE 122L, METR 100, METR 205, METR 370, PHYS 141, PHYS 142, PHYS 211, PHYS 212, PHYS 213, PHYS 221, PHYS 222, PHYS 223, BIOS 103L, BIOS 103L

These courses will fulfill the ACE 4 requirement.

CDR A: Writing
complete 1 from ACE1

CDR C: Humanities
complete 1 from Any Arabic Course at the 300 Level, Any Classics Course, Any Czech Course at the 300 Level, Any Czech Course at the 400 Level, Any English Course, FREN 282, Any French Course at the 300 Level, Any French Course at the 400 Level, GERM 282, Any German Course at the 300 Level, Any German Course at the 400 Level, Any Greek Course at the 300 Level, Any Greek Course at the 400 Level, Any Hebrew Course at the 300 Level, Any Hebrew Course at the 400 Level, Any History Course, Any Japanese Course at the 300 Level, Any Latin Course at the 300 Level, Any Latin Course at the 400 Level, Any Philosophy Course, Any Religious Studies Course at any level, Any Russian Course at the 300 Level, Any Russian Course at the 400 Level, SPAN 264, SPAN 265, Any Spanish Course at the 300 Level, Any Spanish Course at the 400 Level

Complete an approved course from a Humanities discipline: ARAB, CLAS, CZEC, ENGL, FILM, FREN, GERM, GREK, HEBR, HIST, JAPN, LATN, PHIL, RELG, RUSS, SPAN.

16 HR TERM 6

Senior Design Experience
complete CSCE 487

CSCE 487 will fulfill the ACE 10 requirement.

Technical Course
complete either Any Computer Science Course at the 300 Level or Any Computer Science Course at the 400 Level

Complete an approved CSCE course at the 300 or 400 level.

Science Courses
complete 1 from ANTH 242L, ANTH 242, ASTR 204, ASTR 224, BIOS 109, BIOS 111, BIOS 112L, BIOS 112, BIOS 205, BIOS 206, BIOS 207, CHEM 109, CHEM 110, CHEM 113, CHEM 114, CHEM 116, CHEM 221, GEOG 155, GEOI 101, GEOL 103H, GEOL 103, GEOL 210, GEOL 410, LIFE 120L, LIFE 120, LIFE 121L, LIFE 121, LIFE 122L, METR 100, METR 205, METR 370, PHYS 141, PHYS 142, PHYS 211, PHYS 212, PHYS 213, PHYS 221, PHYS 222, PHYS 223, BIOS 103L, BIOS 103L

These courses will fulfill the CDR B and CDR BL requirements.

ACE 2 Communication Skill
complete 1 from ACE2

CDR F: Additional Breadth

recommend 1 or more courses

Complete an approved additional courses from CDR B, CDR C, or CDR D that is outside of the discipline of your primary major.

15 HR TERM 7

Computer Science Depth

complete either CSCE 428 or CSCE 351

Technical Course

complete 1 from Any Computer Science Course at the 300 Level, Any Computer Science Course at the 400 Level, MATH 428, MATH 432, MATH 433, MATH 439, MATH 450, MATH 452

Complete an approved CSCE course at the 300 or 400 level or one of the listed MATH courses.

CDR D: Social Sciences

complete 1 from Any Anthropology Course, Any Communications Course, Any Geography Course, Any National Securities Studies Course, Any Political Science Course, Any Psychology Course, Any Sociology Course

Complete an approved course from a Social Science discipline: ANTH, COMM, GEOG, NSST, POLS, PSYC, SOCI.

ACE 5 Humanities

complete 1 from ACE5

ACE 7 Arts

complete 1 from ACE7

13 HR TERM 8

Computer Science Depth

complete either CSCE 451 or CSCE 423

Science Courses

complete 1 from ANTH 242L, ANTH 242, ASTR 204, ASTR 224, BIOS 109, BIOS 111, BIOS 112L, BIOS 112, BIOS 205, BIOS 206, BIOS 207, CHEM 109, CHEM 110, CHEM 113, CHEM 114, CHEM 221, GEOG 155, GEOG 101, GEOL 103H, GEOL 103, GEOL 210, GEOL 410, LIFE 120L, LIFE 120, LIFE 121L, LIFE 121, METR 100, METR 205, METR 370, PHYS 141, PHYS 142, PHYS 211, PHYS 212, PHYS 213, PHYS 221, PHYS 222, PHYS 223, BIOS 103L, BIOS 103L

ACE 6 Social Sciences

complete 1 from ACE6

ACE 9 Global/Human Divers

complete 1 from ACE9

Graduation Requirements

1. A minimum 2.00 GPA required for graduation.
2. ***Total Credits Applying Toward 120 Total Hours***
3. Complete 30 hours in residence at UNL.

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
• 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
• 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
• 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
• 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