SOFTWARE DEVELOPMENT MINOR

Description
The software development minor prepares students with skill sets to enable them to meet the growing demand for familiarity and competency with software development. The minor is designed to:

- Enable students from a diverse set of majors and backgrounds to participate.
- Provide a strong foundation in software development to allow them to apply computing throughout their career.

The minor consists of five required courses. The minor’s objectives are anchored around a set of core outcomes, such that students completing the minor will be able to:

- Apply sound software development principles and methodologies to create software systems that solve real-world problems in various disciplines.
- Interact, use, and manage large data sets and solve data-centric problems; organize, visualize, and communicate digital data effectively; and use creative competencies to generate creative solutions.
- Understand the roles of various stakeholders in software development projects, including domain experts, project managers, customers, and developers.
- Contribute one’s expertise to the solution of problems by effectively collaborating and communicating with other stakeholders in software development projects.

College Admission
The entrance requirements for the College of Arts and Sciences (CAS), including any of the majors or minors offered through the college, are the same as the UNL General Admission Requirements. In addition to these requirements, the College of Arts and Sciences strongly recommends a third and fourth year of one foreign language in high school. 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.

ACADEMIC AND CAREER Advising
Academic and Career Advising Center
The Academic and Career Advising Center in 107 Oldfather Hall is the undergraduate hub for CAS students in all majors. Centrally located and easily accessed, students encounter friendly, knowledgeable people who are eager to help. Students visit the Advising Center in 107 Oldfather Hall to:

- Choose or change their major, minor, or degree program.
- Check in on policies, procedures, and deadlines.
- Get a college approval signature from the Dean’s representative, Sr. Director of Advising and Student Success.

While the assigned academic advisor should be the student’s primary contact, there are daily walk-ins from 12:3 where a general academic advisor can answer a quick question. In addition, the CAS Career Coaches are located here. They help students explore majors and minors, gain experience, and develop a plan for life after graduation. Not sure where to go or who to ask? The Advising Center team can help.

Assigned Academic Advisors
Academic advisors are critical resources dedicated to students’ academic, personal, and professional success. Every CAS student is assigned an academic advisor based on their primary major. Since most CAS students have more than just a single major, it is important to get to know the advisor for any minors or additional majors. Academic advisors work closely with the faculty to provide the best overall support and the discipline-specific expertise.

Assigned advisors are listed in MyRED (https://its.unl.edu/myunl) and their offices may be located in or near the department of the major for which they advise or in the Academic and Career Advising Center. Students who have declared a pre-health or pre-law area of interest will also work with advisors in the Exploratory and Pre-Professional Advising Center (Explore Center) in 127 Love South, who are specially trained to guide students preparing to enter a professional school.

For complete and current information on advisors for majors, minors, or pre-professional areas, contact the Arts and Sciences Academic and Career Advising Center, 107 Oldfather Hall, 402-472-4190, http://cas.unl.edu/advising.

Career Coaching
The College believes that Academics + Experience = Opportunities and encourages students to complement their academic preparation with real-world experience, including internships, research, education abroad, service, and leadership. Arts and sciences students have access to a powerful network of faculty, staff, and advisors dedicated to providing information and support for their goals of meaningful employment or advanced education. Arts and sciences graduates have unlimited career possibilities and carry with them important career competencies—communication, critical thinking, creativity, context, and collaboration. They have the skills and adaptability that employers universally value. Graduates are not only prepared to effectively contribute professionally in the real world, but they have a solid foundation to excel in an increasingly global, technological, and interdisciplinary world.

Students should contact the career coaches in the Arts and Sciences Academic and Career Advising Center in 107 Oldfather, or their assigned advisor, for more information. The CAS career coaches help students explore career options, identify ways to build experience, and prepare to apply for internships, jobs, or graduate school, including help with resumes, applications, and interviewing.

ACE Requirements
Students must complete one course for each of the ACE Student Learning Outcomes below. Certified course choices are published in the degree audit, or visit the ACE website (http://ace.unl.edu) for the most current list of certified courses.

ACE Student Learning Outcomes

ACE 1: Write texts, in various forms, with an identified purpose, that respond to specific audience needs, integrate research or existing knowledge, and use applicable documentation and appropriate conventions of format and structure.

ACE 2: Demonstrate competence in communication skills.
ACE 3: Use mathematical, computational, statistical, logical, or other formal reasoning to solve problems, draw inferences, justify conclusions, and determine reasonableness.

ACE 4: Use scientific methods and knowledge to pose questions, frame hypotheses, interpret data, and evaluate whether conclusions about the natural and physical world are reasonable.

ACE 5: Use knowledge, historical perspectives, analysis, interpretation, critical evaluation, and the standards of evidence appropriate to the humanities to address problems and issues.

ACE 6: Use knowledge, theories, and research perspectives such as statistical methods or observational accounts appropriate to the social sciences to understand and evaluate social systems or human behaviors.

ACE 7: Use knowledge, theories, or methods appropriate to the arts to understand their context and significance.

ACE 8: Use knowledge, theories, and analysis to explain ethical principles and their importance in society.

ACE 9: Exhibit global awareness or knowledge of human diversity through analysis of an issue.

ACE 10: Generate a creative or scholarly product that requires broad knowledge, appropriate technical proficiency, information collection, synthesis, interpretation, presentation, and reflection.

College Degree Requirements

College Distribution Requirements – BA and BS

The College of Arts and Sciences distribution requirements are common to both the bachelor of arts and bachelor of science degrees and are designed to ensure a range of courses. By engaging in study in several different areas within the College, students develop the ability to learn in a variety of ways and apply their knowledge from a variety of perspectives. All requirements are in addition to University ACE requirements, and no course can be used to fulfill both an ACE outcome and a College Distribution Requirement.

- A student may not use a single course to satisfy more than one College Distribution Requirement, with the exception of CDR Diversity. Courses used to meet CDR Diversity may also meet CDR Writing, CDR Humanities, or CDR Social Science.
- Independent study or reading courses and internships cannot be used to satisfy distribution requirements.
- Courses from interdisciplinary programs will be applied in the same area as courses from the home/cross-listed department.

College Distribution Requirements

<table>
<thead>
<tr>
<th>CDR: Written Communication</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>Select from courses approved for ACE outcome 1.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>CDR: Natural, Physical, and Mathematical Sciences with Lab</th>
<th>4</th>
</tr>
</thead>
<tbody>
<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>
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</tr>
</tbody>
</table>

Some courses from geography and anthropology may also be used to satisfy the lab requirement above.¹

CDR: Humanities

Select from classics, English, history, modern languages and literatures, philosophy, and religious studies.²

CDR: Social Science

Select from anthropology, communication studies, geography, political science, psychology, or sociology.³

CDR: Human Diversity in U.S. Communities

Select from a set of approved courses as listed in the degree audit.

CDR: Language

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

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

Credit Hours Subtotal: 13-32

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 220 and below do not fulfill the CDR Humanities.
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.

Language Requirement

UNL and the College of Arts and Sciences place great value on academic exposure and proficiency in a second language. The UNL entrance requirement of two years of the same foreign language or the College’s language distribution requirement (CDR: Language) will rarely be waived and only with relevant documentation. See the main College of Arts and Sciences page for more details.

Scientific Base - BS Only

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 100 or 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 (excluding MBIO 101), and physics.

See your Degree Audit or your assigned academic advisor for a complete list, including individual classes that fall outside of the disciplines listed above. Up to 12 hours of scientific and technical courses offered by other colleges may be accepted toward this requirement with approval of the College of Arts and Sciences. See your assigned academic advisor to start the approval process.
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 cumulative 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 domestic institutions except for UNO and UNK. All courses taken at UNO and UNK impact the UNL transcript. No transfer of 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. International coursework (including education abroad) with a final grade equivalent to a C- or lower will not be validated by College of Arts and Sciences departments to be degree applicable.

Pass/No Pass Privilege
The College of Arts and Sciences adheres to the University regulations for the Pass/No Pass (P/N) privilege with 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 at the 300 or 400 Level
Thirty (30) of the 120 semester hours of credit must be in courses numbered at the 300 or 400 level. Of those 30 hours, 15 hours (1/2) must be completed in residence at UNL.

Residency Requirement
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 coursework, including 6 hours at the 300 or 400 level in their major and 15 of the 30 hours required at the 300 or 400 level, in residence. Credit earned during education abroad may be used toward the residency requirement only if students register through UNL.

Catalog to Use
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.

Requirements for Minor Offered by Department
At least 15 hours of coursework as follows.

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

Total Credit Hours: 15

Restriction
A course taken to meet the requirement of a major cannot be counted towards this minor. This minor is not available to students majoring or minoring in computer science, computer engineering, or software engineering.

Grade Rules
C- and D Grades
A grade of C or above is required for all courses in the minor.

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

CSCE 100 Introduction to Informatics
Prerequisites: Placement in to MATH 101 or higher
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering.
Description: Introduction to the use of data-centric and information technologies-and issues and challenges-in today’s applications in sciences, engineering, the humanities, and the arts. Exposure to computational thinking and programming, statistical thinking and research design, data analysis and database techniques, and visualization and creative thinking.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 101 Fundamentals of Computer Science
Notes: A course in the science of computation 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
Grading Option: Graded with Option
Prerequisite for: CSCE 101L
ACE: ACE 3 Math/Stat/Reasoning
CSCE 101L Fundamentals of Computing Laboratory
Prerequisites: CSCE 101 or parallel.
Notes: 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
Grading Option: Graded with Option
CSCE 120 Learning to Code
Prerequisites: Placement in to MATH 101 or higher
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering. First course in a sequence for the minor in Software Development.
Description: Introduction to coding in the context of current web development technologies (JavaScript, HTML, CSS). Basic coding skills and an introduction to computing with an emphasis on processing data: data formatting and structure, data manipulation, data presentation and the basics of an interactive program.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 220, CSCE 320
CSCE 155A Computer Science I
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Credit may be earned in only one CSCE 155 course.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156, CSCE 156H, CSCE 230, CSCE 230H, CSCE 235, CSCE 235H, CSCE 311, ECEN 106, ECEN 123, ECEN 224, MECH 300
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155E Computer Science I: Systems Engineering Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Credit may be earned in only one CSCE 155 course.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156, CSCE 156H, CSCE 230, CSCE 230H, CSCE 235, CSCE 235H, CSCE 311, ECEN 106, ECEN 123, ECEN 220, ECEN 224, MECH 300
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155H Honors: Computer Science I
Prerequisites: Good standing in UNL Honors Program; MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Covers the same topics as CSCE 155A, but in greater depth.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156, CSCE 156H, CSCE 230, CSCE 230H, CSCE 235, CSCE 235H, CSCE 311, ECEN 106, ECEN 224, MECH 300
ACE: ACE 3 Math/Stat/Reasoning
CSCE 155N Computer Science I: Engineering and Science Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Recommended for students interested in numerical and graphical applications in engineering and science, such as applied physics, working with time-sequence data, and matrix applications.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CHME 312; CSCE 156; CSCE 156H; CSCE 230; CSCE 230H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 224; MECH 300; MECH 318; MECH 330; MECH 350; MECH 381
ACE: ACE 3 Math/Stat/Reasoning

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

CSCE 155T Computer Science I: Informatics Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Credit may be earned in only one CSCE 155 course.
Description: Introduction to computers and problem-solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 156; CSCE 156H; CSCE 230; CSCE 230H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 224; MECH 300
ACE: ACE 3 Math/Stat/Reasoning

CSCE 155T Computer Science I: Engineering and Science Focus
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Recommended for students interested in numerical and graphical applications in engineering and science, such as applied physics, working with time-sequence data, and matrix applications.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CHME 312; CSCE 156; CSCE 156H; CSCE 230; CSCE 230H; CSCE 235; CSCE 235H; CSCE 311; ECEN 106; ECEN 224; MECH 300; MECH 318; MECH 330; MECH 350; MECH 381
ACE: ACE 3 Math/Stat/Reasoning

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

CSCE 156 Computer Science II
Prerequisites: MATH 102 or a Math Placement Test score for MATH 103 or higher.
Notes: Recommended for students interested in numerical and graphical applications in engineering and science, such as applied physics, working with time-sequence data, and matrix applications.
Description: Introduction to problem solving with computers. Topics include problem solving methods, software development principles, computer programming, and computing in society.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 310; CSCE 310H; CSCE 322; CSCE 322H; CSCE 378; CSCE 378H; SOFT 162

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

ACE: ACE 3 Math/Stat/Reasoning
CSCE 184H Honors: Software Development Essentials
Crosslisted with: RAIK 184H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 183H.
Description: Problem solving with computers. Problem analysis and specification, data structures, relational databases, algorithm development, and program design and implementation. Discrete mathematics topics, propositional and predicate logic, sets, relations, functions, and proof techniques. Software Development Principles.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded
Prerequisite for: BSAD 372H, RAIK 372H; CSCE 231; CSCE 283H; CSCE 322; CSCE 322H; CSCE 378; CSCE 378H; SOFT 260H; RAIK 283H

CSCE 190 Special Topics in Computer Science
Prerequisites: Permission.
Notes: Will not count towards a major or minor in computer science and computer engineering.
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
Grading Option: Graded with Option

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
Grading Option: Graded with Option

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

CSCE 230 Computer Organization
Prerequisites: A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, SOFT 160, SOFT 160H, or RAIK 183H.
Notes: Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Introduction to organization and structure of computer systems. Boolean logic, digital arithmetic, processor organization, machine language programming, input/output, memory organization, system support software, communication, and ethics.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: CSCE 236; CSCE 351; ECEN 220; ECEN 370, CSCE 335

CSCE 230H Honors: Computer Organization
Prerequisites: Good standing in the University Honors Program; a grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, SOFT 160, SOFT 160H or RAIK 183H.
Notes: Covers the same topics as CSCE 230, but in greater depth. Laboratories supplement the lecture material and give an opportunity to practice concepts.
Description: Introduction to organization and structure of computer systems. Boolean logic, digital arithmetic, processor organization, machine language programming, input/output, memory organization, system support software, communication, and ethics.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: CSCE 236; CSCE 351; ECEN 220; ECEN 370, CSCE 335

CSCE 231 Computer Systems Engineering
Prerequisites: Grade of "P" or "C" or better in CSCE 235, CSCE 235H or RAIK 184H.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: CSCE 236; CSCE 351

CSCE 235 Introduction to Discrete Structures
Crosslisted with: CSCE 235H
Prerequisites: A grade of "P" or "C" or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, SOFT 160, SOFT 160H or RAIK 183H; and MATH 106.
Notes: Theoretical concepts with programming assignments.
Description: Survey of elementary discrete mathematics. Elementary graph and tree theories, set theory, relations and functions, propositional and predicate logic, methods of proof, induction, recurrence relations, principles of counting, elementary combinatorics, and asymptotic notations.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 231; CSCE 310; CSCE 310H; SOFT 260
CSCE 235H Introduction to Discrete Structures
Crosslisted with: CSCE 235
Prerequisites: Good Standing in the University Honors program. A grade of 'P' or 'C' or better in CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, SOFT 160, SOFT 160H, or RAIK 183H; and MATH 106.
Notes: Theoretical concepts with programming assignments.
Description: Survey of elementary discrete mathematics. Elementary graph and tree theories, set theory, relations and functions, propositional and predicate logic, methods of proof, induction, recurrence relations, principles of counting, elementary combinatorics, and asymptotic notations.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR
Prerequisite for: CSCE 231; CSCE 310; CSCE 310H; SOFT 260

CSCE 236 Embedded Systems
Prerequisites: A grade of "P" or "C" or better in CSCE 230, CSCE 230H or CSCE 231
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
Grading Option: Graded with Option
Prerequisite for: CSCE 488

CSCE 251 Unix Programming Environment
Notes: Familiarity with at least one high-level programming language.
Description: Introduction to the Unix operating system. Unix file system. Unix tools and utilities. Shell programming.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded with Option
Prerequisite for: CSCE 351; CSCE 361, CSCE 361H; CSCE 493

CSCE 283H Honors: Foundations of Computer Science
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 184H.
Notes: CSCE/RAIK 283H is the third course in the Jeffrey S. Raikes School of Computer Science and Management core.
Description: Advanced data structures and algorithms that solve common problems and standard approaches to solving new problems. Analysis and comparison of algorithms, asymptotic notation and proofs of correctness. Discrete mathematics. Induction and principles of counting and combinatorics as foundation for analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: CSCE 351; CSCE 361, CSCE 361H; SOFT 261H, RAIK 383H

CSCE 290 Special Topics in Computer Science
Prerequisites: Permission.
Notes: 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
Grading Option: Graded with Option
Prerequisite for: CSCE 351; CSCE 361, CSCE 361H; SOFT 261H, RAIK 383H

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

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

CSCE 310H Honors: Data Structures and Algorithms
Prerequisites: Good Standing in UNL Honors Program or by invitation; grades of "P" or "C" or better in CSCE 156/156H or SOFT 161 and CSCE 235/235H.
Description: CSCE 310H covers the same topics as CSCE 310, but in greater depth. For course description, see CSCE 310.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: CSCE 351; CSCE 493
CSCE 310 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: Students may not receive credit for both CSCE 310 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
Grading Option: Graded with Option
Prerequisite for: CSCE 322; CSCE 322H; CSCE 351; CSCE 361, CSCE 361H; CSCE 378; CSCE 378H; CSCE 493; CSCE 493A

CSCE 320 Data Analysis
Prerequisites: A grade of "P" or "C" or better in CSCE 120 or CSCE 220.
Notes: This course does not count towards a major or minor in Computer Science or a major in Computer Engineering or a major in Software Engineering. 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
Grading Option: Graded with Option
Prerequisite for: CSCE 493

CSCE 322 Programming Language Concepts
Prerequisites: A grade of "P" or "C" or better in CSCE 156, CSCE 156H, CSCE 311, SOFT 161, SOFT 161H, or RAII 184H.
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
Grading Option: Graded with Option
Prerequisite for: CSCE 493

CSCE 322H Honors: Programming Language Concepts
Prerequisites: Good Standing in UNL Honors Program or by invitation; A grade of "P" or "C" or better in CSCE 156, CSCE 156H, CSCE 311, SOFT 161, SOFT 161H, or RAII 184H.
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
Grading Option: Graded with Option
Prerequisite for: CSCE 461, CSCE 861, SOFT 461; CSCE 486; CSCE 488

CSCE 335 Digital Logic Design
Crosslisted with: ECEN 370
Prerequisites: ECEN 103/(UNO) ECEN 1030 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
Grading Option: Graded
Prerequisite for: ECEN 307

CSCE 351 Operating System Kernels
Prerequisites: A grade of "P" or "C" or better in CSCE 230 or CSCE 231 and CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAII 283H.
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
Grading Option: Graded with Option

CSCE 361 Software Engineering
Crosslisted with: CSCE 361H
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAII 283H.
Notes: Requires participation in a group design and implementation of a software project.
Description: Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 361H Software Engineering
Crosslisted with: CSCE 361
Prerequisites: Good Standing in UNL Honors Program or by invitation; A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAII 283H.
Notes: Requires participation in a group design and implementation of a software project.
Description: Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 461, CSCE 861; SOFT 461; CSCE 486; CSCE 488

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

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

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

CSCE 383H Honors: Fundamentals of Software Engineering
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; RAIK 370H and CSCE/RAIK 284H.
Notes: Fifth course in the Jeffrey S. Raikes School of Computer Science and Management core.
Description: Proper principles and methods of engineering software. Requirements, design, implementation, management and software evolution.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 384H Honors: Applied Numerical Analysis
Crosslisted with: RAIK 384H
Prerequisites: Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 284H; parallel BSAD/RAIK 282H.
Description: Application of established numerical analysis techniques to selected business and finance problems, finite difference applied to standard options or stochastic processes in modeling financial markets.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 390 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for computer science and computer engineering majors and/or minors. Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option

CSCE 399 Special Topics in Computer Science
Prerequisites: Permission.
Description: Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option

CSCE 401H Honors: RAIK Design Studio I
Prerequisites: Open to students in the honors program and to candidates for degrees with distinction, with high distinction, and with highest distinction.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 401H Honors: RAIK Design Studio II
Prerequisites: Open to students in the honors program and to candidates for degrees with distinction, with high distinction, and with highest distinction.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

CSCE 402H Honors: RAIK Design Studio III
Prerequisites: Open to students in the honors program and to candidates for degrees with distinction, with high distinction, and with highest distinction.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
CSCE 402H Honors: RAIK Design Studio II
Crosslisted with: RAIK 402H, BSAD 402H, SOFT 402H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and BSAD/CSCE/SOFT/RAIK 401H.
Notes: Second semester in the Jeffrey S. Raikes School of Computer Science and Management design studio
Description: Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: RAIK 403H, BSAD 403H, CSCE 403H, SOFT 403H
ACE: ACE 10 Integrated Product
CSCE 403H Honors: RAIK Design Studio III
Crosslisted with: RAIK 403H, BSAD 403H, SOFT 403H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and BSAD/CSCE/SOFT/RAIK 402H.
Notes: Third semester of Jeffrey S. Raikes School of Computer Science and Management design studio sequence.
Description: Application of Jeffrey S. Raikes School of Computer Science and Management core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: RAIK 404H, BSAD 404H, CSCE 404H, SOFT 404H
CSCE 404H Honors: RAIK Design Studio IV
Crosslisted with: RAIK 404H, BSAD 404H, SOFT 404H
Prerequisites: Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; and BSAD/CSCE/SOFT/RAIK 403H.
Notes: Fourth semester in the Jeffrey S. Raikes School of Computer Science and Management design studio sequence.
Description: Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: RAIK 404H, BSAD 404H, CSCE 404H, SOFT 404H
CSCE 411 Data Modeling for Systems Development
Crosslisted with: CSCE 811
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Concepts of relational and object-oriented data modeling through the process of data model development including conceptual, logical and physical modeling. Techniques for identifying and creating relationships between discrete data members, reasoning about how data modeling and analysis are incorporated in system design and development, and specification paradigms for data models. Common tools and technologies for engineering systems and frameworks for integrating data. Design and analysis of algorithms and techniques for identification and exploration of data relationships, such as Bayesian probability and statistics, clustering, map-reduce, and web-based visualization.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 412 Data Visualization
Crosslisted with: CSCE 812
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314.
Description: Fundamentals and implementations of data visualizations techniques. Programming skills and practices in interactive visualization applications. Visualization foundations, human perception for information processing, and visualization techniques for different data types, such as scalar-field data, vector-field data, geospatial data, multivariate data, graph/network data, and text/document data. Advanced visualization algorithms and topics as time permits.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 413 Database Systems
Crosslisted with: CSCE 813
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: Involves practical experience with a working database system.
Description: Data and storage models for database systems; entity/relationship, relational, and constraint models; relational databases; relational algebra and calculus; structured query language; Logical database design: normalization; integrity; distributed data storage; concurrency; security issues. Spatial databases and geographic information systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 913; CSCE 914
CSCE 421 Foundations of Constraint Processing
Crosslisted with: CSCE 821
Prerequisites: A grade of "P" or "C" or better in CSCE 235 and CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Constraint processing for articulating and solving industrial problems such as design, scheduling, and resource allocation. The foundations of constraint satisfaction, its basic mechanisms (e.g., search, backtracking, and consistency-checking algorithms), and constraint programming languages. New directions in the field, such as strategies for decomposition and for symmetry identification.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 921

CSCE 423 Design and Analysis of Algorithms
Crosslisted with: CSCE 823
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Mathematical preliminaries. Strategies for algorithm design, including divide-and-conquer, greedy, dynamic programming and backtracking. Mathematical analysis of algorithms. Introduction to NP-Completeness theory, including the classes P and NP, polynomial transformations and NP-complete problems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 923, CSCE 924

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

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

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

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

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

CSCE 436 Advanced Embedded Systems
Crosslisted with: CSCE 836
Prerequisites: A grade of "P" or "C" or better in CSCE 231, CSCE 236 or ECEN 220.
Description: Embedded hardware design techniques; transceiver design and low-power communication techniques; sensors and distributed sampling techniques; embedded software design and embedded operating systems; driver development; embedded debugging techniques; hardware and software architectures of embedded systems; and design, development, and implementation of embedded applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 438 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  
**Grading Option:** Graded with Option  

CSCE 439 Robotics: Algorithms and Applications  
Crosslisted with: CSCE 839  
**Prerequisites:** A grade of "P" or "C" or better in CSCE 231, CSCE 236 or ECEN 220 and CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H  
**Description:** Fundamental theory and algorithms for real world robot systems. Design and build a robot platform and implement algorithms in C++ or other high level languages. Topics include: open and closed loop control, reactive control, localization, navigation, path planning, obstacle avoidance, dynamics, kinematics, manipulation and grasping, sensing, robot vision processing, and data fusion.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Offered:** FALL/SPR

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

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

CSCE 451 Operating Systems Principles  
Crosslisted with: CSCE 851  
**Prerequisites:** A grade of "P" or "C" or better in CSCE 230, CSCE 230H or CSCE 231 and CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CSCE 455, CSCE 855

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

CSCE 455 Distributed Operating Systems  
Crosslisted with: CSCE 855  
**Prerequisites:** CSCE 451/851.  
**Description:** Organization and structure of distributed operating systems. Control, communication and synchronization of concurrent processes in the context of distributed systems. Processor allocation and scheduling. Deadlock avoidance, detection, recovery in distributed systems. Fault tolerance. Distributed file system concepts and structure.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** CHME 496, CHME 896
CSCE 456 Parallel Programming
Crosslisted with: CSCE 856
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H, or RAIK 283H.
Description: Introduction to the fundamentals of parallel computation and applied algorithm design. Methods and models of modern parallel computation; general techniques for designing efficient parallel algorithms for distributed and shared memory multiprocessor machines; principles and practice in programming an existing parallel machine.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 457 Systems Administration
Crosslisted with: CSCE 857
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Introduction to basic concepts of system administration. Operating systems and networking overview. User and resource management. Networking, systems and internet related security. System services and common applications, web services, database services, and mail servers. Basic scripting in shell, Perl, and Expect. Systems administration on UNIX® platform.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 458 Molecular and Nanoscale Communication
Crosslisted with: CSCE 858
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Introduction to basic concepts of system administration. Operating systems and networking overview. User and resource management. Networking, systems and internet related security. System services and common applications, web services, database services, and mail servers. Basic scripting in shell, Perl, and Expect. Systems administration on UNIX® platform.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

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

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

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

CSCE 462 Communication Networks
Crosslisted with: CSCE 862
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; STAT 380, ECEN 305 or RAIK 270H.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 952; CSCE 953
CSCE 463 Data and Network Security
Crosslisted with: CSCE 863
Prerequisites: A grade of "P" or "C" or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 310 or equivalent programming experience.
Notes: A grade of "P" or "C" or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 310 or equivalent programming experience.
Description: Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 464 Internet Systems and Programming
Crosslisted with: CSCE 864
Prerequisites: A grade of "P" or "C" or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 310 or equivalent programming experience.
Notes: A grade of "P" or "C" or better in CSCE 156, SOFT 161, RAIK 184H or CSCE 310 or equivalent programming experience.
Description: Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 465 Wireless Communication Networks
Crosslisted with: CSCE 865
Prerequisites: A grade of "P" or "C" or better in STAT 380, ECEN 305 or RAIK 270H
Description: Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

CSCE 466 Software Design and Architecture
Crosslisted with: SOFT 466, CSCE 866
Prerequisites: A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 283H.
Notes: Letter grade only.
Description: Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
CSCE 471 Computational Methods in Bioinformatics
Crosslisted with: CSCE 871
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Description: Introduction to computational methods for tackling challenges in biological data analysis and modeling and understanding complex systems at the molecular and cellular level. The main topics include bio-sequence analysis, motif finding, structure prediction, phylogenic inference, regulation network modeling, and high-throughput omics data analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: SPRING
Prerequisite for: CSCE 971

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

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

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

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

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

CSCE 477 Cryptography and Computer Security
Crosslisted with: CSCE 877
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314.
Description: Introductory course on cryptography and computer security. Topics: classical cryptography (substitution, Vigenere, Hill and permutation ciphers, and the one-time pad); Block ciphers and stream ciphers; The Data Encryption Standard; Public-key cryptography, including RSA and El-Gamal systems; Signature schemes, including the Digital Signature Standard; Key exchange, key management and identification protocols.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 478 Introduction to Machine Learning
Crosslisted with: CSCE 878
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: STAT 380, ECEN 305, or RAIK 270H recommended.
Description: Introduction to the fundamentals and current trends in machine learning. Possible applications for game playing, text categorization, speech recognition, automatic system control, date mining, computational biology, and robotics. Theoretical and empirical analyses of decision trees, artificial neural networks, Bayesian classifiers, genetic algorithms, instance-based classifiers and reinforcement learning.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 479 Introduction to Deep Learning
Crosslisted with: CSCE 879
Prerequisites: A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.
Notes: Completing STAT 380, ECEN 305, or RAIK 270 prior to taking this course is recommended.
Description: Fundamentals and current trends in deep learning. Backpropagation, activation functions, loss functions, choosing an optimizer, and regularization. Common architectures such as convolutional, autoencoders, and recurrent. Applications such as image analysis, text analysis, sequence analysis, and reinforcement learning.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: SPRING
CSCE 486 Computer Science Professional Development
Prerequisites: A grade of "P" or "C" or better in SOFT 261, CSCE 361 or CSCE 361H.
Notes: Must be taken exactly one semester before CSCE 487.
Description: Preparation for the senior design project. Professional practice through familiarity with current tools, resources, and technologies. Professional standards, practices and ethics, and the oral and written report styles used specifically in the field of computer science.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: CSCE 487
ACE: ACE 8 Civic/Ethics/Stewardship
CSCE 487 Computer Science Senior Design Project
Prerequisites: CSCE 486
Notes: Should be taken in the immediate next term after CSCE 486.
Description: A substantial computer science project requiring design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and software engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: SOFT 403
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.
Notes: Must be taken exactly one semester before CSCE 489.
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
Grading Option: Graded with Option
Prerequisite for: CSCE 489
ACE: ACE 8 Civic/Ethics/Stewardship
CSCE 489 Computer Engineering Senior Design Project
Prerequisites: CSCE 488 (taken exactly one semester previous).
Description: A substantial computer engineering project requiring hardware-software co-design, planning and scheduling, teamwork, written and oral communications, and the integration and application of technical and analytical aspects of computer science and computer engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
CSCE 490 Special Topics in Computer Science
Crosslisted with: CSCE 890
Prerequisites: Permission
Notes: Will not count toward 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
Grading Option: Graded with Option
CSCE 491 Internship in Computing Practice
Prerequisites: Instructor permission.
Notes: Requires a detailed project proposal and final report.
Description: Experiential learning in conjunction with an approved industrial or government agency under the joint supervision of an outside sponsor and a faculty advisor.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option
CSCE 493 Innovation Lab Project
Prerequisites: CSCE 310, CSCE 310H, CSCE 311, or CSCE 320
Description: Innovative team projects executed under the guidance of members of the faculty of the Department of Computer Science and Managing Director of the CSCE Innovation Lab. Students will work in teams and collaborate with CSE research faculty, supervising MS students, and sponsors that include private sectors and UNL faculty to design and develop real-world systems.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 6
Grading Option: Graded with Option

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

CSCE 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
Grading Option: Graded with Option

CSCE 496H Honors: Special Topics in Computer Science
Prerequisites: Good standing in the University Honors Program or by invitation.
Notes: Specific course prerequisites will vary depending on the topic.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

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