

# 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; and
- 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 stake-holders in software development projects including domain experts, project managers, customers, and developers.
- Contribute one's expertise to the solution problems by effectively collaborating and communicating with other stake-holders in software development projects.

## 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 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.

## Advising

### Academic and Career Advising

The Academic and Career Advising Center in 107 Oldfather is a centrally located and easily accessed resource for students in all majors in the College of Arts and Sciences. The professional academic advisors and career coaches offer 1-1 meetings on a walk-in and appointment basis weekdays. Advisors will provide assistance choosing majors and minors, understanding degree requirements and academic policies, completing paperwork, meeting deadlines, adding/dropping courses, and planning for graduation. In addition, career coaches can help students identify career options related to their interests and connect them with experiences like internships, research, and more that will prepare them for those career

options. These specially trained advisors and coaches also serve as first point of contact in the College for all incoming freshmen and transfer students during New Student Enrollment.

Students in the College who have declared a major will be assigned an academic advisor who is their first point of contact for a variety of questions. Academic advisors help students be successful in adjusting to UNL overall as well as making progress toward degree completion. The assigned advisor may be located within the department of their primary major, or in the Advising Center. Students can identify their assigned advisor in MyRED on the academics tab. In addition, faculty advisors are experts in their discipline, including advanced coursework and requirements, opportunities for research, student organizations, and considering graduate school in the discipline. 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 Library 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>.

## 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 ensure a breadth of courses within the liberal arts degree. 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.

- A student may not use a single course to satisfy 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.
- A student may not 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 second major toward this requirement.
- Independent study, directed readings, or internship courses cannot be used to satisfy a College Distribution Requirement.
- Cross-listed courses from interdisciplinary programs will be applied in the same area as courses from the home/cross-listed department.

### College Distribution Requirements

<i>CDR A - Written Communication</i>	3
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Select from courses approved for ACE outcome 1.

<i>CDR B and BL - Natural, Physical, and Mathematical Sciences with Lab</i>	4
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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.

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

*CDR C - Humanities* 3

Select from classics, English, history, modern languages and literatures, philosophy, and religious studies.<sup>2</sup>

*CDR D - Social Science* 3

Select from anthropology, communication studies, geography, political science, psychology, or sociology.<sup>3</sup>

*CDR E - Language* 0-16

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.

*CDR F - Additional Breadth* 3

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

<sup>1</sup> See Degree Audit or a College of Arts and Sciences advisor for approved geography and anthropology courses that apply as natural science.

<sup>2</sup> Language courses numbered 210 and below do not fulfill the CDR C.

<sup>3</sup> 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 BIOC 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, physics and statistics.

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

## 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 E) will rarely be waived and only with relevant documentation. See the main College of Arts and Sciences page for more details.

## 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 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.

## 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.

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 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, specifically:

CSCE 120	Learning to Code	3
CSCE 220	Software Development for Smart-Mobile Systems	3
CSCE 320	Data Analysis	3
CSCE 311	Data Structures and Algorithms for Informatics	3
or CSCE 464	Internet Systems and Programming	
CSCE 493	Innovation Lab Project	3
Total Credit Hours		15

## 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.

## Restrictions

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.

### 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

**Format:** LEC

### 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

**Format:** LEC

**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

**Format:** LAB

**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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**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; METR 223; METR 311; METR 323**ACE:** ACE 3 Math/Stat/Reasoning**CSCE 155T Computer Science I: Informatics Focus****Prerequisites:** MATH 102 or a Math Placement Test score for MATH 103 or higher.**Notes:** Credit may be earned in only one CSCE 155 course.**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 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 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**Format:** LEC**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

**Format:** LEC

**Prerequisite for:** CSCE 310; CSCE 310H; CSCE 322; CSCE 322H; CSCE 378; CSCE 378H; 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:** CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; ECON 215; MRKT 350; RAIK 184H, CSCE 184H

**ACE:** ACE 3 Math/Stat/Reasoning

**CSCE 184H Honors: Software Development Essentials**

**Crosslisted with:** RAIK 184H

**Prerequisites:** Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 183H.

**Description:** Problem solving with computers. Problem analysis and specification, data structures, relational databases, algorithm development, and program design and implementation. Discrete mathematics topics, propositional and predicate logic, sets, relations, functions, and proof techniques. Software Development Principles.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Format:** LEC

**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

**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:** 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

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**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.

**Description:** Introduction to organization, structure, and applications of computer systems. Boolean Logic, Digital Arithmetic, Processor Organization, C Programming, Machine Language Programming, Input/Output, Memory Organization and Management, Building Embedded System Application.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**CSCE 251K C Programming**

**Notes:** Familiarity with one high-level programming language recommended.

**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**

**Notes:** Credit towards the degree maybe earned in only one of: CSCE 155E or CSCE 155N or CSCE 155T or CSCE 252A.

**Description:** Principles and practice of FORTRAN programming.

**Credit Hours:** 1

**Max credits per semester:** 1

**Max credits per degree:** 1

**Format:** LEC

**CSCE 283H Honors: Foundations of Computer Science**

**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

**Format:** LEC

**Prerequisite for:** CSCE 351; CSCE 361, CSCE 361H; CSCE 411H, RAIK 411H; CSCE 476H; RAIK 284H, CSCE 284H; SOFT 261H, RAIK 383H

**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

**Prerequisite for:** CSCE 383H; RAIK 384H, CSCE 384H; RAIK 401H, BSAD 401H, CSCE 401H, SOFT 401H

**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

**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**

**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

**Format:** LEC

**Prerequisite for:** CSCE 351; CSCE 361, CSCE 361H; CSCE 411H, RAIK 411H; CSCE 476H; 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

**Format:** LEC

**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:** 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

**Format:** LEC

**Prerequisite for:** CSCE 322; CSCE 322H; CSCE 351; CSCE 361, CSCE 361H; CSCE 378; CSCE 378H; CSCE 411H, RAIK 411H; CSCE 476H; 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

**Format:** LEC

**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 RAIK 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

**Format:** LEC

**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 RAIK 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

**Format:** LEC

**Offered:** FALL/SPR

**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

**Format:** LEC

**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 RAIK 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

**Format:** LEC

**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 RAIK 283H.

**Notes:** Requires participation in a group design and implementation of a software project.

**Description:** Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Format:** LEC

**Prerequisite for:** CSCE 461, CSCE 861, SOFT 461; CSCE 486; CSCE 488

**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 RAIK 283H.

**Notes:** Requires participation in a group design and implementation of a software project.

**Description:** Techniques used in the disciplined development of large software projects. Software requirements analysis and specifications, program design, coding and integration testing, and software maintenance. Software estimation techniques, design tools, and complexity metrics.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Format:** LEC

**Prerequisite for:** CSCE 461, CSCE 861, SOFT 461; CSCE 486; CSCE 488

**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

**Prerequisite for:** BSAD 371H, RAIK 371H



**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

**Format:** LEC

**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

**Format:** LEC

**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; 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

**Format:** LEC

**CSCE 384H Honors: Applied Numerical Analysis**

**Crosslisted with:** RAIK 384H

**Prerequisites:** Good standing in the University Honors Program; admission to the Jeffrey S. Raikes School of Computer Science and Management; and CSCE/RAIK 284H; parallel BSAD/RAIK 382H.

**Description:** Application of established numerical analysis techniques to selected business and finance problems, finite difference applied to standard options or stochastic processes in modeling financial markets.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Format:** LEC

**CSCE 390 Special Topics in Computer Science**

**Prerequisites:** Permission.

**Description:** Aspects of computers and computing for non-computer science and computer engineering majors and/or minors. Topics vary.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Format:** LEC

**CSCE 396 Special Topics in Computer Science**

**Prerequisites:** Permission.

**Description:** Aspects of computers and computing for computer science and computer engineering majors and minors. Topics vary.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Format:** LEC

**CSCE 399H Honors Thesis**

**Prerequisites:** Open to students in the honors program and to candidates for degrees with distinction, with high distinction, and with highest distinction.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Format:** IND

**CSCE 401H Honors: RAIK Design Studio I**

**Crosslisted with:** RAIK 401H, BSAD 401H, SOFT 401H

**Prerequisites:** Good standing in the University Honors Program or by invitation; admission to the Jeffrey S. Raikes School of Computer Science and Management; BSAD/RAIK 282H; and CSCE/RAIK 284H.

**Notes:** First semester in the Jeffrey S. Raikes School of Computer Science and Management design studio

**Description:** Application of Raikes School core content in a team oriented, project management setting. Complete projects in consultation with private and public sector clients.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Format:** LEC

**Prerequisite for:** RAIK 402H, BSAD 402H, CSCE 402H, SOFT 402H

**ACE:** ACE 8 Civic/Ethics/Stewardship

**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

**Format:** LEC

**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; 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**Format:** LEC**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**Format:** LEC**CSCE 410 Information Retrieval Systems****Crosslisted with:** CSCE 810**Prerequisites:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.**Description:** Outline of the general information retrieval problem, functional overview of information retrieval. Deterministic models of information retrieval systems; conventional Boolean, fuzzy set theory, p-norm, and vector space models. Probabilistic models. Text analysis and automatic indexing. Automatic query formulation. System-user adaptation and learning mechanisms. Intelligent information retrieval. Retrieval evaluation. Review of new theories and future directions. Practical experience with a working experimental information retrieval system.**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:** 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**Format:** LEC**CSCE 411H Honors: Data Modeling for Systems Development****Crosslisted with:** RAIK 411H**Prerequisites:** Good standing in the University Honors Program; A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.**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:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314.**Description:** Fundamentals and implementations of data visualization techniques. Programming skills and practices in interactive visualization applications. Visualization foundations, human perception for information processing, and visualization techniques for different data types, such as scalar-field data, vector-field data, geospatial data, multivariate data, graph/network data, and text/document data. Advanced visualization algorithms and topics as time permits.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**Offered:** FALL/SPR

**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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**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.**Description:** Turing machine model of computation: deterministic, nondeterministic, alternating, probabilistic. Complexity classes: Time and space bounded, deterministic, nondeterministic, probabilistic. Reductions and completeness. Complexity of counting problems. Non-uniformity. Lower bounds. Interactive proofs.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**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 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:** 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**Format:** LEC**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**Format:** LEC**Prerequisite for:** CSCE 437, CSCE 837**CSCE 432 High-Performance Processor Architectures****Crosslisted with:** CSCE 832**Prerequisites:** CSCE 430; MATH 314; MATH/STAT 380 or ECEN 305**Notes:** Assumes knowledge of computer architecture, pipelining, memory hierarchy, instruction level parallelism, and compiler principles.**Description:** High performance computing at the processor level. The underlying principles and micro-architectures of contemporary high-performance processors and systems. State-of-the-art architectural approaches to exploiting instruction level parallelism for performance enhancements. Case studies of actual systems highlight real-world trade-offs and theories.**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.

**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:** 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**Format:** LEC**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**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:** 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**Format:** LEC**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**Format:** LEC**Prerequisite for:** CSCE 942, MATH 942**CSCE 441 Approximation of Functions****Crosslisted with:** CSCE 841, MATH 441, MATH 841**Prerequisites:** MATH 221/MATH 221H and MATH 314/MATH 314H.

**Description:** Polynomial interpolation, uniform approximation, orthogonal polynomials, least-first-power approximation, polynomial and spline interpolation, approximation and interpolation by rational functions.

**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**Prerequisite for:** CSCE 942, MATH 942**Groups:** Advanced Mathematics Courses

**CSCE 447 Numerical Linear Algebra****Crosslisted with:** CSCE 847, MATH 447, MATH 847**Prerequisites:** MATH 314**Description:** Mathematics and algorithms for numerically stable matrix and linear algebra computations, including solution of linear systems, computation of eigenvalues and eigenvectors, singular value decomposition, and QR decomposition.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**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.**Description:** Organization and structure of operating systems. Control, communication, and synchronization of concurrent processes. Processor and job scheduling. Memory organization and management including paging, segmentation, and virtual memory. Resource management. Deadlock avoidance, detection, recovery. File system concepts and structure. Protection and security. Substantial programming.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**Prerequisite for:** CSCE 437, CSCE 837; 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 topic 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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**CSCE 458 Molecular and Nanoscale Communication****Crosslisted with:** CSCE 858**Prerequisites:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; STAT 380, ECEN 305 or RAIK 270H.**Notes:** Completing CSCE 462/862 and CSCE 465/865 prior to taking this course is recommended. Exceptions can be granted on a per-student basis by the instructor.**Description:** Overview of nanoscale communication options. Focus on bio-inspired communication through molecule exchange and biochemical reactions. Different techniques to realize nanomachines will be surveyed in the course, with particular attention to the tools provided by synthetic biology for the programming of biological cooperative systems.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**Offered:** FALL/SPR



**CSCE 459 Genetically Engineered Systems****Crosslisted with:** CSCE 859**Prerequisites:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; STAT 380, ECEN 305 or RAIK 270H.**Notes:** Completing CSCE/MATH 440/840, MATH 432/832, MATH 439/839, and CSCE 471/871 prior to taking this course is recommended. Exceptions can be granted on a per-student basis by the instructor.**Description:** Introduction to the field of synthetic biology, and its interdisciplinary foundational concepts. Presents the technologies at the basis of synthetic biology, together with the engineering concepts that underlie the design, modeling, and realization of genetically engineered systems. Surveys examples of cutting edge applications.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**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**Format:** LEC**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**Format:** LEC**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.**Description:** Introduction to the architecture of communication networks and the rudiments of performance modeling. Circuit switching, packet switching, hybrid switching, protocols, local and metro area networks, wide area networks and the Internet, elements of performance modeling, and network programming. Network security, asynchronous transfer mode (ATM), optical, wireless, cellular, and satellite networks, and their performance studies.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**Prerequisite for:** CSCE 952; CSCE 953**CSCE 463 Data and Network Security****Crosslisted with:** CSCE 863**Prerequisites:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.**Description:** Concepts and principles of data and network security. Focuses on practical aspects and application of crypto systems in security protocols for networks such as the Internet. Topics include: applications of cryptography and cryptosystems for digital signatures, authentication, network security protocols for wired and wireless networks, cyberattacks and countermeasures, and security in modern computing platforms.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**CSCE 464 Internet Systems and Programming****Crosslisted with:** CSCE 864**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:** 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:** A grade of "P" or "C" or better in STAT 380, ECEN 305 or RAIK 270H**Description:** Discussion of theoretical and practical insight to wireless communications and wireless networking, current practices, and future trends. Wireless network architectures, mobility management, radio propagation, modulation, power control, antennas, channel access, pricing, and standards.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**CSCE 466 Software Design and Architecture****Crosslisted with:** SOFT 466, CSCE 866**Prerequisites:** A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 383H.**Notes:** Letter grade only.**Description:** Introduction to the concepts, principles, and state-of-the-art methods in software design and architecture. Topics include application of software engineering process models and management approaches for the design and architecture of large-scale software systems, trade-offs of designing for qualities such as performance, security, and dependability, and techniques and tools for analyzing and evaluating software architectures.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC

**CSCE 467 Testing, Verification and Analysis****Crosslisted with:** SOFT 467, CSCE 867**Prerequisites:** A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 383H.**Notes:** Letter grade only.**Description:** In-depth coverage of problems related to software quality, and approaches for addressing them. Topics include testing techniques, dynamic and static program analysis techniques, and other approaches for verifying software qualities. Tool support for performing testing, verification, and analysis will also be studied.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**CSCE 468 Requirements Elicitation, Modeling and Analysis****Crosslisted with:** SOFT 468, CSCE 868**Prerequisites:** A grade of "P" or "C" or better in CSCE 361, CSCE 361H, SOFT 261, SOFT 261H or RAIK 383H.**Notes:** Letter grade only.**Description:** In-depth coverage of processes, methods and techniques for determining, or deciding, what a proposed software system should do. Topics include the requirements engineering process, identification of stakeholders, requirements elicitation techniques, methods for informal and formal requirements documentation, techniques for analyzing requirements models for consistency and completeness, and traceability of requirements across system development and evolution. Tool support for modeling functional and non-functional requirements to support elicitation and analysis will be studied.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**CSCE 470 Computer Graphics****Crosslisted with:** CSCE 870**Prerequisites:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H; MATH 314**Description:** Display and recording devices; incremental plotters; point, vector, and character generation; grey scale displays, digitizers and scanners, digital image storage; interactive and passive graphics; pattern recognition; data structures and graphics software; the mathematics of three dimensions; homogeneous coordinates; projections and the hidden-line problem.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**CSCE 471 Computational Methods in Bioinformatics****Crosslisted with:** CSCE 871**Prerequisites:** A grade of "P" or "C" or better in CSCE 310, CSCE 310H, CSCE 311, SOFT 260, SOFT 260H or RAIK 283H.**Description:** Introduction to computational methods for tackling challenges in biological data analysis and modeling and understanding complex systems at the molecular and cellular level. The main topics include bio-sequence analysis, motif finding, structure prediction, phylogenetic inference, regulation network modeling, and high-throughput omics data analysis.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Format:** LEC**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**Format:** LEC**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**Format:** LEC

**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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**Prerequisite for:** CSCE 976**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:** 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:** 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**Format:** LEC**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**Format:** LEC**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**Format:** LEC**Offered:** SPRING

**CSCE 486 Computer Science Professional Development**

**Prerequisites:** A grade of "Pass" 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

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**ACE:** ACE 10 Integrated Product

**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

**Format:** LEC

**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

**Format:** FLD

**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

**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.

**Notes:** 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