Software Engineering

Description

The University of Nebraska–Lincoln Department of Computer Science and Engineering (CSE) offers Nebraska’s only comprehensive program of higher education, research, and service outreach in computer engineering, computer science, and software engineering.

The CSE department offers a unique and challenging baccalaureate degree program in software engineering, incorporating hands-on learning and an integrated computer science and software engineering core curriculum to prepare graduates for professional practice in a wide range of industries and for post-graduate education.

Software engineers work on multidisciplinary teams to identify and formulate software solutions and maintain software intensive systems of all sizes. The focus of this program is on the rigorous engineering practices necessary to build, maintain and protect modern software intensive systems. Consistent with this focus, the software engineering baccalaureate program consists of a rigorous curriculum of science, math, computer science, and software engineering courses.

Students completing the major will have the ability to:

- Apply disciplined software engineering practices and principles to the design, architecture, development, analysis, testing and maintenance of complex software systems to meet the desired needs of the stakeholders and within realistic constraints.
- Identify, formulate and solve engineering problems using computational resources.
- Contribute their expertise by effectively collaborating and communicating with other stakeholders in multidisciplinary teams.
- Adapt to rapid advances in computing and software engineering tools, technologies, principles and practices.

Students will also have:

- The background and perspective for post-graduate education. Studies develop skills in the application of theory, experimentation, and life-long learning/professional development.
- Insight into the world of practicing professionals for collaborations, mutual support, and representing the profession to government and society. Studies include teamwork, communication, and hands-on experience, plus students are provided with multiple opportunities for involvement in organizations such as ACM, UPE, and IEE.

The CSE department also offers a degree of bachelor of science in computer engineering through the College of Engineering, and a bachelor of science in computer science through the College of Arts and Sciences. All students majoring in the CSE department should see their advisors during the first semester to ensure they understand the differences in the requirements between the three majors. Majors should consult with their advisors each semester for registration advising.

Introductory Courses. Entering students take SOFT 160 Software Engineering I, the first course in the software engineering core series (SOFT 160, SOFT 161 Software Engineering II, SOFT 260 Software Engineering III, SOFT 261 Software Engineering IV). This course provides an introduction to fundamental software engineering concepts and foundational computer science topics to prepare students for more advanced software engineering and computer science courses.

Graduate Programs. The CSE Department offers several graduate degree programs: master of science in computer science, master of science in computer science with a computer engineering specialization, master of science in computer science with a bioinformatics specialization, doctor of philosophy in computer science, doctor of philosophy in engineering with computer engineering specialization, doctor of philosophy in computer science with bioinformatics specialization, and joint doctor of philosophy in computer science and mathematics. See the Graduate Studies Catalog for details.

Major Department Admission

Students are expected to meet minimum college entrance requirements. After being admitted to the college, students desiring to pursue a degree in software engineering must go through the Professional Admission process, which is automatically performed for qualifying students at the end of the sophomore year. In order to be considered for Professional Admission to the software engineering program, students must receive at least a C+ in SOFT 260 Software Engineering III (RAIK 283H Honors: Software Engineering III), SOFT 261 Software Engineering IV (RAIK 383H Software Engineering IV), and CSCE 235 Introduction to Discrete Structures (RAIK 184H Honors: Software Development Essentials) and a GPA of at least 2.5 (semester and cumulative). If a student’s cumulative GPA drops below 2.4, the student may be placed on restricted status, may be removed from the College, and may not be able to graduate.

College Requirements

College Admission

College Entrance Requirements

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

1. Mathematics – 4 units: 2 of algebra, 1 of geometry, 1 of precalculus and trigonometry
2. English – 4 units
3. Natural sciences – 3 units that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management)
4. Foreign language – 2 units of a single foreign language
5. Social studies – 3 units
6. Students having a composite ACT score of 28 or greater (or equivalent SAT score) will be admitted to the College of Engineering even if they lack any one of the following: trigonometry, chemistry, or physics.
7. Students having an ACT score of 19 or less in English (or equivalent SAT score) must take ENGL 150 Writing and Inquiry or ENGL 151 Writing and Argument.

A total of 16 units is required for admission.

Students must have an ACT (enhanced) score of 24 or greater (or equivalent SAT). Students who lack entrance requirements may be admitted based on ACT scores, high school rank and credits, or may be admitted to pre-engineering status in the Exploratory and Pre-Professional Advising Center. Pre-engineering students are advised within the College of Engineering.

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

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

Students should consult their advisor, their department chair, or Engineering Student Services if they have questions on current policies.

Other Admission Requirements
Students who transfer to the University of Nebraska–Lincoln from other accredited colleges or universities and wish to be admitted to the College of Engineering (COE) must meet COE freshman entrance requirements and have a minimum cumulative GPA of 2.5, and be calculus-ready. Students not meeting either of these requirements must enroll in the Explore Center or another University college until they meet COE admission requirements. Students transferring from UNO, UNL, or UNK to the College of Engineering must be in good academic standing with their institution.

The COE accepts courses for transfer for which a C or better grade was received. Although the University of Nebraska–Lincoln accepts D grades from the University of Nebraska at Kearney and at Omaha, not all majors in the COE accept such low grades. Students must conform to the requirements of their intended major and, in any case, are strongly encouraged to repeat courses with a grade of C- or less.

All transfer students must adopt the curricular requirements of the undergraduate catalog current at the time of transfer to the COE—not that in use when they entered the University of Nebraska–Lincoln. Upon admission to Nebraska, students wishing to pursue degree programs in the COE will be classified and subject to the policies defined in the subsequent section.

Students who were previously admitted to COE and are returning to the College of Engineering must demonstrate a cumulative GPA of 2.5 in order to be readmitted to COE.

College Degree Requirements

Grade Rules

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

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

Learning Outcomes

Graduates of the software engineering program will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The above student outcomes have been approved by the ABET Engineering Area Delegation for use beginning with the 2019-20 academic year, and have been adopted by the faculty of the Department of Computer Science and Engineering.

Major Requirements

The software engineering degree requires 124 hours of coursework, including a set of required core courses and technical elective courses in computer science and software engineering and a 2-year capstone (79 credit hours), and courses in mathematics (18 credit hours), science (12 credit hours), and other supporting courses (15 credit hours) as described below.

Computer Science and Software Engineering Core

Computer Science

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 10</td>
<td>Introduction to CSE</td>
<td>0</td>
</tr>
<tr>
<td>CSCE 231</td>
<td>Computer Systems Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CSCE 235</td>
<td>Introduction to Discrete Structures</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 322</td>
<td>Programming Language Concepts</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 378</td>
<td>Human-Computer Interaction</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 411</td>
<td>Data Modeling for Systems Development</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 423</td>
<td>Design and Analysis of Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>CSCE 451</td>
<td>Operating Systems Principles</td>
<td>3</td>
</tr>
<tr>
<td>or CSCE 351</td>
<td>Operating System Kernels</td>
<td></td>
</tr>
<tr>
<td>CSCE 491</td>
<td>Internship in Computing Practice</td>
<td>1</td>
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</tbody>
</table>

Software Engineering

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOFT 160</td>
<td>Software Engineering I</td>
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<tr>
<td>SOFT 161</td>
<td>Software Engineering II</td>
<td>4</td>
</tr>
<tr>
<td>SOFT 260</td>
<td>Software Engineering III</td>
<td>4</td>
</tr>
<tr>
<td>SOFT 261</td>
<td>Software Engineering IV</td>
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</tr>
<tr>
<td>SOFT 360</td>
<td>Software Engineering Mentoring and Leadership</td>
<td>1</td>
</tr>
<tr>
<td>SOFT 461</td>
<td>Advanced Topics in Software Engineering</td>
<td>3</td>
</tr>
<tr>
<td>SOFT 466</td>
<td>Software Design and Architecture</td>
<td>3</td>
</tr>
<tr>
<td>SOFT 467</td>
<td>Testing, Verification and Analysis</td>
<td>3</td>
</tr>
</tbody>
</table>
SOFT 468 Requirements Elicitation, Modeling and Analysis 3

Total Credit Hours 52

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

Computer Science

CSCE 10 Introduction to CSE 0
CSCE 231 Computer Systems Engineering 4
CSCE 322 Programming Language Concepts 3
CSCE 378 Human-Computer Interaction 3
CSCE 411 Data Modeling for Systems Development 3
CSCE 423 Design and Analysis of Algorithms 3
CSCE 451 Operating Systems Principles 3
or CSCE 351 Operating System Kernels
CSCE 491 Internship in Computing Practice 1

Software Engineering

RAIK 183H Honors: Computer Problem Solving Essentials 4
RAIK 184H Honors: Software Development Essentials 4
SOFT 162 Introduction to CSE 0
RAIK 283H Honors: Software Engineering III 4
RAIK 383H Software Engineering IV 4
RAIK 186H Honors: Foundations of Leadership II 1
SOFT 461 Advanced Topics in Software Engineering 3
SOFT 466 Software Design and Architecture 3
SOFT 467 Testing, Verification and Analysis 3
SOFT 468 Requirements Elicitation, Modeling and Analysis 3

Total Credit Hours 51

Science (minimum 12 hrs)

Must take at least 12 credit hours of science courses intended for science/engineering majors and must include at least one laboratory. The CSE department has identified the following five disciplines with their acceptable courses.

Chemistry

CHEM 109 & CHEM 110 & CHEM 221 General Chemistry I and Fundamental Chemistry I and Elementary Quantitative Analysis 3
CHEM 113 & CHEM 114 & CHEM 221 Fundamental Chemistry II and Fundamental Chemistry II and Elementary Quantitative Analysis 3
CHEM 261 Organic Chemistry
CHEM 262 Organic Chemistry
CHEM 263 Organic Chemistry Laboratory 3
CHEM 264 Organic Chemistry Laboratory 3

Physics and Astronomy

PHYS 141 Elementary General Physics I
PHYS 142 Elementary General Physics II 3
PHYS 211 General Physics I
PHYS 221 General Physics Laboratory I 3
PHYS 212 General Physics II
PHYS 222 General Physics Laboratory II 3
PHYS 213 General Physics III
PHYS 223 General Physics Laboratory III 3
ASTR 204 Introduction to Astronomy and Astrophysics
ASTR 224 Astronomy and Astrophysics Laboratory 3

Biological Sciences

BIOS 205 Genetics, Molecular and Cellular Biology Laboratory 3
BIOS 206 General Genetics
BIOS 207 Ecology and Evolution 3
LIFE 120 & LIFE 120L Fundamentals of Biology I and Fundamentals of Biology I Laboratory 3
LIFE 121 & LIFE 121L Fundamentals of Biology II and Fundamentals of Biology II Laboratory 3

Total Credit Hours 18-19

Mathematics (minimum 18 hrs)

MATH 106 Calculus I 5
MATH 107 Calculus II 4
MATH 314 Statistics and Applications 3
Select one of the following: 3-4
MATH 208 Calculus III
MATH 208H Honors: Calculus III
MATH 428 Principles of Operations Research
MATH 439 Mathematical Models in Biology
STAT 412 Introduction to Experimental Design
STAT 414 Introduction to Survey Sampling
STAT 442 Computational Biology
STAT 450 Introduction to Regression Analysis

Total Credit Hours 15

Technical Electives

Students must take at least 15 credit hours of SOFT or CSCE technical electives

Total Credit Hours 15

Capstone Experience

CSCE 486 Computer Science Professional Development 3
CSCE 487 Computer Science Senior Design Project 3
SOFT 403 Software Engineering Capstone I 3
SOFT 404 Software Engineering Capstone II 3

Credit Hours Subtotal: 12

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

RAIK 401H Honors: RAIK Design Studio I 3
RAIK 402H Honors: RAIK Design Studio II 3
RAIK 403H Honors: RAIK Design Studio III 3
RAIK 404H Honors: RAIK Design Studio IV 3

Credit Hours Subtotal: 12
Earth and Atmospheric Sciences
GEOG 155  Elements of Physical Geography 3
GEOL 101  Dynamic Earth 3
GEOL 103  Evolution of the Earth 3
GEOL 210  Earth Materials: Rocks and Minerals 3
GEOL 211  Sedimentology and Stratigraphy 3
GEOL 310  Depositional Environments 3
METR 100  Weather and Climate 3
METR 205  Introduction to Atmospheric Science
METR 223  Atmospheric Thermodynamics 3
METR 311  Dynamic Meteorology I
METR 312  Dynamic Meteorology II
METR 323  Physical Meteorology
METR 341  Synoptic Meteorology 3

Anthropology
ANTH 242  Introduction to Biological Anthropology
ANTH 242L  Introduction to Biological Anthropology Laboratory 3

Other Supporting Courses (minimum 15 hrs)
ENGR 20  Sophomore Engineering Seminar 0
JGEN 200  Technical Communication I 3
Select one course each from ACE outcomes 5, 6, 7, and 9 12
Credit Hours Subtotal: 15

or, for students in the J.S. Raikes school of computer Science and Management:
RAIK 288H  Honors Business Writing 3
Select one course each from ACE outcomes 5, 6, 7, and 9 12
Credit Hours Subtotal: 15

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1. Students must take at least 15 credit hours of SOFT or CSCE technical electives. Up to 3 hours of CSCE 491 can be used towards technical electives. Up to 3 hours of CSCE 498 can be used towards technical electives at least 9 hours must be taken at the 400 level except SOFT and CSCE courses required by the software engineering major and except courses that have been designated as courses that will not count toward a major or minor in computer science or software engineering by the Department of Computer Science and Engineering.

   Included courses at the 200 level are: CSCE 236.

   Included courses at the 300 level are: CSCE 335, CSCE 396, CSCE 399H.

   In addition to the courses mentioned above, excluded CSCE designated courses are: CSCE 401H, CSCE 402H, CSCE 488, CSCE 489, CSCE 490, CSCE 493. Honors versions of these courses are also not allowed to count towards technical elective credits.

2. Students must take Capstone Experience courses in strict sequence.

3. Indicates a lab course or that a lab is included with the course.

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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 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, 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, SOFTWARE 160, SOFTWARE 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.
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: LEC

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: 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: LAB
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 411H; CSCE 493

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 351; CSCE 361, CSCE 361H; CSCE 411H, RAIK 411H; CSCE 476H; RAIK 411H; CSCE 493

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: Foundation 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). Foundation 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" 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" 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
Crosslisted with: RAIK 403H, BSAD 403H, CSCE 403H, SOFT 403H
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 397H 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
Prerequisite for: RAIK 411H

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.
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
Prerequisite for: RAIK 411H

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
Prerequisite for: RAIK 411H

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.
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 runtime symbol tables, lexical scan, syntax scan, object code generation, error diagnostics, object code optimization techniques, and overall design.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC

CSCE 428 Automata, Computation, and Formal Languages
Crosslisted with: CSCE 828
Prerequisites: 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

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.
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.
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.
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 RAII 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 RAII 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 RAII 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 RAII 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  
**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, RAII 184H or CSCE 311 or equivalent programming experience.  
**Notes:** A grade of "Pass" or C or better in CSCE 156, SOFT 161, RAII 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, RAII 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, data mining, computational biology, and robotics. Theoretical and empirical analyses of decision trees, artificial neural networks, Bayesian classifiers, genetic algorithms, instance-based classifiers and reinforcement learning.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Format: LEC

CSCE 479 Introduction to 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: CSCE 488

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 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: LEC

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: FLD

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: Experiential learning in conjunction with an approved industrial or government agency 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: LEC

SOFT 160 Software Engineering I
Prerequisites: MATH 103 or equivalent
Description: Introduction to software engineering and to problem solving with computers. Topics include problem solving methods, the use of computational resources to solve problems, and techniques for collaborative software development. Techniques based on disciplined software engineering principles and practices for engineering, building, analyzing and managing software-related artifacts. Common tools and techniques for developing, analyzing, testing, debugging, and managing software and software-related artifacts.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Offered: FALL
Prerequisite for: CSCE 230; CSCE 230H; CSCE 235, CSCE 235H; CSCE 310; CSCE 310H; CSCE 322; CSCE 322H; CSCE 378, CSCE 378H; SOFT 260; SOFT 360

SOFT 160H Software Engineering I Honors
Prerequisites: A grade of C+ or higher in either SOFT 160 or SOFT 160H.
Notes: Letter grade only.
Description: Software engineering techniques and tools for designing, modeling, and building event-driven and multi-layer applications. Topics include advanced data structure, persistent data storage, object-oriented programming, and techniques for testing complex software systems.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Offered: SPRING
Prerequisite for: CSCE 322; CSCE 322H; CSCE 378; CSCE 378H; SOFT 260

SOFT 162 Software Engineering Fundamentals
Prerequisites: CSCE 156, CSCE 156H or equivalent
Notes: Students must earn a grade of C+ or higher in this course to be admitted to the Software Engineering program.
Description: Introduction to software engineering and problem solving with computers.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC
Offered: SUMMER
Prerequisite for: SOFT 260
SOFT 260 Software Engineering III
Prerequisites: A grade of C+ or higher in either SOFT 161, SOFT 161H or SOFT 162; CSCE 235.
Notes: Letter grade only.
Description: Advanced data structures and their associated algorithms for solving computational problems. Techniques for systematically specifying, managing, and analyzing software requirements, and for managing software change and working effectively in teams.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: SOFT 361
Crosslisted with: RAIK 283H

SOFT 260H Honors: Software Engineering III
Prerequisites: A grade of C+ or higher in either SOFT 161 or SOFT 161H or SOFT 162 or RAIK 184H or equivalent; CSCE 235.
Description: Advanced data structures and their associated algorithms for solving computational problems. Techniques for systematically specifying, managing, and analyzing software requirements, and for managing software change and working effectively in teams.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Offered: FALL
Prerequisite for: CSCE 351; CSCE 361, CSCE 361H; CSCE 411H, RAIK 411H; CSCE 476H; SOFT 261; SOFT 261H, RAIK 383H; SOFT 360

SOFT 261 Software Engineering IV
Prerequisites: A grade of C+ or higher in SOFT 260 or equivalent.
Description: Techniques and tools based on disciplined software engineering principles for producing, interpreting, and communicating visual artifacts related to software architecture and construction.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Offered: FALL/SPR
Prerequisite for: CSCE 461, CSCE 861, SOFT 461; CSCE 486
ACE: ACE 2 Communication Competence

SOFT 261H Software Engineering IV
Crosslisted with: RAIK 383H
Prerequisites: Good Standing in UNL Honors Program or by invitation; a grade of C+ or higher in SOFT 260, SOFT 260H, or RAIK 283H.
Description: Techniques and tools based on disciplined software engineering principles for producing, interpreting, and communicating visual artifacts related to software architecture and construction.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Offered: FALL/SPR
Prerequisite for: CSCE 461, CSCE 861, SOFT 461; CSCE 486
ACE: ACE 2 Communication Competence

SOFT 360 Software Engineering Mentoring and Leadership
Prerequisites: A grade of C or higher in SOFT 160, SOFT 161, SOFT 260 or SOFT 261
Notes: Letter grade only.
Description: Mentoring and leading software engineering teams. Topics include roles and responsibilities of a leader, roles and responsibilities of a mentor, and traits of effective leaders and mentors. Techniques for effectively mentoring and leading software engineering teams.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB

SOFT 401H Honors: RAIK Design Studio I
Crosslisted with: RAIK 401H, BSAD 401H, CSCE 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

SOFT 402H Honors: RAIK Design Studio II
Crosslisted with: RAIK 402H, BSAD 402H, CSCE 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

SOFT 403 Software Engineering Capstone I
Prerequisites: CSCE 487 or equivalent
Notes: Must be taken exactly one semester before SOFT 404.
Description: A substantial software engineering 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 in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Offered: FALL
Prerequisite for: SOFT 404
SOFT 403H Honors: RAIK Design Studio III
Crosslisted with: RAIK 403H, BSAD 403H, CSCE 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
SOFT 404 Software Engineering Capstone II
Prerequisites: SOFT 403 (taken exactly one semester previous).
Description: A substantial software engineering 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 in consultation with private and public sector clients.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Offered: SPRING
SOFT 404H Honors: RAIK Design Studio IV
Crosslisted with: RAIK 404H, BSAD 404H, CSCE 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
SOFT 461 Advanced Topics in Software Engineering
Crosslisted with: CSCE 461, CSCE 861
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
SOFT 466 Software Design and Architecture
Crosslisted with: CSCE 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
SOFT 467 Testing, Verification and Analysis
Crosslisted with: CSCE 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
SOFT 468 Requirements Elicitation, Modeling and Analysis
Crosslisted with: CSCE 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
PLEASE NOTE
This document represents a sample 4-year plan for degree completion with this major. Actual course selection and sequence may vary and should be discussed individually with your college or department academic advisor. Advisors also can help you plan other experiences to enrich your undergraduate education such as internships, education abroad, undergraduate research, learning communities, and service learning and community-based learning.