ELECTRICAL ENGINEERING

Description
Website: http://engineering.unl.edu/ece/

The Department of Electrical and Computer Engineering offers a complete electrical engineering undergraduate program to students on the City (Lincoln) and Scott (Omaha) campuses of the University of Nebraska. Curriculum requirements are nearly identical on both campuses and students can complete all degree requirements on either campus.

Electrical engineering is concerned with the production, transmission, and utilization of electrical energy and the creation, transmission and processing of information. This includes power generation and transmission systems, motors, batteries and control systems, as well as radio frequency (RF) systems, telecommunications, remote sensing, signal processing, digital circuits, instrumentation, audio, video and opto-electronics. Employment opportunities for electrical engineers cover a wide spectrum of activities including design, development, research, sales, and management. These activities are carried on in industrial organizations, public and private utilities, the communications and computer industry, governmental and educational institutions, and consulting engineering firms. The objective of this major is to offer students an education to become productive electrical engineers and be active, contributing citizens of the nation and the world.

This department has over 40 faculty involved in research related to electronic materials, nanotechnology, optical systems, communications, biomedical applications, signal processing, microelectronics design, energy systems, and electromagnetics. Students are encouraged to participate in research activities, and have opportunities to travel and present their research results.

The department has extensive research facilities for all areas including state of the art computing facilities, integrated circuits and systems research facilities, communications and signal processing laboratories, applied electromagnetics research, solid state laboratories, nanotechnologies research, opto-electronics research and energy systems laboratories.

The curriculum is designed to provide a broad education in fundamental principles and laboratory applications, and an awareness of the socioeconomic impact of technology. Technical electives are normally selected from advanced courses in electrical engineering to provide for specialization in selected areas. However, technical electives can also be selected from courses offered by other departments of the College of Engineering or from appropriate physics, chemistry, mathematics, and biological sciences courses.

The department administers a network of high-end UNIX workstations and PCs, upgraded regularly, and used for classroom instruction as well as the individual needs of students.

Major Department Admission

Admittance to Degree Program

Students are required to achieve admission into the electrical engineering major. Students are eligible to be reviewed for professional admission after completion of 43 credit hours applicable to their electrical engineering degree and completion of both ECEN 215 Electronics and Circuits I and ECEN 216 Electronics and Circuits II. Transfer students must have completed 12 credit hours of degree applicable upper-level electrical engineering coursework at UNL prior to being reviewed.

After meeting the requirements for review, the appointed faculty committee will review students to see if they are meeting the following criteria:

- Completion of both ECEN 215 and ECEN 216 with a C or better
- Cumulative GPA of 2.40 or higher
- No more than seven retakes and withdrawals, excluding ACE elective coursework

Those who are not admitted to the degree program the first time are advised of the outcome and will be reviewed again after they have retaken the appropriate coursework and/or after the next semester. If after two reviews a student is not admitted to the degree program, the student is advised of other majors, in engineering or elsewhere, in which they may be likely to find success.

Other

EE Resource Room/Tutoring

The Department of Electrical and Computer Engineering has a resource room staffed by upper class undergraduates and graduate students. Students can get help with their homework, get answers to technical questions, etc. The room is open approximately 20 hours per week. Open hours for each semester are posted outside the room.

A list of tutors is available from the Department of Electrical and Computer Engineering, 209N, SEC. At the beginning of each semester students are invited to offer their services through these lists.

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, and 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 Exploratory and Pre-Professional Advising Center.

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 electrical 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 Electrical and Computer Engineering.

Major Requirements

Requirements for the Degree

First Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 102</td>
<td>Introduction to Electrical Engineering</td>
<td>2</td>
</tr>
<tr>
<td>ENGR 10</td>
<td>Freshman Engineering Seminar</td>
<td>0</td>
</tr>
<tr>
<td>MATH 106</td>
<td>Calculus I</td>
<td>5</td>
</tr>
<tr>
<td>Science Elective</td>
<td>Select 4 hours of science elective from the following</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 109</td>
<td>General Chemistry I</td>
<td></td>
</tr>
<tr>
<td>or CHEM 111 Chemistry for Engineering and Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or CHEM 113 Fundamental Chemistry I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIFE 120</td>
<td>Fundamentals of Biology I</td>
<td></td>
</tr>
<tr>
<td>&amp; LIFE 120L</td>
<td>and Fundamentals of Biology I laboratory</td>
<td></td>
</tr>
<tr>
<td>MATH 314</td>
<td>Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>PHYS 213</td>
<td>General Physics III</td>
<td></td>
</tr>
</tbody>
</table>

ACE Elective

Select one course from not yet satisfied ACE outcomes 5, 6, 7, 8, or 9

Credit Hours Subtotal: 14

Second Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 103</td>
<td>Electrical and Computer Engineering</td>
<td>4</td>
</tr>
<tr>
<td>MATH 107</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>General Physics I</td>
<td>4</td>
</tr>
</tbody>
</table>
### Electrical Engineering

**Computer Programming Elective**
- CSCE 155E Computer Science I: Systems Engineering Focus 3 Credit Hours Subtotal: 15

**Third Semester**
- ECEN 215 Electronics and Circuits I 3
- ECEN 235 Introductory Electrical Laboratory I 1
- ENGR 20 Sophomore Engineering Seminar 0
- MATH 208 Calculus III 4
- PHYS 212 General Physics II 4
- PHYS 222 General Physics Laboratory II 1

**Communications Elective**
Select one of the following to meet both ACE 1 and 2: 3
- JGEN 200 Technical Communication I
- JGEN 300 Technical Communication II
- COMM 286 Business and Professional Communication

Credit Hours Subtotal: 16

**Fourth Semester**
- ECEN 216 Electronics and Circuits II 3
- ECEN 220 Introduction to Embedded Systems 3
- ECEN 236 Introductory Electrical Laboratory II 1
- MATH 221 Differential Equations 3

**Science Elective**
Select at least 3 hours of science elective from the following: 3
- CHEM 109 General Chemistry I
- CHEM 111 Chemistry for Engineering and Technology
- CHEM 113 Fundamental Chemistry I
- LIFE 120 Fundamentals of Biology I
- LIFE 120L and Fundamentals of Biology I laboratory
- MATH 314 Linear Algebra
- PHYS 213 General Physics III

**ACE Elective**
Select one course from not yet satisfied ACE outcomes 5, 6, 7, 8, or 9 3

Credit Hours Subtotal: 16

**Fifth Semester**
- ECEN 304 Signals and Systems I 3
- ECEN 307 Electrical Engineering Laboratory I 2
- ECEN 316 Electronics and Circuits III 3
- ECEN 327 Discrete Systems Laboratory 1
- ECEN 370 Digital Logic Design 3

**ACE Elective**
Select one course from not yet satisfied ACE outcomes 5, 6, 7, 8, or 9 3

Credit Hours Subtotal: 15

**Sixth Semester**
- ECEN 305 Probability Theory and Statistics for Electrical and Computer Engineers (NOTE: Both RAIK 270H and RAIK 370H together count for ECEN 305 for students in the Raikes program.) 3
- ECEN 306 Electromagnetic Field Theory 3
- ECEN 347 Electrical Engineering Laboratory II 1

**Technical Electives**
Each EE undergraduate student must choose one of the emphasis areas listed below for the EE technical electives.

### Electrical Engineering Emphasis Areas
- Communications and Signal Processing
- Electromagnetic Fields and Optics
- Electronics
- Energy and Power Systems
- Materials and Devices
- Bioengineering
- Modeling and Simulation
- Telecommunications

### Electives
There are 27 credit hours of technical electives required. Of these 27 credit hours, at least 12 credit hours must be taken in electrical engineering (ECEN) emphasis area courses which are referred to as "EE technical electives." Below is a list of courses in each emphasis area. (Lincoln Campus course numbers are given. Some courses have an equivalent on Omaha Campus.)

### Communications and Signal Processing
- ECEN 410 Multivariate Random Processes 3
- ECEN 462 Communication Systems (Core Course) 3
- ECEN 463 Digital Signal Processing (Core Course) 3
- ECEN 464 Digital Communication Systems 3
- ECEN 465 Introduction to Data Compression 3

### Electromagnetic Fields and Optics
- ECEN 408 Engineering Electromagnetics (Core Course) 3
- ECEN 467 Electromagnetic Theory and Applications 3
No more than a total of 3 credit hours may be taken in EE or other technical electives and Engineering, Mathematics, Statistics, or Physics and Astronomy at Nebraska.

In addition, at least one 3-credit-hour course from a different EE emphasis area must be taken. The remaining 3 credits may be satisfied by any non-required 300- or 400-level electrical engineering course except ECEN 399 Undergraduate Research.

The remaining 15 credit hours of technical electives which are referred to as “EE or other technical electives” may be taken from any 300- or 400-level course offering (with the exception of those listed below) in the Department of Electrical and Computer Engineering or in any other engineering department within the College of Engineering at Nebraska, or in the Departments of Biological Sciences, Chemistry, Computer Science and Engineering, Mathematics, Statistics, or Physics and Astronomy at Nebraska.

Of these 12 credit hours, 6 credit hours must be taken from one of the eight EE emphasis areas listed. This must include at least one Core Course in that area.

In addition, at least one 3-credit-hour course from a different EE emphasis area must be taken. The remaining 3 credits may be satisfied by any non-required 300- or 400-level electrical engineering course except ECEN 399 Undergraduate Research.

The remaining 15 credit hours of technical electives which are referred to as “EE or other technical electives” may be taken from any 300- or 400-level course offering (with the exception of those listed below) in the Department of Electrical and Computer Engineering or in any other engineering department within the College of Engineering at Nebraska, or in the Departments of Biological Sciences, Chemistry, Computer Science and Engineering, Mathematics, Statistics, or Physics and Astronomy at Nebraska.

Not Allowed 300- and 400-Level Technical Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 310</td>
<td>School of Biological Sciences Seminar</td>
</tr>
<tr>
<td>MATH 495</td>
<td>Seminar</td>
</tr>
<tr>
<td>MATH 496</td>
<td>Seminar in Mathematics</td>
</tr>
</tbody>
</table>

In addition, a list of courses at the 100 and 200 level, which also will be accepted as technical elective credits, are listed below.

Allowed 100- and 200-Level Technical Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGEN 225 / BSEN 225</td>
<td>Engineering Properties of Biological Materials</td>
</tr>
<tr>
<td>ASTR 204</td>
<td>Introduction to Astronomy and Astrophysics</td>
</tr>
<tr>
<td>ASTR 224</td>
<td>Astronomy and Astrophysics Laboratory</td>
</tr>
<tr>
<td>BIOS 206</td>
<td>General Genetics</td>
</tr>
<tr>
<td>BIOS 213</td>
<td>Human Physiology</td>
</tr>
<tr>
<td>CHME 202</td>
<td>Mass and Energy Balances</td>
</tr>
<tr>
<td>CHME 331</td>
<td>Equilibrium Stage Operations</td>
</tr>
<tr>
<td>CHEM 110</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>CHEM 114</td>
<td>Fundamental Chemistry II</td>
</tr>
<tr>
<td>CHEM 2xx</td>
<td>Any 200 level chemistry course</td>
</tr>
<tr>
<td>CSCE 156</td>
<td>Computer Science II</td>
</tr>
<tr>
<td>CSCE 235</td>
<td>Introduction to Discrete Structures</td>
</tr>
<tr>
<td>CSCE 251</td>
<td>Unix Programming Environment</td>
</tr>
<tr>
<td>MATL 260</td>
<td>Elements of Materials Science</td>
</tr>
<tr>
<td>MATL 262</td>
<td>Materials Laboratory I</td>
</tr>
<tr>
<td>MECH 223</td>
<td>Engineering Statics</td>
</tr>
<tr>
<td>MECH 250</td>
<td>Mechanics I</td>
</tr>
<tr>
<td>MECH 200</td>
<td>Engineering Thermodynamics</td>
</tr>
</tbody>
</table>

No more than a total of 3 credit hours may be taken in ECEN 399 or similar offerings from other departments.

However, students can choose a “Research Option.” The purpose of a research option is to provide research experiences and offer opportunities for students to work with a faculty advisor on a specific research topic. A certificate of completion of thesis will be awarded to the students, and outstanding thesis awards will be presented at the end...
of semester functions. Requirements for the research option are listed below.

**Research Option**
1. Selection of a faculty advisor (ECE department faculty), research topic, and thesis committee (at least one other faculty).
2. Registration for 6 credit hours of undergraduate research (ECEN 399) over at least two consecutive semesters on the same research topic.
3. GPA of above 3.0.
4. Write an undergraduate thesis or report and make an oral presentation to be graded by thesis committee members.

**Additional Major Requirements**

**Grade Rules**

**C- and D Grades**
- ECEN 216 Electronics and Circuits II – Prereq: A grade of C or better in ECEN 215; Prereq or Parallel: MATH 221 and ECEN 236
- ECEN 304 Signals and Systems I – Prereq: A grade of C or better in ECEN 216; MATH 221
- ECEN 316 Electronics and Circuits III – Prereq: A grade of C or better in ECEN 216
- ECEN 306 Electromagnetic Field Theory – Prereq: A grade of C or better in ECEN 216; PHYS 212; MATH 221

**ECEN 102 Introduction to Electrical Engineering**
**Prerequisites:** Open to first year students only or by permission.
**Description:** An overview of the electrical engineering field. Introduction to some basic concepts and skills needed in electrical engineering. Professionalism and ethics are addressed as well as the need for lifelong learning experiences. Information on professional careers available upon graduation.

**Credit Hours:** 2

**Max credits per semester:** 2

**Max credits per degree:** 2

**Grading Option:** Graded

**ECEN 103 Electrical and Computer Engineering Fundamentals**
**Prerequisites:** MATH 106/108H or (UNO) MATH 1950, or parallel.
**Description:** Introduction to DC circuit analysis and digital logic. Ohm’s and Kirchoff’s laws, mesh and nodal analysis, Boolean algebra, logic gates, minimization, counters, and flip-flops. Uses of computer based resources for data analysis and report generation. Use of internet to locate and retrieve engineering resources.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option

**Offered:** FALL/SPR

**Prerequisite for:** ECEN 106; ECEN 123; ECEN 213; ECEN 220; ECEN 225

**ECEN 106 Microprocessor Applications**
**Prerequisites:** ECEN 103 or (UNO) ECEN 1030; CSCE 155A, 155E, 155H, 155N, 155T or (UNO) CIST 1400.
**Description:** Introduction to assembly language programming of microprocessors / microcontrollers, assemblers, and debugging tool utilization. Microprocessor system hardware components, control signals, and ‘C’ language micro-controller programming.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** ECEN 224; ECEN 313; ECEN 327; ECEN 332; ECEN 345

**ECEN 121 Introduction to Electrical Engineering I**
**Description:** Introduction to basic electrical engineering concepts including energy, power systems, communications and signal processing.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**ECEN 122 Introduction to Electrical Engineering II**
**Description:** Introduction to several electrical engineering areas including digital, circuits, electromagnetics, materials and devices, and optics.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**ECEN 123 Introduction to Electrical and Computer Engineering**
**Prerequisites:** ECEN 103/(UNO)1030 or parallel; CSCE155A/CSCE 155E/ (UNO) CIST 1400 or parallel. Open to first year students only.
**Description:** Laboratory design projects introducing some basic concepts and skills needed in electrical and computer engineering.

**Credit Hours:** 1

**Max credits per semester:** 1

**Max credits per degree:** 1

**Grading Option:** Graded

**Offered:** FALL/SPR

**ECEN 192 Individual Study in Computer and Electronics Engineering I**
**Notes:** Requires a ECE departmentally approved proposal.
**Description:** Individual study in a selected electrical, computer, or electronics engineering area under the supervision and guidance of an electrical and computer engineering faculty member.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**ECEN 194 Special Topics in Electrical and Computer Engineering I**
**Prerequisites:** Freshman standing.
**Description:** Special topics in the emerging areas of electrical, computer, and electronics engineering which may not be covered in other courses in the electrical and computer engineering curriculum.

**Credit Hours:** 1-4

**Min credits per semester:** 1

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option
ECEN 198 Special Topics in Electrical Engineering I  
Prerequisites: Permission.  
Description: Offered as the need arises to treat electrical engineering topics for first-year students not covered in other courses.  
Credit Hours: 1-6  
Min credits per semester: 1  
Max credits per semester: 6  
Max credits per degree: 6  
Grading Option: Graded with Option  

ECEN 211 Elements of Electrical Engineering I  
Prerequisites: Prerequisite or parallel: MATH 107/(UNO) MATH 1960 and PHYS 211/(UNO) PHYS 2110.  
Notes: Not for electrical engineering majors.  
Description: Basic circuit analysis including direct and alternating currents and operational amplifiers. Digital signals and circuits.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option  
Prerequisite for: AGEN 325, BSEN 325; AREN 320; AREN 322; ECEN 231; MECH 350  

ECEN 213 Electrical Circuits I  
Prerequisites: ECEN 103 or (UNO) ECEN 1030; ECEN 225 or (UNO) ECEN 2250; MATH 221/221H/821 or (UNO) MATH 2250, or parallel.  
Description: Electrical circuit theory. Kirchhoff's and Ohm's laws, circuit analysis theorems, Norton and Thevenin equivalence. The analysis of resistor circuits, with capacitors and inductors, in DC and AC steady state. Transients and variable frequency responses are studied, including computer solutions to circuit problems.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option  
Offered: FALL/SPR  
Prerequisite for: ECEN 217; ECEN 218; ECEN 222  

ECEN 214 Electrical Circuits II  
Prerequisites: ECEN 213 or (UNO) ECEN 2130; ECEN 218 or (UNO) ECEN 2184; (UNO) MATH 2505 or parallel.  
Description: Introduction to the analysis of electrical circuits in sinusoidal steady states. The concepts of impedance, phasors, power, frequency response, resonance, magnetic circuits, and two-port networks. Transform techniques for circuit analysis.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option  
Prerequisite for: ECEN 304; ECEN 338; ECEN 355  

ECEN 215 Electronics and Circuits I  
Prerequisites: Prerequisite or parallel: MATH 208/(UNO) MATH 1970.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option  
Prerequisite for: ECEN 216; ECEN 235; ECEN 306  

ECEN 216 Electronics and Circuits II  
Prerequisites: ECEN 215/(UNO) ECEN 2150 with a grade of "C" or better. Prerequisite or parallel: MATH 221/(UNO) MATH 2350 or MATH 221H.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option  

ECEN 217 Electrical Circuits III  
Prerequisites: ECEN 213 or (UNO) ECEN 2130  
Notes: This course is for computer engineering majors only.  
Description: Analysis of first and second order RLC circuits using differential equations and Laplace transforms. Variable frequency network performance analysis.  
Credit Hours: 1  
Max credits per semester: 1  
Max credits per degree: 1  
Grading Option: Graded with Option  

ECEN 218 Electrical Circuits Laboratory  
Prerequisites: ECEN 213/(UNO) ECEN 2130 or parallel.  
Notes: Lab to accompany ECEN 213/(UNO) ECEN 2130.  
Description: The use of laboratory tools for measurement and verification of electrical concepts. Experiments using both passive and semiconductor devices at audio frequencies. Analysis verification with computer simulation.  
Credit Hours: 1  
Max credits per semester: 1  
Max credits per degree: 1  
Grading Option: Graded with Option  
Prerequisite for: ECEN 214; ECEN 222  

ECEN 220 Introduction to Embedded Systems  
Prerequisites: CSCE 155E; ECEN 103 or CSCE 230  
Description: Basic hardware and software concepts of embedded microprocessor systems and interfacing with other hardware components. Simple circuits are designed and drivers to run them are written. Design and build hardware and write drivers in assembly or C programming languages.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Offered: FALL/SPR  
Prerequisite for: CSCE 488; ECEN 307; ECEN 327
ECEN 222 Electronic Circuits I  
**Prerequisites:** ECEN 213/(UNO) ECEN 2130 with a grade of "C" or better; ECEN 218/(UNO) ECEN 2184  
**Description:** Analysis and design of modern electronic circuits. Diode circuits, bipolar and field effect transistor switching and amplifier circuits, and operational amplifier circuits.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Grading Option:** Graded with Option  
**Offered:** FALL/SPR  
**Prerequisite for:** ECEN 310; ECEN 325; ECEN 347; ECEN 352; ECEN 494

ECEN 224 Introduction to Signal Processing  
**Prerequisites:** ECEN 106 or (UNO) ECEN 1060; CSCE 155A, 155E, 155H, 155N, 155T or (UNO) CIST 1400; MATH 107/107H or (UNO) MATH 1960.  
**Description:** The use of mathematical and digital computation tools key to engineering applications. Auditory and visual senses are used in the presentation and study of sinusoidal signals, sampling, frequency response and filtering theory.  
**Credit Hours:** 4  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Grading Option:** Graded with Option  

ECEN 225 Electrical and Computer Engineering Seminar  
**Prerequisites:** ECEN 103 or (UNO) ECEN 1030 or parallel  
**Description:** An overview of electrical, computer, electronics and telecommunication fields. There will be information on professional careers available upon graduation. Professionalism and ethics are addressed as well as the need for lifelong learning experiences.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Grading Option:** Graded with Option  

ECEN 231 Electrical Engineering Laboratory  
**Prerequisites:** Prerequisite or parallel: ECEN 211/(UNO) ECEN 2110.  
**Description:** Laboratory accompanying ECEN 211/(UNO) ECEN 2110.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Grading Option:** Graded with Option  

ECEN 235 Introductory Electrical Laboratory I  
**Prerequisites:** Prerequisite or parallel: ECEN 215/(UNO) ECEN 2150.  
**Description:** Laboratory accompanying ECEN 215/(UNO) ECEN 2150.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Grading Option:** Graded with Option  
**Prerequisite for:** ECEN 236

ECEN 236 Introductory Electrical Laboratory II  
**Prerequisites:** ECEN 235/(UNO) ECEN 2350; Prerequisite or parallel: ECEN 216/(UNO) ECEN 2160.  
**Description:** Laboratory accompanying ECEN 216/(UNO) ECEN 2160.  
**Credit Hours:** 1  
**Max credits per semester:** 1  
**Max credits per degree:** 1  
**Grading Option:** Graded with Option  
**Prerequisite for:** ECEN 307

ECEN 292 Individual Study in Electrical and Computer Engineering II  
**Prerequisites:** Sophomore standing.  
**Notes:** Requires a ECE departmentally approved proposal.  
**Description:** Individual study in a selected electrical, computer or electronics engineering area under the supervision and guidance of an electrical and computer engineering faculty member.  
**Credit Hours:** 1-3  
**Min credits per semester:** 1  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  

ECEN 294 Special Topics in Electrical and Computer Engineering II  
**Prerequisites:** Permission.  
**Description:** Special topics in the emerging areas of electrical, computer, and electronics engineering which may not be covered in other courses in the electrical and computer engineering curriculum.  
**Credit Hours:** 1-4  
**Min credits per semester:** 1  
**Max credits per semester:** 4  
**Max credits per degree:** 4  
**Grading Option:** Graded with Option

ECEN 298 Special Topics in Electrical Engineering II  
**Prerequisites:** Permission.  
**Description:** Offered as the need arises to treat electrical engineering topics for second-year students not covered in other courses.  
**Credit Hours:** 1-6  
**Min credits per semester:** 1  
**Max credits per semester:** 6  
**Max credits per degree:** 6  
**Grading Option:** Graded with Option

ECEN 304 Signals and Systems I  
**Prerequisites:** ECEN 214 or (UNO) ECEN 2140 or ECEN 216 or (UNO) 2160 with a grade of "C" or better; MATH 221 or 221H or (UNO) MATH 2350.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** ECEN 494

ECEN 305 Probability Theory and Statistics for Electrical and Computer Engineers  
**Prerequisites:** MATH 208/(UNO) MATH 1970.  
**Description:** Random experiment model, random variables, functions of random variables, and introduction to random processes; statistics and practical data analysis.  
**Credit Hours:** 3  
**Max credits per semester:** 3  
**Max credits per degree:** 3  
**Grading Option:** Graded with Option  
**Prerequisite for:** ECEN 850, ECEN 450
ECEN 306 Electromagnetic Field Theory
Prerequisites: ECEN 215 or (UNO) ECEN 2130 with a grade of "C" or better, PHYS 212 or (UNO) PHYS 2120, MATH 208 or (UNO) MATH 1970, MATH 221 or (UNO) 2350.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 494

ECEN 307 Electrical Engineering Laboratory I
Prerequisites: ECEN 220 or (UNO) ECEN 1060 and ECEN 236 or (UNO) ECEN 2220; prereq or parallel ECEN 370 or (UNO) ECEN 3700 or (UNO) ECEN 3130; admission to the College of Engineering.
Description: Laboratory work on circuits and systems, digital and analog electronic circuits.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded with Option
Offered: FALL/SPR

ECEN 310 Digital Design and Interfacing
Prerequisites: ECEN 222/(UNO) ECEN 2220; ECEN 313/(UNO) ECEN 3130, or parallel.
Notes: Lab exercises provide practical experience with design tools and the design process.
Description: Digital design from both the circuit and system perspectives. The structure and analysis of digital integrated circuits, interface signal integrity, Field Programmable Gate Array (FPGA) design and synthesis, and software simulation.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 313 Switching Circuits Theory
Prerequisites: ECEN 106 or (UNO) ECEN 1060.
Description: Combinational circuit analysis and design. State machine analysis and design. Synchronous/clock mode circuits and asynchronous sequential circuits. Minimization, race, and hazard elimination are covered. Circuits are implemented in discrete logic and in CPLD and FPGA devices. VHDL hardware description language is used to describe circuits. Circuits are implemented in discrete logic and in CPLD/FPGA devices.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: ECEN 310; ECEN 494

ECEN 316 Electronics and Circuits III
Prerequisites: ECEN 216/(UNO) ECEN 2160 with a grade of "C" or better.
Description: Kirchhoff's laws and circuit analysis theorems applied to steady state transistor circuits. Frequency response of filters and amplifiers. Basic power amplifier types. Advanced operational amplifier circuits. Introduction to the fundamentals of semiconductor theory and their application to p-n junction and field devices.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: ECEN 347, ECEN 361

ECEN 317 Electrical Engineering Laboratory II
Prerequisites: ECEN 304/(UNO) ECEN 3040 and ECEN 307/(UNO) ECEN 3070; prereq or parallel ECEN 306/(UNO) ECEN 3060 and ECEN 316/(UNO) ECEN 3160; admission to the College of Engineering.
Description: Lab work on electromagnetic fields and waves, solid state devices, discrete systems, control systems, and communications.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded with Option

ECEN 325 Communications Systems
Prerequisites: ECEN 222/(UNO) ECEN 2220; MATH/STAT 380/(UNO) STAT 3800.
Description: Relevant communications systems; principles of transmission and reception; amplitude; frequency and phase modulation. Sampling theorem, pulse-code modulation and delta modulation.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 327 Discrete Systems Laboratory
Prerequisites: ECEN 106/1060 or ECEN 220/2200
Description: Laboratory work on discrete systems.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded

ECEN 328 Applied Fields and Lines I
Prerequisites: MATH 208/208H or (UNO) MATH 1970; MATH 221/821 or (UNO) MATH 2350.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: ECEN 329

ECEN 329 Applied Fields and Lines II
Prerequisites: ECEN 328 or (UNO) ECEN 3280.
Description: Metallic wave guides with rectangular, circular, and coaxial cross section, antennas, free space, propagation in free space, applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ECEN 332 Assembly Language Programming
Prerequisites: ECEN 106 or (UNO) ECEN 1060
Description: Introduction to the architecture and assembly language programming of 80 x 86 microprocessors. Assemblers and debugging tool utilization.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded with Option

ECEN 338 Introduction to Power and Energy Systems
Prerequisites: ECEN 216 or (UNO) ECEN 2160 or ECEN 214 or (UNO) ECEN 2140 with a grade of "C" or better.
Description: Energy sources, environmental impacts, power systems principles, three-phase circuits, transmission lines, transformers, per unit analysis, generators, loads, and power system modeling.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Offered: FALL/SPR

ECEN 345 Mobile Robotics I
Prerequisites: ECEN 106 or (UNO) ECEN 1060, ECEN 213 or (UNO) ECEN 2130.
Description: Introduction to the primary issues spanning the field of mobile robotics, including robotics history, robot components (sensors, actuators), robot system design considerations, low-level control (feedback control) and robotics control architectures. The lab focuses on the practical implementation of autonomous robot control on a real mobile robot using behavior-based methods in the C language.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 347 Electrical Engineering Laboratory II
Prerequisites: ECEN 316/3160 or ECEN 222/2220
Description: Lab work on electromagnetics, fields and waves, solid state devices and control systems.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Grading Option: Graded

ECEN 350 Electrical Engineering Internship or Cooperative Education
Prerequisites: Open to Electrical Engineering majors only. Approval of faculty sponsor prior to the internship or Co-op is required.
Description: For Internships or Cooperatives primarily technical in nature lasting 4.5 months or greater. Weekly communication and/or final report required. Must be taken during or after the semester in which the Internship/Co-op occurs.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 352 Electronics Circuits II
Prerequisites: ECEN 222/(UNO) CEEN 2220.
Description: Operational amplifier circuit design and analysis feedback and stability. Design and analysis of large signal power amplifiers. Other integrated devices such as: regulators, comparators, Schmitt triggers, oscillators, and active filters.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: ECEN 362

ECEN 355 Signals and Linear Systems
Prerequisites: ECEN 214/(UNO) ECEN 2140
Description: Continuous and discrete representations of signals. System modeling and analysis using differential and difference equations. Fourier, Laplace, and Z transforms. State description of continuous and discrete time transfer functions. The primary mathematical tools used in the analysis of continuous and discrete time systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 361 Advanced Electronics and Circuits
Prerequisites: ECEN 316/(UNO) ECEN 3160.
Description: Analog and digital electronics for discrete and integrated circuits. Multistage amplifiers, frequency response, feedback amplifiers, simple filters and amplifiers, MOS and bipolar logic gates and families, A/D and D/A converters.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 362 Data and Telecommunications Transceivers
Prerequisites: ECEN 352 or (UNO) ECEN 3520; ECEN 325 or (UNO) ECEN 3250, or parallel; and ECEN 328 or (UNO) ECEN 3280, or parallel.
Description: Noise and signal distortions in communication systems, impedance matching techniques, high frequency measurement techniques, design of high frequency amplifiers and oscillators, PLL and frequency synthesizers, data synchronization and multiplexing techniques, Antennas and their arrays.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded

ECEN 370 Digital Logic Design
Crosslisted with: CSCE 335
Prerequisites: ECEN 103/(UNO) ECEN 1030 or CSCE 230
Description: Combinational and sequential logic circuits. MSI chips, programmable logic devices (PAL, ROM, PLA) used to design combinational and sequential circuits. CAD tools. LSI and PLD components and their use. Hardware design experience.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 307
ECEN 392 Individual Study in Electrical and Computer Engineering III
Prerequisites: Junior standing.
Notes: Requires a ECE departmentally approved proposal.
Description: Individual study in a selected electrical, computer or electronics engineering area under the supervision and guidance of an electrical and computer engineering faculty member.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 394 Special Topics in Electrical and Computer Engineering III
Prerequisites: Junior standing
Description: Special topics in the emerging areas of electrical, computer, and electronics engineering which may not be covered in other courses in the electrical and computer engineering curriculum.
Credit Hours: 1-4
Min credits per semester: 1
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 398 Undergraduate Research
Prerequisites: Junior standing
Description: Offered as the need arises to treat electrical engineering topics for third-year students not covered in other courses.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 6
Grading Option: Graded with Option

ECEN 399 Undergraduate Research
Prerequisites: Electrical engineering seniors.
Description: Research accompanied by a written report of the results.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 399R Undergraduate Research
Description: Independent research project executed under the guidance of a member of the faculty of the Department of Electrical Engineering which contributes to the advancement of knowledge in the field. Culminates in a written thesis or report and an oral presentation. For electrical engineering majors selecting the research option. ECEN 399/(UNO) ECEN 3990 and ECEN 399R/(UNO) 3990R should be taken in consecutive semesters.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 400 Electronic Instrumentation
Crosslisted with: ECEN 800
Prerequisites: Senior standing in engineering
Description: Applications of analog and digital devices to electronic instrumentation. Includes transducers, instrumentation amplifiers, mechanical and solid-state switches, data acquisition systems, phase-lock loops, and modulation techniques. Demonstrations with working circuits and systems.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 406 Power Systems Analysis
Crosslisted with: ECEN 806
Prerequisites: ECEN 338/(UNO) ECEN 3380 or ECEN 838/(UNO) ECEN 8386.
Description: Symmetrical components and fault calculations, power system stability, generator modeling (circuit viewpoint), voltage control system, high voltage DC transmission, and system protection.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 957

ECEN 407 Power Systems Planning
Crosslisted with: ECEN 807
Prerequisites: ECEN 305/(UNO) ECEN 3050
Description: Economic evaluation, load forecasting, generation planning, transmission planning, production simulation, power plant reliability characteristics, and generation system reliability.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 408 Engineering Electromagnetics
Crosslisted with: ECEN 808
Prerequisites: ECEN 306/(UNO) ECEN 3060
Notes: Laboratory experiments.
Description: Applied electromagnetics: Transmission lines in digital electronics and communication. The quasistatic electric and magnetic fields: electric and magnetic circuits and electromechanical energy conversion. Guided waves: rectangular and cylindrical metallic waveguides and optical fibers. Radiation and antennas: line and aperture antennas and arrays.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 410 Multivariate Random Processes
Crosslisted with: ECEN 810
Prerequisites: ECEN 305/(UNO) ECEN 3050
Description: Probability space, random vectors, multivariate distributions, moment generating functions, conditional expectations, discrete and continuous-time random processes, random process characterization and representation, linear systems with random inputs.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 911; ECEN 912; ECEN 915; ECEN 946
ECEN 416 Materials and Devices for Computer Memory, Logic, and Display  
Crosslisted with: ECEN 816  
Prerequisites: PHYS 212/(UNO) PHYS 2120  
Description: Survey of fundamentals and applications of devices used for memory, logic, and display. Magnetic, superconductive, semiconductive, and dielectric materials.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

ECEN 417 Semiconductor Fundamentals II  
Crosslisted with: ECEN 817  
Prerequisites: ECEN 421/(UNO) ECEN 4210 or ECEN 821/(UNO) ECEN 8216  
Description: Analysis of BJT's and MOSFET's from a first principle materials viewpoint. Static and dynamic analysis and characterization. Device fabrication processes.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

ECEN 420 Plasma Processing of Semiconductors  
Crosslisted with: ECEN 820  
Prerequisites: Senior or graduate standing.  
Description: Physics of plasmas and gas discharges developed. Includes basic collisional theory, the Boltzman equation and the concept of electron energy distributions. Results are related to specific gas discharge systems used in semiconductor processing, such as sputtering, etching, and deposition systems.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

ECEN 421 Principles of Semiconductor Materials and Devices I  
Crosslisted with: ECEN 821  
Prerequisites: PHYS 213/(UNO) PHYS 2130  
Description: Introduction to semiconductor fundamentals, charge carrier concentration and carrier transport, energy bands, and recombination. PN junctions, static and dynamic, and special PN junction diode devices.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded

ECEN 422 Introduction to Physics and Chemistry of Solids  
Crosslisted with: PHYS 422, PHYS 822, ECEN 822  
Prerequisites: PHYS 213 or CHEM 481/881, MATH 221/821.  
Description: Introduction to structural, thermal, electrical, and magnetic properties of solids, based on concepts of atomic structure, chemical bonding in molecules, and electron states in solids. Principles underlying molecular design of materials and solid-state devices.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option

ECEN 424 Digital Signal Processing  
Crosslisted with: ECEN 824  
Prerequisites: ECEN 355 or (UNO) ECEN 3550.  
Description: The temporal and spectral analysis of digital signals and systems, the design of digital filters and systems, and advanced systems including multi-rate digital signal processing techniques.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option  
Prerequisite for: ECEN 815; ECEN 926

ECEN 428 Power Electronics  
Crosslisted with: ECEN 828  
Prerequisites: ECEN 304/(UNO) ECEN 3040 and ECEN 316/(UNO) ECEN 3160  
Description: Basic analysis and design of solid-state power electronic devices and converter circuitry.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded  
Prerequisite for: ECEN 932

ECEN 430 Wind Energy  
Crosslisted with: ECEN 830  
Prerequisites: Senior standing  
Description: Engineering principles of both the mechanical/aero dynamical and electrical components and systems, along with economic and environmental considerations for citing and public policy, to appropriately cover the relevant topics associated with all scales of wind energy implementations.  
Credit Hours: 3  
Max credits per semester: 3  
Max credits per degree: 3  
Grading Option: Graded with Option

ECEN 433 Microprocessor System Design  
Crosslisted with: ECEN 833  
Prerequisites: ECEN 310 or (UNO) ECEN 3100 with a grade of "C" or better; ECEN 332 or (UNO) ECEN 3320 with a grade of "C" or better.  
Description: Microprocessor based systems: architecture; design; and interfacing. Hardware topics: memory design; input/output ports; serial communications; and interrupts. Software topics: generating assembly ROM code; assembly/C firmware generation; and designing device drivers.  
Credit Hours: 4  
Max credits per semester: 4  
Max credits per degree: 4  
Grading Option: Graded with Option  
Offered: FALL/SPR  
Prerequisite for: ECEN 435, ECEN 835; ECEN 496

ECEN 435 Microprocessor System Design II  
Crosslisted with: ECEN 835  
Prerequisites: ECEN 433 or (UNO) ECEN 4330  
Description: Advanced system design of microcomputer based systems. Hardware topics: Advances and integration of computer systems and memory design. Software topics: Operating systems; embedded systems; real-time systems.  
Credit Hours: 4  
Max credits per semester: 4  
Max credits per degree: 4  
Grading Option: Graded with Option

ECEN 496 Special Problems  
Crosslisted with: ECEN 896  
Offered: FALL/SPR  
Prerequisite for: ECEN 435, ECEN 835; ECEN 496
ECEN 435 Embedded Microcontroller Design
Crosslisted with: ECEN 835
Prerequisites: ECEN 433/833 or (UNO) ECEN 4330/8336 with a grade of "C" or better; STAT 380 or (UNO) STAT 3800.
Description: Microcontroller architecture: design, programming, and interfacing for embedded systems. Timing issues, memory interfaces, serial and parallel interfacing, and functions for common microcontrollers.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Offered: FALL/SPR
Prerequisite for: ECEN 437, ECEN 837

ECEN 436 Electric Machines
Crosslisted with: ECEN 836
Prerequisites: PHYS 212/(UNO) PHYS 2120 and ECEN 216/(UNO) ECEN 2160
Description: Provides a solid background in electric machine analysis, covering fundamental concepts, techniques, and methods for analysis and design. Discussion of transformers and presentation of some new systems and applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: ECEN 932

ECEN 437 Parallel and Distributed Processing
Crosslisted with: ECEN 837
Prerequisites: ECEN 435/835 or (UNO) ECEN 4350/8366
Description: Parallel and distributed processing concepts, principles, techniques, and machines.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 438 Integrated Systems Programming
Crosslisted with: ECEN 838
Prerequisites: ECEN 310 or (UNO) ECEN 3100 and ECEN 332 or (UNO) ECEN 3320
Description: Introduction to the basics of computer architectural details under the context of computer system programming. Topics include representing and manipulating information, machine level representation of programs, processor architecture and pipelining, compiling and linking, optimizing program performance from the system level, memory hierarchy, dynamic memory allocation and exceptional control flow. Linux system programming tool chain will also be introduced.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: FALL/SPR
Prerequisite for: ECEN 406, ECEN 806

ECEN 442 Basic Analytical Techniques in Electrical Engineering
Crosslisted with: ECEN 842
Prerequisites: MATH 221/(UNO) MATH 2350
Description: Applications of partial differential equations, matrices, vector analysis, complex variables, and infinite series to problems in electrical engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 444 Linear Control Systems
Crosslisted with: ECEN 844
Prerequisites: ECEN 304/(UNO) ECEN 3040
Description: Classical (transfer function) and modern (state variable) control techniques. Both time domain and frequency domain techniques are studied. Traditional proportional, lead, lag, and PID compensators are examined, as well as state variable feedback.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 448 Decision Analysis
Crosslisted with: ECEN 848
Prerequisites: ECEN 305/(UNO) ECEN 3050 or STAT 380/(UNO) STAT 3800
Description: Principles of engineering economy including time value of money, net present value and internal rate of return. Use of influence diagram and decision tree to structure and analyze decision situations under uncertainty including use of stochastic dominance, value of information, and utility theory. Fundamentals of two-person matrix games including Nash equilibrium.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 450 Bioinformatics
Crosslisted with: ECEN 850
Prerequisites: Computer programming language and ECEN 305/(UNO) ECEN 3050 or MECH 321 or STAT 380/(UNO) STAT 3800 or equivalent
Description: Examination of how information is organized in biological sequences such as DNA and proteins and computational techniques which make use of this structure. Various biochemical processes that involve these sequences are studied to understand how these processes affect the structure of these sequences. In the process bioinformatics algorithms, tools, and techniques which are used to explore genomic and amino acid sequences are also introduced.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 451 Introduction to VLSI System Design
Crosslisted with: ECEN 851
Prerequisites: ECEN 310 or (UNO) ECEN 3100
Description: The concepts, principles, and methodology at all levels of digital VLSI system design and focused on gate-level VLSI implementation.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ECEN 452 Introduction to Computer-Aided Digital Design
Crosslisted with: ECEN 852
Prerequisites: ECEN 310 or (UNO) ECEN 3100
Description: The concepts, simulation techniques and methodology in computer-aided digital design at system and logic levels.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 453 Computational and Systems Biology
Crosslisted with: ECEN 853
Prerequisites: By permission.
Notes: Basic knowledge of probability and statistics (e.g. ECEN 305 or STAT 380) and basic programming skills are recommended. This course is to be listed as ECEN 4530/8536 in the UNO catalog as it may also be taught as a distance course for the Omaha campus.
Description: Provides the required biology primer and covers functional genomics, transcriptomics, differential expression, clustering, classification, prediction, biomarker discovery, pathway analysis and network based approaches to high throughput biological data analysis. Includes the development of databases, algorithms, web-based and other tools regarding management and analysis of life science data. Areas of study include DNA, RNA, and protein sequence analysis, functional genomics and proteomics, 3D macromolecule structure prediction, and systems/network approach.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Offered: SPRING

ECEN 454 Power Systems Operation and Control
Crosslisted with: ECEN 854
Prerequisites: ECEN 338/(UNO) ECEN 3380
Description: Characteristics and generating units. Control of generation, economic dispatch, transmission losses, unit commitment, generation with limited supply, hydrothermal coordination, and interchange evaluation and power pool.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 460 Labview Programming
Crosslisted with: ECEN 860
Prerequisites: Prior programming experience
Description: Labview as a programming language and for applications to acquire and analyze data, to access the network, control lab instruments, and for video and sound applications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 461 Digital Communications Media
Crosslisted with: ECEN 861
Prerequisites: ECEN 325 or (UNO) 3250 or ECEN 462 or (UNO) ECEN 4620
Description: Topics related to the transport of bit streams from one geographical location to another over various physical media such as wire pairs, coaxial cable, optical fiber, and radio waves. Transmission characteristics, media interfacing, delay, distortion, noise, and error detection and correction techniques.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Offered: FALL/SPR
Prerequisite for: ECEN 466, ECEN 866; ECEN 479, ECEN 879; ECEN 885; ECEN 977

ECEN 462 Communication Systems
Crosslisted with: ECEN 862
Prerequisites: ECEN 304/(UNO) ECEN 3040 and ECEN 305/(UNO) ECEN 3050
Description: Mathematical descriptions of signals in communication systems. Principles of analog modulation and demodulation. Performance analysis of analog communication systems in the presence of noise.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 911

ECEN 463 Digital Signal Processing
Crosslisted with: ECEN 863
Prerequisites: ECEN 304/(UNO) ECEN 3040
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 915

ECEN 464 Digital Communication Systems
Crosslisted with: ECEN 864
Prerequisites: ECEN 462/(UNO) ECEN 4620.
Description: Principals of digital transmission of information in the presence of noise. Design and analysis of baseband PAM transmission systems and various carrier systems including ASK, FSK, PSK.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 911; ECEN 912; ECEN 959

ECEN 465 Introduction to Data Compression
Crosslisted with: ECEN 865
Prerequisites: ECEN 305/(UNO) ECEN 3050
Description: Introduction to the concepts of Information Theory and Redundancy removal. Simulation of various data compression schemes such as Delta Modulation, Differential Pulse Code Modulation, Transform Coding and Runlength Coding.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
ECEN 466 Telecommunications Engineering I
Crosslisted with: ECEN 866
Prerequisites: ECEN 362 or (UNO) ECEN 3620; ECEN 461/861 or (UNO) ECEN 4610/8610, or parallel.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 965

ECEN 467 Electromagnetic Theory and Applications
Crosslisted with: ECEN 867
Prerequisites: ECEN 306/(UNO) ECEN 3060
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 965

ECEN 468 Microwave Engineering
Crosslisted with: ECEN 868
Prerequisites: ECEN 306/(UNO) ECEN 3060
Description: Applications of active and passive devices to microwave systems. Includes impedance matching, resonators, and microwave antennas.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 965

ECEN 469 Analog Integrated Circuits
Crosslisted with: ECEN 869
Prerequisites: ECEN 361/(UNO) ECEN 3610
Description: Analysis and design of analog integrated circuits both bipolar and MOS. Basic circuit elements such as differential pairs, current sources, active loads, output drivers used in the design of more complex analog integrated circuits.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 913

ECEN 470 Digital and Analog VLSI Design
Crosslisted with: ECEN 870
Prerequisites: ECEN 316/(UNO) ECEN 3160
Description: Introduction to VLSI design techniques for analog and digital circuits. Fabrication technology and device modelling. Design rules for integrated circuit layout. LSI design options with emphasis on the standard cell approach of digital and analog circuits. Lab experiments, computer simulation and layout exercises.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 471 Computer Communication Networks
Crosslisted with: ECEN 871
Prerequisites: ECEN 325 or (UNO) ECEN 3250
Description: High-speed access control protocols, routing protocols, traffic management, and network topologies. Giga-bit Ethernet, ATM, and TCP/IP. Performance modeling and simulation techniques.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 473 Mobile and Personal Communications
Crosslisted with: ECEN 873
Prerequisites: ECEN 325 or (UNO) ECEN 3250
Description: Concepts on mobile and personal communications. Modulation techniques for mobile radio, equalization, diversity, channel coding, and speech coding.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 474 Digital Systems
Crosslisted with: ECEN 874
Prerequisites: ECEN 370/(UNO) ECEN 3700
Description: Synthesis using state machines; design of digital systems; micro programming in small controller design; hardware description language for design and timing analysis.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded
Prerequisite for: ECEN 477, ECEN 877

ECEN 475 Satellite Communications
Crosslisted with: ECEN 875
Prerequisites: ECEN 325 OR (UNO) ECEN 3250
Description: The fundamental concepts of satellite communications. Orbits, launching satellites, modulation and multiplexing, multiple access, earth stations, coding, interference and special problems in satellite communications.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded

ECEN 476 Wireless Communications
Crosslisted with: ECEN 876
Prerequisites: ECEN 325 or ECEN 462 or parallel
Description: The fundamental concepts of wireless communications. Basic communications concepts such as multiple access and spectrum. Propagation, radio standards and internet working. Current issues in wireless communications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
Prerequisite for: ECEN 926, ECEN 977
ECEN 477 Digital Systems Organization and Design
Crosslisted with: ECEN 877
Prerequisites: ECEN 474/(UNO) ECEN 4740 or ECEN 874/(UNO) ECEN 8746
Description: Hardware development languages, hardware organization and realization, microprogramming, interrupt, intersystem communication, and peripheral interfacing.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 479 Optical Fiber Communications
Crosslisted with: ECEN 879
Prerequisites: ECEN 461/861 or (UNO) ECEN 4610/8616.
Description: Fundamentals of lightwave communication in optical fiber waveguides, physical description of fiber optic systems. Properties of the optical fiber and fiber components. Electro-optic devices: light sources and modulators, detectors and amplifiers; optical transmitter and receiver systems. Fiber optic link design and specification; fiber optic networks.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option
Prerequisite for: ECEN 979

ECEN 480 Introduction to Lasers and Laser Applications
Crosslisted with: ECEN 880, PHYS 480, PHYS 880
Prerequisites: PHYS 213/(UNO) PHYS 2130
Description: Physics of electronic transition production stimulated emission of radiation. Threshold conditions for laser oscillation. Types of lasers and their applications in engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

ECEN 482 Antennas and Radio Propagation for Wireless Communications
Crosslisted with: ECEN 882
Prerequisites: ECEN 328 or (UNO) ECEN 3280
Description: Fundamental theory of antennas and radio propagation for wireless communications. Basic antenna characteristics and various antennas and antenna arrays. Basic propagation mechanisms and various channel models, such as Friis free space model, Hata model, lognormal distribution, and multipath model. Includes practical antenna design for high radio frequency (RF) with modeling software tools such as Numerical Electromagnetic Code (NEC) and Advanced Design System (ADS). Design projects will be assigned as the main part of course.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 486 Applied Photonics
Crosslisted with: ECEN 886
Prerequisites: ECEN 306/(UNO) ECEN 3060
Description: Introduction to the use of electromagnetic radiation for performing optical measurements in engineering applications. Basic electromagnetic theory and light interaction with matter are covered with corresponding laboratory experiments conducted.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded

ECEN 488 Wireless Security
Crosslisted with: ECEN 888
Prerequisites: ECEN 325 or (UNO) ECEN 3250
Description: A comprehensive overview on the recent advances in wireless network and system security. Covers security issues and solutions in emerging wireless access networks and systems as well as multihop wireless networks.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 491 Special Topics in Electrical and Computer Engineering IV
Crosslisted with: ECEN 891
Prerequisites: Senior standing
Description: Special topics in the emerging areas of electrical, computer, and electronics engineering which may not be covered in other courses in the electrical and computer engineering curriculum.
Credit Hours: 1-4
Min credits per semester: 1
Max credits per semester: 4
Max credits per degree: 4
Grading Option: Graded with Option

ECEN 492 Individual Study in Electrical and Computer Engineering IV
Crosslisted with: ECEN 892
Prerequisites: Senior standing
Notes: Requires a ECE departmentally approved proposal.
Description: Individual study in a selected electrical, computer, or electronics engineering area under the supervision and guidance of an electrical and computer engineering faculty member.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ECEN 494 Electrical Engineering Capstone I
Prerequisites: ECEN 2220, ECEN 3040, ECEN 3060, ECEN 3130, and (UNO) ENGL 1160.
Notes: The first in a two semester capstone senior design course sequence.
Description: A substantial design project that allows application of electrical engineering skills to a multidisciplinary project. Requires project definition, planning and scheduling, effective written and oral communication of technical ideas, incorporation of realistic constraints and engineering standards, functioning effectively on a multidisciplinary team, and applying new ideas as needed to meet project goals.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded
Offered: FALL/SPR

ECEN 495 Capstone II
Prerequisites: ECEN 494/(UNO) ECEN 4940 or permission; admission to the College of Engineering.
Notes: The second in a two semester capstone senior design course sequence.
Description: Continuation of a substantial design project that allows application of electrical engineering skills to a multidisciplinary project. Requires effective written and oral communication of technical ideas, incorporation of realistic constraints and engineering standards, functioning effectively on a multidisciplinary team, and applying new ideas as needed to meet project goals.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ACE: ACE 10 Integrated Product

ECEN 496 Computer Engineering Capstone I
Prerequisites: ECEN 4330; (UNO) ENGL 1160.
Notes: For Computer Engineering students.
Description: Preliminary investigation into topics for the capstone course. Defining deliverables, scheduling, and interdisciplinary team design.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Grading Option: Graded
Offered: FALL
Prerequisite for: ECEN 499

ECEN 498 Special Topics in Electrical Engineering IV
Crosslisted with: ECEN 898
Prerequisites: Permission
Notes: Offered as the need arises for electrical engineering topics for fourth-year and graduate students not covered in other courses.
Credit Hours: 1-6
Min credits per semester: 1
Max credits per semester: 6
Max credits per degree: 18
Grading Option: Graded with Option

ECEN 499 Capstone II
Prerequisites: ECEN 496 or (UNO) ECEN 4960.
Description: ECEN 499/(UNO) ECEN 4990 requires the completion of a design project that demonstrates the ability to combine the knowledge from individual courses in the program to complete a design task. The capstone design course for the B.S. in computer engineering and electronics engineering.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option
ACE: ACE 10 Integrated Product

ECEN 499H Honors Thesis
Prerequisites: Senior standing in electrical engineering; admission to the University Honors Program
Description: Honors thesis research project meeting the requirements of the University Honors Program. Independent research project executed under the guidance of a member of the faculty of the Department of Electrical Engineering which contributes to the advancement of knowledge in the field. Culminates in the presentation of an honors thesis to the department and college.
Credit Hours: 1-3
Min credits per semester: 1
Max credits per semester: 3
Max credits per degree: 3
Grading Option: Graded with Option

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

Career Information
The following represents a sample of the internships, jobs and graduate school programs that current students and recent graduates have reported.

Jobs of Recent Graduates
• Design Engineer & Project Manager, LI-COR Biosciences - Lincoln NE
• Operations Management Trainee, Union Pacific - Hermon OR
• Protection and Controls Engineer, Lincoln Electric System - Lincoln NE
• System Engineer, NASA Marshall Space Flight Center - Huntsville AL
• Engineering Leadership Program, National Instruments - Austin TX
• Controls Engineer, Cleaver-Brooks - Lincoln NE
• Assistant Electrical Engineer, Burns and McDonnell - Kansas City MO
• Avionics Engineer, Textron Aviation - Wichita KS
• Electrical Engineer, Black & Veatch - Kansas City KS
• Instrumentation Engineer, ExxonMobil - Beaumont TX
• Embedded Systems Engineer, Lockheed Martin - Denver CO
• Orbital Vehicle Program Manager, United States Air Force - White Sands NM
• Staff Engineer, IBM - Poughkeepsie NY
• Software Engineer, Microsoft Inc. - Redmond WA
• Protection Engineer, Nebraska Public Power District - Columbus NE
• Electrical Engineer, U.S. Army Corps of Engineers - Omaha NE
• Design Engineer, Garmin - Olathe KS
• Technical Services Engineer, Epic Systems Corporation - Madison WI
• Electrical Engineer, Raytheon - Tucson AZ
• Electrical Engineer, EAD Engineering - Omaha NE
• Research Scientist, Pacific Gas & Electric - San Francisco CA
• Design Engineer, Hexagon Lincoln - Lincoln NE
• Assistant Engineer, Olsson Associates - Lincoln NE
• Subtransmission and Distributions Asset Planning Engineer, NPPD - Norfolk NE
• Assistant Electrical Engineer, Aviation & Federal, Burns & McDonnell - Kansas City MO

Internships
• Electrical Engineering Intern, Burns and McDonnell - Kansas City MO
• Summer IT Intern, Union Pacific - Omaha NE
• Software Design Engineer Intern, LI-COR Biosciences - Lincoln NE
• Electrical Project Engineer Intern, Nebraska Public Power District - Lincoln NE
• NASA Summer Intern, NASA - Johnson Space Center - Houston TX
• Electrical Engineering Co-op, OPPD - Omaha NE
• Software Engineer, Avionics Interface Technologies - Elkhorn NE
• Electronics Modules Engineer, Textron Aviation - Wichita KS
• Electrical Engineering Co-op, Lincoln Electric System - Lincoln NE
• Electrical Engineering Co-op, National Renewable Energy Lab - Golden CO
• Electrical Engineering Intern, Becton Dickinson - Broken Bow NE
• Energy Sciences Research Summer Internship, Nebraska Center for Energy Sciences Research - Lincoln NE
• Electrical Intern, Davis Design - Lincoln NE
• Electrical Engineering Co-op, Altec Industries - St. Joseph MO
• Electrical Engineer Intern, Black & Veatch Corporation - Overland Park KS
• Research & Development Intern, J.A. Woollam Company - Lincoln NE
• Electrical Engineering Intern, Textron Aviation-Cessna Brand - Wichita KS
• Electrical Engineering Co-op, General Electric - Atlanta GA
• Intern, ARUP - New York NY
• Intern, Sandhills Publishing - Lincoln NE
• Student Technician/Power Electrical Team, Olsson Associates - Lincoln NE
• Electrical Engineering Co-op, NASA - Marshall Space Flight Center - Huntsville AL
• Quality Engineering Intern, Schneider Electric - Lincoln NE
• Electrical Engineering Co-op, Communication Systems Solutions - Lincoln NE
• Research and Development Intern, Vishay - Columbus NE

Graduate & Professional Schools
• Electrical Engineering, Ph.D., University of Nebraska-Lincoln - Lincoln NE
• Juris Doctor, University of Nebraska-Lincoln - Lincoln NE
• Electrical Engineering, Ph.D., Stanford University - Palo Alto CA
• Robotics Engineering, M.S., Northwestern - Evanston IL
• Masters of Electrical Engineering, Rice University - Houston TX
• Biomedical Engineering, Ph.D., University of Nebraska-Lincoln - Lincoln NE
• Electrical Engineering Systems, Ph.D., University of Michigan - Ann Arbor MI
• Electrical Engineering, M.S., University of Southern California - Los Angeles CA
• Computer Science, Ph.D., University of Colorado - Boulder CO
• Masters of Business Administration, University of Nebraska-Lincoln - Lincoln NE
• Energy Systems, M.S., Northeastern University - Boston MA
• Electrical Engineering, M.S., University of Kansas - Lawrence KS
• Masters of Business Administration, University of Nebraska Omaha - Omaha NE
• Agricultural and Biological Systems Engineering, M.S., University of Nebraska-Lincoln - Lincoln NE
• Electrical Engineering, M.S., Purdue University - West Lafayette IN
• Electrical Engineering, Ph.D., Syracuse University - Syracuse NY