ELECTRICAL ENGINEERING

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

Electrical engineering is concerned with the production, transmission, and utilization of electrical energy and the transmission and processing of information. 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, nanostructures research, electro-optics 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

Requirements for admission to the Department of Electrical and Computer Engineering will be granted if he/she has:

- maintained a cumulative GPA of at least 2.4 and is in good standing in the College of Engineering, and,
- completed ECEN 215 Electronics and Circuits I and ECEN 216 Electronics and Circuits II with a grade of C or better.

A transfer student will be admitted if he/she has:

- completed courses equivalent to ECEN 215 and ECEN 216 at other institutions with acceptable transfer grades of C or better, and,
- a GPA of 2.4 or better during their first 12 credit hours in electrical engineering course work at UNL.

Transfer students will be able to appeal to the advisors for admission if they fail to meet the GPA requirement for an additional semester.

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. 4 units of mathematics: 2 of algebra, 1 of geometry, 1 of precalculus and trigonometry.
2. 4 units of English.
3. 3 units of natural science that must include 1 unit of physics and 1 unit of chemistry (chemistry requirement waived for students in construction management).
4. 2 units of a single foreign language.
5. 3 units of social studies.
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 UNL 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 UNL.

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 for Nebraska residents or 3.0 for non-residents, and be calculus-ready. Students not meeting either
of these requirements must enroll in the Explore Center or another UNL college until they meet COE admission requirements.

The COE accepts courses for transfer for which a C or better grade was received. Although UNL 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 UNL. Upon admission to UNL, students wishing to pursue degree programs in the COE will be classified and subject to the policies defined in the subsequent section.

**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 UNL. In consultation with advisors, a student may choose to follow a subsequent catalog for any academic year in which they are admitted to and enrolled as a degree-seeking student at UNL in the College of 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**

At the time of graduation, students in the electrical engineering program will have achieved the following:

1. An ability to apply knowledge of mathematics, science, and engineering. (a)
2. An ability to design and conduct experiments, as well as to analyze and interpret data. (b)
3. An ability to design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. (c)
4. An ability to function on multidisciplinary teams. (d)
5. An ability to identify, formulate, and solve engineering problems. (e)
6. An understanding of professional and ethical responsibility. (f)
7. An ability to communicate effectively. (g)
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. (h)
9. A recognition of the need for, and an ability to engage in lifelong learning. (i)
10. A knowledge of contemporary issues. (j)
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. (k)

**Major Requirements**

**Requirements for the Degree**

**First Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 121</td>
<td>Introduction to Electrical Engineering I</td>
<td>3</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>
</tbody>
</table>

**Science Elective**

Select 4 credit hours of science elective of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 109</td>
<td>General Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>or CHEM 111</td>
<td>Chemistry for Engineering and Technology</td>
<td>4</td>
</tr>
<tr>
<td>or CHEM 113</td>
<td>Fundamental Chemistry I</td>
<td>4</td>
</tr>
</tbody>
</table>

**Second Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 122</td>
<td>Introduction to Electrical Engineering II</td>
<td>3</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>

**Computer Programming Elective**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCE 155E</td>
<td>Computer Science I: Systems Engineering Focus</td>
<td>3</td>
</tr>
</tbody>
</table>

**Third Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 215</td>
<td>Electronics and Circuits I</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 235</td>
<td>Introductory Electrical Laboratory I</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 20</td>
<td>Sophomore Engineering Seminar</td>
<td>0</td>
</tr>
<tr>
<td>MATH 208</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 212</td>
<td>General Physics II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 222</td>
<td>General Physics Laboratory II</td>
<td>1</td>
</tr>
</tbody>
</table>

**Communications Elective**

Select one of the following to meet both ACE 1 and 2:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>JGEN 200</td>
<td>Technical Communication I</td>
<td>3</td>
</tr>
<tr>
<td>JGEN 300</td>
<td>Technical Communication II</td>
<td>3</td>
</tr>
<tr>
<td>COMM 286</td>
<td>Business and Professional Communication</td>
<td>3</td>
</tr>
</tbody>
</table>

**Fourth Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 216</td>
<td>Electronics and Circuits II</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 220</td>
<td>Introduction to Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 236</td>
<td>Introductory Electrical Laboratory II</td>
<td>3</td>
</tr>
<tr>
<td>MATH 221</td>
<td>Differential Equations</td>
<td>3</td>
</tr>
</tbody>
</table>

**Science Elective**

Select at least 3 credit hours of science elective of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 109</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>or CHEM 111</td>
<td>Chemistry for Engineering and Technology</td>
<td>3</td>
</tr>
</tbody>
</table>
Electrical Engineering

or CHEM 113

LIFE 120 & LIFE 120L

MATH 314

PHYS 213

ACE Elective

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

Credit Hours Subtotal: 16

Fifth Semester

ECEN 304

ECEN 307

ECEN 316

ECEN 370

ECEN 398

ACE Elective

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

Credit Hours Subtotal: 15

Sixth Semester

ECEN 305

ECEN 306

ECEN 398

Technical Electives

Communications Elective

Select one of the following to meet both ACE 1 and 2:

JGEN 200

JGEN 300

COMM 286

Credit Hours Subtotal: 16

Seventh Semester

ECEN 494

Technical Electives

ACE Elective

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

Credit Hours Subtotal: 17

Eighth Semester

ECEN 495

Technical Electives

ACE Elective

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

Credit Hours Subtotal: 15

Total Credit Hours 124

Technical Electives

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

**Electrical Engineering Emphasis Areas**

1. Communications and Signal Processing
2. Electromagnetic Fields and Optics
3. Electronics
4. Energy and Power Systems
5. Materials and Devices
6. Bioengineering
7. Modeling and Simulation
8. 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 & 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

ECEN 468 Microwave Engineering 3

ECEN 479 Optical Fiber Communications 4

ECEN 480 Introduction to Lasers and Laser Applications 3

ECEN 486 Applied Photonics 3

**Electronics**

ECEN 361 Advanced Electronics and Circuits (Core Course) 3

ECEN 362 Data and Telecommunications Transceivers 4

ECEN 462 Communication Systems 3

ECEN 469 Analog Integrated Circuits 3

ECEN 470 Digital and Analog VLSI Design 3

ECEN 474 Digital Systems (Core Course) 3

**Energy and Power Systems**

ECEN 338 Introduction to Power and Energy Systems (Core Course) 3

ECEN 406 Power Systems Analysis 3

ECEN 428 Power Electronics (Core Course) 3

ECEN 430 Wind Energy 3

ECEN 436 Electric Machines 3

ECEN 444 Linear Control Systems 3

ECEN 498 Special Topics in Electrical Engineering IV (Solar Energy) 1-6

**Materials and Devices**

ECEN 417 Semiconductor Fundamentals II 3
Allowed 100- and 200-Level Technical Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 420</td>
<td>Plasma Processing of Semiconductors</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 421</td>
<td>Principles of Semiconductor Materials and Devices I (Core Course)</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 422</td>
<td>Introduction to Physics and Chemistry of Solids</td>
<td>3</td>
</tr>
<tr>
<td>Bioengineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECEN 450</td>
<td>Bioinformatics (Core Course)</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 460</td>
<td>Labview Programming</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 498</td>
<td>Special Topics in Electrical Engineering IV (Computational and Systems Biology)</td>
<td>1-6</td>
</tr>
<tr>
<td>ECEN 498</td>
<td>Special Topics in Electrical Engineering IV (Bioengineering Image and Signal Processing)</td>
<td>1-6</td>
</tr>
<tr>
<td>Modeling and Simulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECEN 398</td>
<td>Special Topics in Electrical Engineering III (Computational Modeling and Simulation: Discrete Systems-Core Course)</td>
<td>1-6</td>
</tr>
<tr>
<td>ECEN 448</td>
<td>Decision Analysis</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 498</td>
<td>Special Topics in Electrical Engineering IV (Computational Modeling and Simulation: Continuous Systems)</td>
<td>1-6</td>
</tr>
<tr>
<td>Telecommunications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECEN 362</td>
<td>Data and Telecommunications Transceivers</td>
<td>4</td>
</tr>
<tr>
<td>ECEN 464</td>
<td>Digital Communication Systems (Core Course)</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 466</td>
<td>Telecommunications Engineering I (Core Course)</td>
<td>4</td>
</tr>
</tbody>
</table>

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 areas 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 UNL, or in the Departments of Biological Sciences, Chemistry, Computer Science and Engineering, Mathematics, Statistics, or Physics and Astronomy at UNL.

Not Allowed 300- and 400-Level Technical Electives

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS 310</td>
<td>School of Biological Sciences Seminar</td>
<td>1</td>
</tr>
<tr>
<td>MATH 495</td>
<td>Seminar</td>
<td>1-3</td>
</tr>
<tr>
<td>MATH 496</td>
<td>Seminar in Mathematics</td>
<td>1-3</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>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGEN 225</td>
<td>Engineering Properties of Biological</td>
<td>3</td>
</tr>
<tr>
<td>BSEN 225</td>
<td>Materials</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Prerequisites</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ECEN 102</td>
<td>Introduction to Electrical Engineering</td>
<td>Open to first year students only or by permission.</td>
</tr>
<tr>
<td>ECEN 103</td>
<td>Electrical and Computer Engineering Fundamentals</td>
<td>MATH 106/108H or (UNO) MATH 1950, or parallel.</td>
</tr>
<tr>
<td>ECEN 106</td>
<td>Microprocessor Applications</td>
<td>ECEN 103 or (UNO) ECEN 1030; CSCE 155A, 155E, 155H, 155N, 155T or (UNO) CIST 1400.</td>
</tr>
<tr>
<td>ECEN 121</td>
<td>Introduction to Electrical Engineering I</td>
<td>ECEN 103 or (UNO) ECEN 1030; ECEN 225 or (UNO) ECEN 225</td>
</tr>
<tr>
<td>ECEN 122</td>
<td>Introduction to Electrical Engineering II</td>
<td>ECEN 103 or (UNO) ECEN 1030; ECEN 225 or (UNO) ECEN 225</td>
</tr>
<tr>
<td>ECEN 123</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td>ECEN 103 or (UNO) ECEN 1030; CSCE 155A/CSCE 155E/ (UNO) CIST 1400 or parallel.</td>
</tr>
</tbody>
</table>

**ECEN 192 Individual Study in Computer and Electronics Engineering I**

**Notes:** ECEN 192 (UNO - ECEN 1920) 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

**Format:** IND

**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:** 6

**Format:** LEC

**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

**Format:** LEC

**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

**Format:** LEC

**Prerequisite for:** AGEN 325, BSEN 325; ECEN 231; MECH 350

**ECEN 213 Electrical Circuits I**

**Prerequisites:** ECEN 103 or (UNO) ECEN 1030; ECEN 225 or (UNO) ECEN 2500; MATH 221/221H/821 or

**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

**Format:** LEC

**Prerequisite for:** ECEN 217; ECEN 218; ECEN 222
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Format</th>
<th>Max credits per semester</th>
<th>Max credits per degree</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 214</td>
<td>Electrical Circuits II</td>
<td>ECEN 213 or (UNO) ECEN 2130; ECEN 218 or (UNO) ECEN 2184; (UNO) MATH 2050 or parallel.</td>
<td>LEC</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>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.</td>
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<tr>
<td>ECEN 215</td>
<td>Electronics and Circuits I</td>
<td>Prerequisite or parallel: MATH 208/(UNO) MATH 1970.</td>
<td>LEC</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 216</td>
<td>Electronics and Circuits II</td>
<td>ECEN 215/(UNO) ECEN 2150 with a grade of &quot;C&quot; or better.</td>
<td>LEC</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 217</td>
<td>Electrical Circuits III</td>
<td>ECEN 213 or (UNO) ECEN 2130</td>
<td>LEC</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Notes: This course is for computer engineering majors only.</td>
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<tr>
<td></td>
<td>Description: Analysis of first and second order RLC circuits using differential equations and Laplace transforms. Variable frequency network performance analysis.</td>
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</tr>
<tr>
<td>ECEN 218</td>
<td>Electrical Circuits Laboratory</td>
<td>ECEN 213/(UNO) ECEN 2130 or parallel.</td>
<td>LEC</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Notes: ECEN 218/(UNO) ECEN 2184 is a lab to accompany ECEN 213/(UNO) ECEN 2130.</td>
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<tr>
<td></td>
<td>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.</td>
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<tr>
<td>ECEN 219</td>
<td>Introduction to Embedded Systems</td>
<td>Prerequisites: ECEN 304; ECEN 338; ECEN 355</td>
<td>LEC</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>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.</td>
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</tr>
<tr>
<td>ECEN 220</td>
<td>Electronic Circuits I</td>
<td>Prerequisite or parallel: MATH 208/(UNO) MATH 1970.</td>
<td>LEC</td>
<td>4</td>
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<td></td>
<td>Description: Analysis and design of modern electronic circuits. Diode circuits, bipolar and field effect transistor switching and amplifier circuits, and operational amplifier circuits.</td>
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<tr>
<td>ECEN 224</td>
<td>Introduction to Signal Processing</td>
<td>ECEN 106 or (UNO) ECEN 1060; CSCE 155A, 155E, 155H, 155N, 155T or (UNO) CIST 1400; MATH 107/107H or (UNO) MATH 1960.</td>
<td>LEC</td>
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<td>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.</td>
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<tr>
<td>ECEN 225</td>
<td>Electrical and Computer Engineering Seminar</td>
<td>ECEN 103 or (UNO) ECEN 1030 or parallel</td>
<td>LEC</td>
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<td>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.</td>
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<tr>
<td>ECEN 231</td>
<td>Electrical Engineering Laboratory</td>
<td>Prerequisite or parallel: ECEN 211/(UNO) ECEN 2110.</td>
<td>LAB</td>
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<td>Description: Laboratory accompanying ECEN 211/(UNO) ECEN 2110.</td>
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</table>
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
Format: LAB
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
Format: LAB
Prerequisite for: ECEN 307

ECEN 292 Individual Study in Electrical and Computer Engineering II
Prerequisites: Sophomore standing.
Notes: ECEN 292 (UNO - ECEN 2920) 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
Format: IND

ECEN 294 Special Topics in Electrical and Computer Engineering II
Prerequisites: Sophomore 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
Format: LEC

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
Format: LEC

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
Format: LEC
Prerequisite for: ECEN 305

ECEN 305 Probability Theory and Statistics for Electrical and Computer Engineers
Prerequisites: ECEN 304/(UNO) ECEN 3040.
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
Format: LEC
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
Format: LEC
Prerequisite for: ECEN 347

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
Format: LAB
Offered: FALL/SPR
Prerequisite for: ECEN 327
ECEN 310 Digital Design and Interfacing
Prerequisites: ECEN 222/(UNO) ECEN 2220; ECEN 313/(UNO) ECEN 3130, or parallel.
Notes: ECEN 310/3100 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
Format: LEC

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
Format: LEC
Prerequisite for: ECEN 310; ECEN 496

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
Format: LEC
Prerequisite for: ECEN 347

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
Format: LAB
Prerequisite for: ECEN 494

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
Format: LEC

ECEN 327 Discrete Systems Laboratory
Prerequisites: ECEN 106/1060 or ECEN 220/2200 and ECEN 307/3074
Description: Laboratory work on discrete systems.
Credit Hours: 1
Max credits per semester: 1
Max credits per degree: 1
Format: LAB

ECEN 328 Applied Fields and Lines I
Prerequisites: MATH 208/208H or (UNO) MATH 1970; MATH 221/221 or (UNO) MATH 2350.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
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
Format: LEC

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
Format: LAB

ECEN 333 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
Format: LAB

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
Format: LEC
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
Format: LEC

ECEN 347 Electrical Engineering Laboratory II
Prerequisites: ECEN 306/3060 or ECEN 3280 and ECEN 316/3160 or ECEN 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
Format: LAB

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
Format: IND

ECEN 352 Electronics Circuits II
Prerequisites: CEEN 222/(UNO) ECEN 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
Format: LEC
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
Format: LEC

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
Format: LEC
Prerequisite for: ECEN 361

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
Format: LEC

ECEN 370 Digital Logic Design
Crosslisted with: CSCE 335
Prerequisites: ECEN 121/(UNO) ECEN 1210 or CSCE 230
Description: Combinational and sequential logic circuits. MSI chips, programmable logic devices (PAL, ROM, PLA) used to design combinational and sequential circuits. CAD tools. LSI and PLD components and their use. Hardware design experience.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
Prerequisite for: ECEN 307

ECEN 392 Individual Study in Electrical and Computer Engineering III
Prerequisites: Junior standing.
Notes: ECEN 392 (UNO - ECEN 3920) 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
Format: IND

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
Format: LEC
ECEN 398 Special Topics in Electrical Engineering III
Prerequisites: Permission.
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
Format: LEC

ECEN 399 Undergraduate Research
Prerequisites: Electrical engineering seniors or approval.
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
Format: IND

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
Format: IND

ECEN 400 Electronic Instrumentation
Crosslisted with: ECEN 800
Prerequisites: Senior standing in engineering or permission.
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
Format: LEC

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 view point), voltage control system, high voltage DC transmission, and system protection.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
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
Format: LEC

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
Format: LEC

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
Format: LEC
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
Format: LEC

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
Format: LEC
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  
Format: LEC

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  
Format: LEC

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, or permission.  
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  
Format: LEC

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  
Format: LEC  
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  
Format: LEC  
Prerequisite for: ECEN 932

ECEN 430 Wind Energy  
Crosslisted with: ECEN 830  
Prerequisites: Senior standing or permission  
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  
Format: LEC

ECEN 433 Microprocessor System Design  
Crosslisted with: ECEN 833  
Prerequisites: ECEN 433/833 or (UNO) ECEN 4330/8336 with a grade of "C" or better; STAT/MATH 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  
Format: LEC  
Offered: FALL/SPR

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/MATH 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  
Format: LEC  
Offered: FALL/SPR  
Prerequisite for: ECEN 496

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  
Format: LEC  
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
Format: LEC

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
Format: LEC

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
Format: LEC

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 ecision 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
Format: LEC

ECEN 450 Bioinformatics
Crosslisted with: ECEN 850
Prerequisites: Computer programming language and ECEN 305/(UNO) ECEN 3050 or IMSE 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
Format: LEC

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
Format: LEC

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
Format: LEC

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
Format: LEC

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
Format: LEC

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
Format: LEC
Offered: FALL/SPR
Prerequisite for: 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
Format: LEC
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
Format: LEC
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
Format: LEC
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
Format: LEC

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: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
Prerequisite for: ECEN 496

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
Format: LEC
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
Format: LEC
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
Format: LEC
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
Format: LEC

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
Format: LEC
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
Format: LEC

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
Format: LEC
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
Format: LEC

ECEN 476 Wireless Communications
Crosslisted with: ECEN 876
Prerequisites: Permission.
Description: The fundamental concepts of wireless communications. Basic communications concepts such as multiple access and spectrum. Propagation, radio standards and internetworking. Current issues in wireless communications.
Credit Hours: 3
Max credits per semester: 3
Max credits per degree: 3
Format: LEC
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
Format: LEC

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
Format: LEC
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
Format: LEC

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
Format: LEC

ECEN 484 Network Security
Crosslisted with: ECEN 884
Prerequisites: ECEN 325 or (UNO) ECEN 3250
Description: Network security and cryptographic protocols. Classical encryption techniques, block ciphers and stream ciphers, public-key cryptography, authentications digital signatures, key management and distributions, network vulnerabilities, transport-level security, IP security.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC
ECEN 486 Applied Photonics
Crosslisted with: ECEN 886
Prerequisites: ECEN 306/(UNO) ECEN 3060 or permission
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
Format: LEC
Prerequisite for: ECEN 986

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 multi-hop wireless networks.
Credit Hours: 4
Max credits per semester: 4
Max credits per degree: 4
Format: LEC

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
Format: LEC

ECEN 492 Individual Study in Electrical and Computer Engineering IV
Crosslisted with: ECEN 892
Prerequisites: Senior standing
Notes: ECEN 492 (UNO - ECEN 4920) 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
Format: IND

ECEN 494 Capstone I
Prerequisites: ECEN 317/(UNO) ECEN 3170 or (UNO) ECEN 2220 and (UNO) ECEN 3040 and (UNO) ECEN 3060 and (UNO) ECEN 3130; completed ACE 1 requirement or (UNO) ENGL 3980 or permission; admission to the College of Engineering.
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
Format: LEC
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. A project that meets specifications and that is completed according to a pre-determined schedule and within budget. 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
Format: LEC

ECEN 496 Capstone I
Prerequisites: ECEN 313/(UNO) ECEN 3130 with a grade of "C" or better; ECEN 435/835/(UNO) ECEN 4350/8356 or ECEN 466/866/(UNO) ECEN 4660/8666, or parallel; and JGEN 300 or (UNO) ENGL 3980.
Notes: For Computer Engineering and Electronics Engineering students.
Description: Preliminary investigation into topics for the capstone course. Defining deliverables, scheduling, interdisciplinary team design.
Credit Hours: 2
Max credits per semester: 2
Max credits per degree: 2
Format: LEC
Offered: FALL
Prerequisite for: ECEN 499

ECEN 498 Special Topics in Electrical Engineering IV
Crosslisted with: ECEN 898
Prerequisites: Permission.
Notes: ECEN 498/898 (UNO ECEN 4980/8986) is 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
Format: LEC
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  
**Format:** IND  
**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  
**Format:** IND

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

**Icon Legend: Critical**

### 15 HR TERM 1

**Engr Seminar**  
complete ENGR10#  
**0hr**  
ENGR 10 becomes critical to your success in the major if not completed by the end of the first term of enrollment.

**Intro Electrical Engr**  
complete ECEN 121  
**3hr**  
ECEN 121 becomes critical to your success in the major if not completed by the end of the first term of enrollment.

**ACE 3 Mathematics**  
complete MATH 106

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### 14 HR TERM 2

**Intro Electrical Engr**  
complete ECEN 122  
**3hr**  
ECEN 122 becomes critical to your success in the major if not completed by the end of the third term of enrollment.

**ACE 4 Science Elect Reqd**  
complete 1 from CHEM 109, CHEM 113, LIFE 120, LIFE 120L, PHYS 213  
**4hr**

**ACE 5 Humanities**  
complete 1 from ACE5  
**3hr**  
Complete an ACE 5, 6, 7, 8, or 9 requirement this term.

**Math And Physics II**  
complete MATH 107  
**4hr**  
MATH 107 is critical to your success in the major if not completed by the end of the third term of enrollment.

**ACE 4 Physics Reqd**  
complete PHYS 211  
**4hr**

**Computer Prog Elect**  
complete CSCE 155E  
**3hr**  
CSCE 155E becomes critical to your success in the major if not completed by the end of the third term of enrollment.

### 18 HR TERM 3

**Electronics and Circuits**  
complete ECEN 215  
**3hr**  
ECEN 215 becomes critical to your success in the major if not completed by the end of the fourth term.
Electrical Engineering Topics
complete ECEN 235
3hr

Engr Seminar
complete ENGR20#
0hr
ENGR 20 becomes critical to your success in the major if not completed by the end of the fifth term of enrollment.

ACE 3 Mathematics
complete MATH 208
4hr

Math And Physics II
complete PHYS 212
4hr
PHYS 212 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

ACE 4 Physics Reqd
complete PHYS 222
1hr

ACE 2 Oral Comm
complete either COMM 286 or JGEN 300
3hr

16 HR TERM 4
Electronics and Circuits
complete ECEN 216
3hr
ECEN 216 becomes critical to your success in the major if not completed by the end of the fifth term of enrollment.

Intro Electrical Engr
complete ECEN 220
3hr
ECEN 220 becomes critical to your success in the major if not completed by the end of the fifth term of enrollment.

Electrical Engineering Topics
complete ECEN 236
1hr

Math And Physics II
complete MATH 221
3hr
MATH 221 becomes critical to your success in the major if not completed by the end of the fourth term of enrollment.

ACE 4 Science Elect Reqd
complete 1 from ACE6, CHEM 109, CHEM 113, LIFE 120, LIFE 120L, PHYS 213
3hr

ACE 6 Social Sciences
complete 1 from ACE6
3hr
Complete an ACE 5, 6, 7, 8, or 9 requirement this term.

17 HR TERM 5
Electronics and Circuits
complete ECEN 304
3hr
ECEN 304 becomes critical to your success in the major if not completed by the end of the sixth term of enrollment.

ELEC Tech Elect 27 Hrs
recommend 1 or more courses
3hr
See department website for approved courses.

ACE 7 Arts
complete 1 from ACE7
3hr
Complete an ACE 5, 6, 7, 8, or 9 requirement this term.

**Milestones**

1. Professional Admission into College.

**17 HR TERM 6**

**Elec Engineering Topics**

complete ECEN 305, ECEN 306, ECEN 317

**ELEC Tech Elect 27 Hrs**

recommend 1 or more courses

See department website for approved courses.

**ACE 1 Written**

complete JGEN 200

**14 HR TERM 7**

**Senior Design**

complete ECEN 494

ECEN 494 becomes critical to your success in the major if not completed by the end of the seventh term of enrollment.

**ELEC Tech Elect 27 Hrs**

recommend 1 or more courses

See department website for approved courses.

**ACE 8 Ethical Principles**

complete 1 from ACE8

Complete an ACE 5, 6, 7, 8, or 9 requirement this term.

**15 HR TERM 8**

**Senior Design**

complete ECEN 495

ECEN 495 becomes critical to your success in the major if not completed by the end of the eighth term of enrollment.

**ELEC Tech Elect 27 Hrs**

recommend 1 or more courses

See department website for approved courses.

**ACE 9 Global/Human Divers**

complete 1 from ACE9

Complete an ACE 5, 6, 7, 8, or 9 requirement this term.

**Graduation Requirements**

1. 124 hours required for graduation.
2. 2.40 GPA required for graduation.
3. 30 of the last 36 hours must be taken at UNL/UNO.

**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**

- Engineering Leadership Program, National Instruments - Austin TX
- System Engineer, NASA Marshall Space Flight Center - Huntsville AL
- Embedded Systems Engineer, Lockheed Martin - Denver CO
- Orbital Vehicle Program Manager, United States Air Force - White Sands NM
- Functions Test Engineer, Kawasaki Manufacturing - Lincoln NE
- Controls Engineer, Cleaver-Brooks - Lincoln NE
- Operations Management Trainee, Union Pacific - Hermston OR
- Avionics Engineer, Textron Aviation - Wichita KS
- Electrical Engineer, Black & Veatch - Kansas City KS
- Protection and Controls Engineer, Lincoln Electric System - Lincoln NE

**Internships**

- Energy Sciences Research Summer Internship, Nebraska Center for Energy Sciences Research - Lincoln NE
- Electrical Engineer Intern, Black & Veatch Corporation - Overland Park KS
- Electrical Project Engineer Intern, Nebraska Public Power District - Lincoln NE
- Electrical Engineering Co-op, National Renewable Energy Lab - Golden CO
- Electrical Intern, Davis Design - Lincoln NE
- 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, LES - Lincoln NE
- Research Assistant, Nebraska Center for Energy Sciences Research - Lincoln NE
Grad Schools

- PhD in Electrical Engineering, University of Nebraska-Lincoln - Lincoln NE
- Juris Doctor, University of Nebraska-Lincoln - Lincoln NE
- Ph.D. in Electrical Engineering, Stanford University - Palo Alto CA
- Robotics Engineering, Northwestern - Evanston IL
- Masters of Electrical Engineering, Rice University - Houston TX
- Ph.D. in Biomedical Engineering, University of Nebraska-Lincoln - Lincoln NE
- Ph.D. in Electrical Engineering Systems, University of Michigan - Ann Arbor MI
- Electrical Engineering, M.S., University of Southern California - Los Angeles CA
- Ph.D. in Computer Science, University of Colorado - CO
- Masters of Business Administration, University of Nebraska at Omaha - Omaha NE