

**Electrical and Computer Engineering  
Undergraduate Advising Handbook  
for  
ECE Undergraduate Students<sup>1</sup>**

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<sup>1</sup>Revision Date: September 13, 2021

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## Introduction<sup>1</sup>

The School of Electrical and Computer Engineering (ECE) has compiled this advising handbook for undergraduate students to assist them with the selection of their courses and to help them complete their degree in a timely and orderly fashion. This handbook is not intended to replace or supersede the official degree sheets for the Bachelor of Science (BS) in Electrical Engineering (EE) or the BS in Computer Engineering (CpE) degree programs. The student is expected to meet all requirements listed on the official Degree Requirement Sheet corresponding to the year of matriculation. Per the University Catalog: **“The responsibility for satisfying all requirements for a degree rests with the student. Advisers, faculty members and administrators offer help to the student in meeting this responsibility.”**

Upon admission into ECE as either a new student or transfer student, a student is assigned an Academic Staff Adviser. That adviser will assist students with course selections, prerequisite compliance, degree audit, graduation requirements, and other nuances associated with the ECE programs. Once enrolled in ECEN 3714, Network Analysis, the student will also be assigned an ECE Faculty Adviser. Students are strongly encouraged to discuss with their faculty adviser all aspects of the ECE curriculum and inquire about the career and technologies of electrical engineering and/or computer engineering. The faculty adviser assignment can be found using Banner (<https://my.okstate.edu>).

Many lower division ECE courses have rigorous “C or better” prerequisites. For example, a “C” or better grade in ECEN 2714, MATH 2233, and PHYS 2114 is required to be enrolled in ECEN 3714. Students who do not satisfy such prerequisites will not be allowed to enroll in the intended course (e.g., ECEN 3714) or stay enrolled if they “slip” through the enrollment system. Students are strongly encouraged to review course listings in the *OSU General Catalog* to be fully informed about any course and its prerequisites.

Transfer students are encouraged to discuss previously completed courses taken at a non-OSU university with their academic adviser. Transferable courses are determined on a case-by-case basis unless an articulation agreement has been established between OSU and the non-OSU university. Students who wish to transfer a course as an equivalent ECEN course must have earned a “C” or better in that course and taken it from an ABET (or equivalent) accredited institution. In most cases, the School does not accept engineering technology courses.

Students pursuing the BS degree in Electrical Engineering (BSEE) are given the opportunity during their junior year and senior year to take courses that align with their personal interests and career goals. These “elective” courses cover many electrical engineering sub-disciplines including a) communications (Com), control systems, and digital signal processing (DSP), b) electric power

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<sup>1</sup> Revised September 13, 2021

and energy, c) computer architecture, embedded systems, and digital electronics, d) solid-state and analog electronics, and e) microwaves and photonics. ECE faculty can provide advice about the alignment of a student's career goals with any given sub-discipline. To facilitate a conversation between BSEE students and faculty, the following list provides a brief overview of each sub-discipline:

- Communications: wireless technologies, internet, information theory, data networks, encryption, security, digital and analog modulation, encoding and decoding, noise, telecommunications, GPS, internet-of-things
- Control Systems: Robotics, mechatronics, autonomous vehicles, embedded control, feedback, compensation, stability, neural networks, optimization, intelligent systems
- Digital Signal Processing: Machine vision, artificial intelligence, pattern and voice recognition, speech synthesis, video and image processing, digital filters, analog/digital interfaces, data mining, graphical processors
- Electric Power and Energy: Generation, transmission, electric machines, protection, smart and micro-grids, power electronics, electric drives, electro-mechanical transducers, sustainability, renewable energy, energy storage, reliability, batteries, energy conversion and transformation
- Computer Architecture, Embedded Systems, and Digital Electronics: Computer architectures, VLSI design, central and graphical processing units, networking, memory and storage devices, software engineering and coding, embedded controllers, computer arithmetic, internet-of-things, cloud computing, sequential and combinational logic, peripherals
- Solid-State and Analog Electronics: Transistors, diodes, semiconductors, microelectronics, transmitters, receivers, amplifiers, mixers, detectors, regulators, mixed-signal devices, filters, operational amplifiers, oscillators, instrumentation, high speed and low power devices, systems-on-a-chip
- Microwaves and Photonics: Radar, lasers, LIDAR, antennas, wireless transmission, fiber optics, THz communications, medical diagnostics and surgery, beamforming, wave scattering, electromagnetic interference, lumped and distributed circuits, optoelectronics, holography, LED's, photodetectors, imaging systems, spectroscopy

Students pursuing the BS degree in Computer Engineering (BSCpE) are by default taking a set of courses in Computer Architecture, Embedded Systems, and Digital Electronics with additional topics in computer science, including discrete mathematics, programming, data structures, and operating systems. Computer Engineering students have the opportunity to enroll in the Software Engineering Option (BSCpE+SOFT). This option adds three credit hours to the BSCpE degree program and specifies a total of 12 credit hours of software-specific courses that need to be taken.

Students also have the option to pursue a dual degree in electrical engineering and computer engineering (BSEE+BSCpE). This dual degree program requires 137 credit hours to complete (i.e.,

12 credit hours beyond the BSCpE program plus ENSC 2113, Statics). In principle, it can be completed in four years by taking approximately 17 credit hours each semester.

Likewise, Students can pursue a BSEE and BSCpE dual degree with a Software Engineering Option (BSEE+BSCpE+SOFT). This joint degree program requires 143 credit hours to complete. In principle, it can be completed in four years by taking approximately 18 credit hours each semester.

In addition to the dual degree program, the School also offers a “4+1” program that combines the BSEE or BSCpE program with the School’s Master of Engineering in Electrical Engineering (MEngEE) program. Effectively, this program adds 24 credit hours of graduate courses to the BSEE/BSCpE programs to obtain a BSEE/BSCpE degree and MEngEE degree, thus suggesting that the program requires four years to complete the BSEE/BSCpE degree and one year to complete the MEngEE degree (i.e., “4+1”). Specific details of the “4+1” program can be found on the web in the “Memorandum to Graduate Students”; see <https://ece.okstate.edu/>.

Students are highly encouraged to discuss the BSEE+BSCpE, BSCpE+SOFT, BSEE+BSCpE+SOFT, and “4+1” programs with their faculty and school advisers. These value-added programs have been devised to provide students a competitive edge in the workforce by giving them broader and deeper knowledge of the electrical and computer engineering disciplines.

Cooperative (co-op) experiences are oftentimes available that allow a student to earn credit towards their degree while being employed at a participating organization. Such experiences allow a student to be educated in a real-world setting about the engineering profession. When such experiences are available with participating organizations, students, with department permission, can enroll in ECEN 4030. The number of credit hours assigned to the co-op experience is determined on a case-by-case basis in accordance with the nature and duration of the proposed work. Department permission must be granted to enroll in co-op courses and to allow such courses to be applied to the degree requirements. Summer employment and/or internships do not necessarily qualify without preapproval from ECE.

Course advising sheets for ECE’s various degree programs are available in this Handbook. Flow charts are also provided to show how some of these programs can be potentially completed in four years.

This handbook also lists the 2000, 3000, and 4000 level courses offered by the ECE along with their corresponding course catalog entries. In most cases, the ECEN course numbering scheme adheres to the following algorithm: ECEN ABXY:

- A = 1 → Freshman Course
- A = 2 → Sophomore Course

- A = 3 → Junior Course
- A = 4 → Senior Course
- A = 5 → Graduate Course
- A = 6 → PhD Course
- B = 1 → Electric Power and Energy
- B = 2 → Computer Architecture, Embedded Systems, and Digital Electronic
- B = 3 → Solid-State and Analog Electronics
- B = 4 → Control Systems
- B = 5 → Communications
- B = 6 → Microwaves and Electromagnetics
- B = 7 → Signal Processing
- B = 8 → Photonics
- X = 1,2,...,9 for any given course in an area
- Y = Number of credit hours (CH)

For example, ECEN 4613 is a three credit hour, senior level course in the area of microwaves<sup>2</sup>.

A list of the ECE faculty is provided in this handbook along with their area of specialization. In general, all faculty will be able to advise any undergraduate student. However, students are encouraged to contact any faculty member to get detailed information about any area or course.

The number of occupations associated with electrical engineering or computer engineering is quite large—too large to tabulate within this document. However, some course lists are provided that may be applicable for various generic position titles. The courses on the list are suggested courses; students have the flexibility to pick and choose courses as they see fit in accordance with this handbook and the official degree sheets.

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<sup>2</sup> It should be noted that ECE is the name of the School (i.e., School of ECE); ECEN is the four letter OSU course prefix (e.g., ECEN 4613).

## Electrical Engineering (124 CH): Course Advising Sheet<sup>1</sup>

### I. Required Courses (91 CH):

- ENGL 1113, POLS 1113, HIST 1103, ENGL 3323
- ENGR 1111, ENSC 2113, ENSC 2611, IEM 3503
- CS1113, CS 2433
- MATH 2144, MATH 2153, MATH 2233, MATH 2163, MATH 3013
- CHEM 1414, PHYS 2014, PHYS 2114
- ECEN 2714, ECEN 3213, ECEN 3233, ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714, ECEN 3903, ECEN 4013, ECEN 4024, ECEN 4503

II. ECEN Junior Elective (3 CH): Choose one course from the following list. (Depending on departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices

III. ECEN Electives (18 CH): Choose six ECEN courses, not previously chosen, from the following list. (Depending on departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester. Note that ECEN 3723 is a prerequisite to ECEN 4413. All of other courses listed below only have required courses as prerequisites.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices
- ECEN 4133 - Power Electronics
- ECEN 4153 - Power System Analysis and Design
- ECEN 4213 - Embedded Computer Systems Design
- ECEN 4233 - High Speed Computer Arithmetic
- ECEN 4243 - Computer Architecture
- ECEN 4273 - Software Engineering
- ECEN 4283 - Computer Networks
- ECEN 4303 - Digital Integrated Circuit Design
- ECEN 4313 - Linear Electronics Circuit Design
- ECEN 4353 - Communication Electronics

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<sup>1</sup> Revision Date: September 13, 2021

- ECEN 4413 - Automatic Control Systems
- ECEN 4523 - Communication Theory
- ECEN 4533 - Data Communications
- ECEN 4613 - Microwave Engineering
- ECEN 4743 - Introduction to Biomedical Engineering Modeling and Systems
- ECEN 4763 - Introduction to Digital Signal Processing
- ECEN 4773 - Real Time Digital Signal Processing
- ECEN 4823 - Design of Optical Systems
- ECEN 4843 - Design of Lasers and Systems

IV. Controlled Elective (3 CH): Choose a) ENSC 2123, ENSC 2143, ENSC 2213, ENSC 3233, or ENSC 3313, or b) any course, 3000 level or above from ECEN, BAE, MAE, CIVE, IEM, PHYS, MATH, CHEM, STAT, or CS. Exclusions or with ECE approval (and in some cases, approval from other departments):

- All ENGR Courses
- ECEN 3020
- BAE 4001, BAE 4012, BAE 4400
- CHEM 4990
- CIVE 4010, CIVE 4041, CIVE 4043
- CS 3570, CS 4570, CS 4993
- IEM 4010, IEM 4020, IEM 4913, IEM 4931
- MAE 4010, MAE 4342, MAE 4344, MAE 4353, MAE 4354, MAE 4363, MAE 4374
- MATH 3403, MATH 3603, MATH 3910, MATH 3933, MATH 4033, MATH 4590, MATH 4900, MATH 4910
- PHYS 4010, PHYS 4712, PHYS 4993
- STAT 4053, STAT 4063, STAT 4910, STAT 4981, STAT 4991, STAT 4993

V. Humanities, Social Science, International, & Diversity Electives (9 CH): A total of at least 6 credits designated as “H” and 3 credits designated as “S” is required. Of these, 3 CH must meet the International Dimensions “I” component and 3 CH must meet the Diversity “D” component.

VI. Co-Op Experience (6 CH maximum): With department pre-approval, student may enroll in ECEN 4030 to get degree credit for their co-op experience. Depending on the agreement with a participating organization, a student may receive between one to six credit hours for their experience. Multiple experiences are allowed with permission. Up to three credit hours of co-op experience may be applied to the Controlled Elective degree requirement and up to an additional three credit hours of co-op experience may be applied to the ECEN Elective degree requirement for a maximum of six credit hours. Note: The Controlled Elective is satisfied first before the ECEN Elective requirement.



## **BSEE Program: Suggested Course Combinations for Various Job Titles<sup>1</sup>**

The following lists are suggested courses that a student may wish to take as electives for a given job title. Students, however, may mix and match courses as they see fit. Although the number of job titles is quite large, the following titles are representative of common titles found in industry and laboratories.

### **Communications Systems Engineer:**

- ECEN 3723, Systems I
- ECEN 4523, Communication Theory
- ECEN 4533, Data Communications
- ECEN 4763, Intro to Digital Signal Processing

### **Control Systems Engineer:**

- ECEN 3723, Systems I
- ECEN 4413, Automatic Control Systems (Prereq. ECEN 3723)
- ECEN 4763, Intro to Digital Signal Processing
- ECEN 4773, Real-Time Digital Signal Processing (Prereq. ECEN 4673)

### **Digital Hardware Designer and/or Computer Architect:**

- ECEN 4233, High-Speed Computer Arithmetic
- ECEN 4243, Computer Architecture
- ECEN 4303, Digital Integrated Circuits

### **Electronics Engineer:**

- ECEN 3723, Systems I
- ECEN 4303, Digital Integrated Circuit Design
- ECEN 4313, Linear Electronics Circuit Design
- ECEN 4353, Communication Electronics

### **Embedded or Computer Systems Engineer:**

- ECEN 4243, Computer Architecture
- ECEN 4273, Software Engineering
- ECEN 4213, Embedded Computer System Design
- ECEN 4283/CS 4283, Computer Networks

### **Microwave, Antenna or Radar Engineer:**

- ECEN 3623, Applied Fields and Waves II
- ECEN 4353, Communication Electronics

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<sup>1</sup> Created: September 13, 2021

- ECEN 4613, Microwave Engineering
- ECEN 4843, Design of Lasers and Systems

Optics and Photonics Engineer:

- ECEN 3623, Applied Fields and Waves II
- ECEN 3913, Solid State Electronic Devices
- ECEN 4613, Microwave Engineering
- ECEN 4843, Design of Lasers and Systems

Power Electronics Engineer

- ECEN 3113, Energy, Environment and Economics
- ECEN 3913, Solid State Electronic Devices
- ECEN 4133, Power Electronics
- ECEN 4153, Power System Analysis and Design

Power Systems Engineer:

- ECEN 3723, Systems I
- ECEN 3113, Energy, Environment and Economics
- ECEN 4133, Power Electronics
- ECEN 4153, Power System Analysis and Design

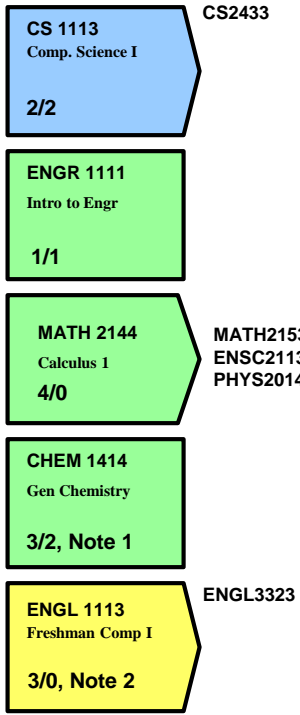
Radio Frequency (RF) Systems Engineer:

- ECEN 3723, Systems I
- ECEN 3623, Applied Fields and Waves II
- ECEN 4353, Communication Electronics
- ECEN 4613, Microwave Engineering

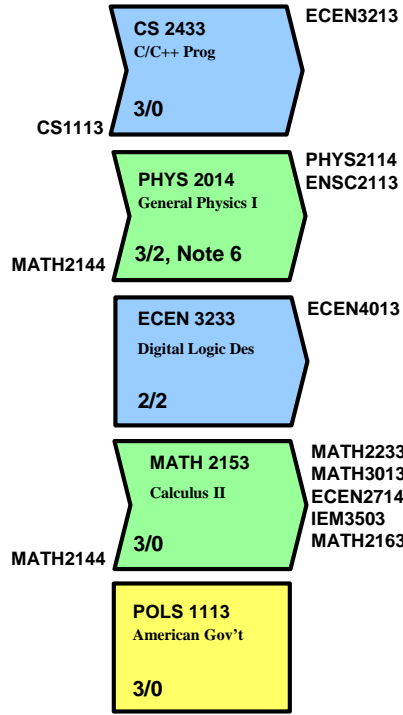
Signal Processing Engineer:

- ECEN 3723, Systems I
- ECEN 4743, Introduction Biomedical Engineering (Prereq. ECEN 4673)
- ECEN 4763, Introduction to Digital Signal Processing
- ECEN 4773, Real-Time Digital Signal Processing (Prereq. ECEN 4673)

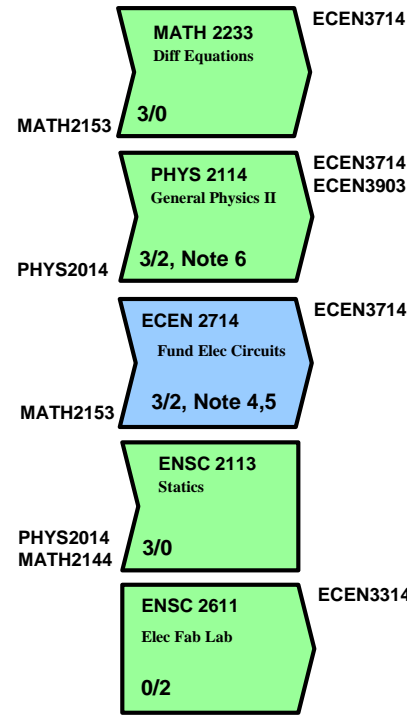
## Semester 1 15 Credit Hours



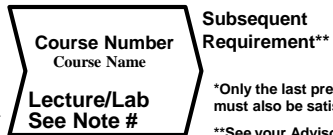
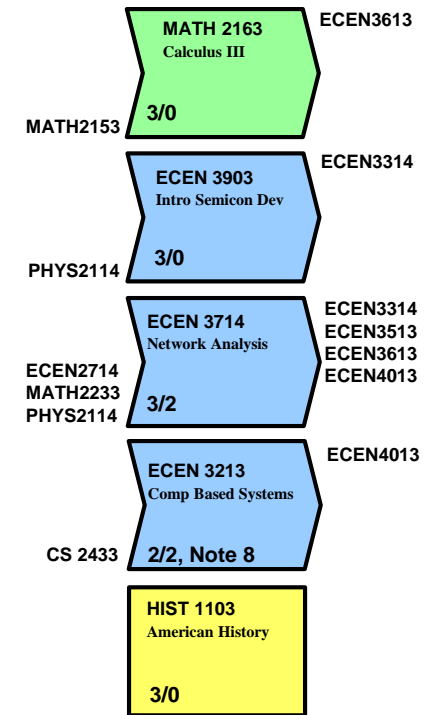
## Semester 2 16 Credit Hours



## Semester 3 15 Credit Hours



## Semester 4 16 Credit Hours



\*Only the last prerequisite in a sequence is listed. All earlier prerequisites must also be satisfied before taking the course.

\*\*See your Advisor, the ECE Advising Document, and Banner for additional information.

Prerequisites\*



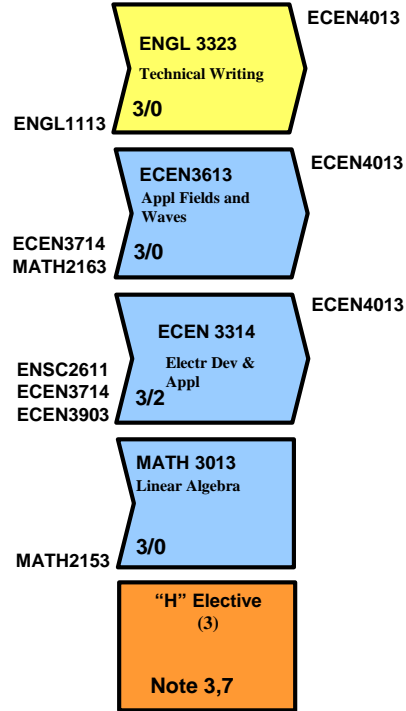
### Suggested Course Plan

The anticipation at OSU and most institutions of higher education is that for one semester credit hour (SCH) the student spends one hour per week in lecture (two for lab courses) and two hours studying outside of class (one for lab courses). A three credit hour class requires about nine hours per week. This study plan is recommended for students who will devote full time to university studies and do not have excessive extracurricular activities or other obligations.

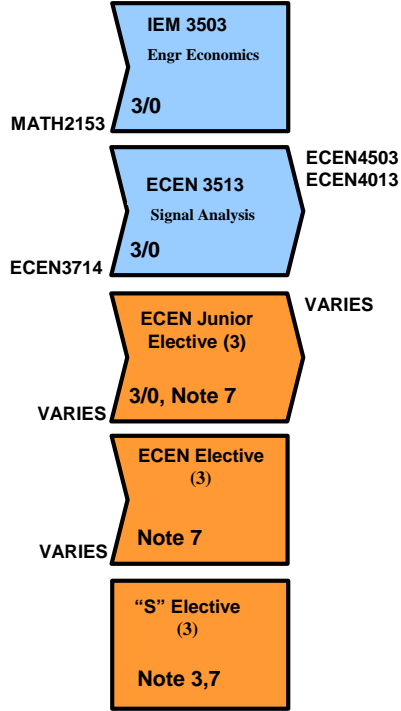
### NOTES:

- 1) CHEM 1515 may be substituted for CHEM 1414 and should be taken by all students considering medical school.
- 2) Students with less than a "B" in ENGL 1113 or 1313 must take ENGL 1213 or 1413 prior to ENGL 3323.
- 3) A total of at least 6 hours designated "H" and 3 hours designated "S" is required. Of these, 3 hrs must meet the International Dimension "I" component and 3 hrs must meet the Diversity "D" component.
- 4) ECEN 2714 replaces ENSC 2613 effective fall 2018.
- 5) MATH 2233 and PHYS 2114 must be taken prior to or at the same time as ECEN 2714.
- 6) General Physics I and II are key prerequisites and should be taken at the earliest possible time.
- 7) Must be at least 3 SCH.
- 8) ECEN 3213 replaces ENSC 3213.

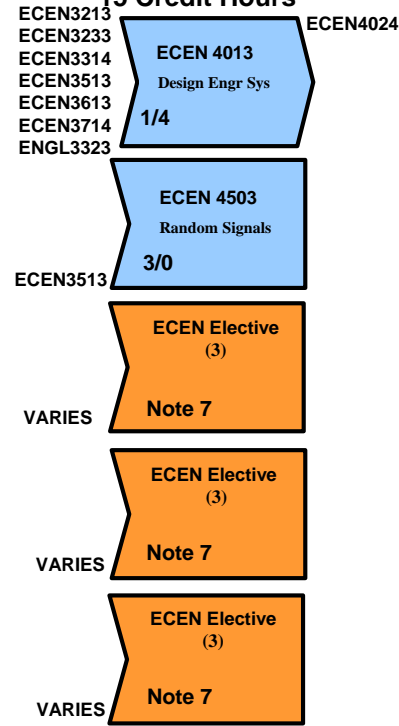
**Semester 5  
16 Credit Hours**



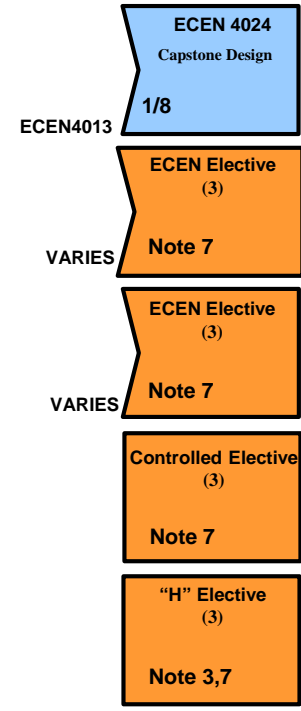
**Semester 6  
15 Credit Hours**



**Semester 7  
15 Credit Hours**



**Semester 8  
16 Credit Hours**

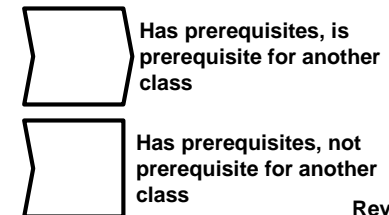
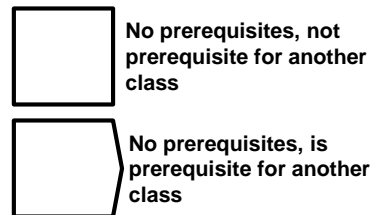


• This flowchart represents one path of many to graduation. Students are not required to follow the chart, but prerequisites limit path options.

• This flowchart is only an advising instrument. When conflicts occur, the official 2021-2022 Degree Requirement Sheet takes precedence. Always check for the most current version of this flowchart.

• Be sure to pay careful attention to the prerequisite requirements, grade requirements, and other official information on Banner. Some prerequisites also have minimum grade requirements. Grade requirements are not shown on this flowchart.

• Consult your Advisor if you have any questions or need clarification.



## Computer Engineering (125 CH): Course Advising Sheet<sup>1</sup>

### I. Required Courses (107 CH):

- ENGL 1113, POLS 1113, HIST 1103, ENGL 3323
- ENGR 1111, ENSC 2611, IEM 3503
- CS 1113, CS 2433, CS 2351, CS 3353, CS 3653; CS 4323 or ECEN 4283.
- MATH 2144, MATH 2153, MATH 2233, MATH 2163, MATH 3013
- CHEM 1414, PHYS 2014, PHYS 2114
- ECEN 2714, ECEN 3213, ECEN 3233, ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714, ECEN 3903, ECEN 4013, ECEN 4024, ECEN 4213, ECEN 4243, ECEN 4303, ECEN 4503

II ECEN Electives (6 CH): Choose two ECEN courses from the following list. (Depending on departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester. Note that ECEN 3723 is a prerequisite to ECEN 4413. All of other courses listed below only have required courses as prerequisites.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices
- ECEN 4133 - Power Electronics
- ECEN 4153 - Power System Analysis and Design
- ECEN 4273 - Software Engineering
- ECEN 4283 - Computer Networks
- ECEN 4313 - Linear Electronics Circuit Design
- ECEN 4353 - Communication Electronics
- ECEN 4413 - Automatic Control Systems
- ECEN 4523 - Communication Theory
- ECEN 4533 - Data Communications
- ECEN 4613 - Microwave Engineering
- ECEN 4743 - Introduction to Biomedical Engineering Modeling and Systems
- ECEN 4763 - Introduction to Digital Signal Processing
- ECEN 4773 - Real Time Digital Signal Processing
- ECEN 4823 - Design of Optical Systems
- ECEN 4843 - Design of Lasers and Systems

III. Controlled Elective (3 CH): Choose a) ENSC 2113, ENSC 2123, ENSC 2143, ENSC 2213, ENSC 3233, or ENSC 3313, or b) any course, 3000 level or above from ECEN, BAE, MAE, CIVE,

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<sup>1</sup> Revision Date: September 13, 2021

IEM, PHYS, MATH, CHEM, STAT, or CS. Exclusions or with ECE approval (and in some cases, approval from other departments):

- All ENGR Courses
- ECEN 3020
- BAE 4001, BAE 4012, BAE 4400
- CHEM 4990
- CIVE 4010, CIVE 4041, CIVE 4043
- CS 3570, CS 4570, CS 4993
- IEM 4010, IEM 4020, IEM 4913, IEM 4931
- MAE 4010, MAE 4342, MAE 4344, MAE 4353, MAE 4354, MAE 4363, MAE 4374
- MATH 3403, MATH 3603, MATH 3910, MATH 3933, MATH 4033, MATH 4590, MATH 4900, MATH 4910
- PHYS 4010, PHYS 4712, PHYS 4993
- STAT 4053, STAT 4063, STAT 4910, STAT 4981, STAT 4991, STAT 4993

IV. Humanities, Social Science, International, & Diversity Electives (9 CH): A total of at least 6 credits designated as “H” and 3 credits designated as “S” is required. Of these, 3 CH must meet the International Dimensions “I” component and 3 CH must meet the Diversity “D” component.

V. Co-Op Experience (6 CH maximum): With department pre-approval, student may enroll in ECEN 4030 to get degree credit for their co-op experience. Depending on the agreement with a participating organization, a student may receive between one to six credit hours for their experience. Multiple experiences are allowed with permission. Up to three credit hours of co-op experience may be applied to the Controlled Elective degree requirement and up to an additional three credit hours of co-op experience may be applied to the ECEN Elective degree requirement for a maximum of six credit hours. Note: The Controlled Elective is satisfied first before the ECEN Elective requirement.

## Semester 1 15 Credit Hours

**CS 1113**  
Comp. Science I  
2/2

CS2433  
CS2351

**ENGR 1111**  
Intro to Engr  
1/0

**MATH 2144**  
Calculus I  
4/0

MATH2153  
PHYS2014  
CS3653

**CHEM 1414**  
Gen Chemistry  
3/2, Note 1

**ENGL 1113**  
Freshman Comp I  
3/0, Note 2

ENGL3323

## Semester 2 17 Credit Hours

**CS 2433**  
C/C++ Prog  
3/0

CS1113

ECEN3213  
CS3353

**PHYS 2014**  
General Physics I  
3/2, Note 5

MATH2144

PHYS2114

**ECEN 3233**  
Digital Logic Des  
2/2

ECEN4213  
ECEN4243  
ECEN4013  
ECEN4303

**MATH 2153**  
Calculus II  
3/0

MATH2144

MATH2233  
MATH3013  
ECEN2714  
MATH2163  
IEM3503

**POLS 1113**  
American Gov't  
3/0

**CS 2351**  
UNIX Prog  
1/0

CS1113

## Semester 3 15 Credit Hours

**MATH 2233**  
Diff Equations  
3/0

MATH2153

ECEN3714

**PHYS 2114**  
General Physics II  
3/2, Note 5

PHYS2014

ECEN3714  
ECEN3903

**ECEN 2714**  
Fund Elec Circuits  
3/2, Note 4,7

MATH2153

ECEN3714

**CS 3653**  
Discrete Math  
3/0

MATH2144

CS3353

**ENSC 2611**  
Elec Fab Lab  
0/2

ECEN3314

## Semester 4 16 Credit Hours

**MATH 2163**  
Calculus III  
3/0

MATH2153

ECEN3613

**ECEN 3903**  
Intro Semicon Dev  
3/0

PHYS2114

ECEN3314

**ECEN 3714**  
Network Analysis  
3/2

ECEN2714  
MATH2233  
PHYS2114

ECEN3314  
ECEN3513  
ECEN3613  
ECEN4013

**ECEN 3213**  
Comp Based Systems  
2/2

CS2433

ECEN4013  
ECEN4243  
ECEN4213  
CS4323

**HIST 1103**  
American History  
3/0

Course Number  
Course Name

Subsequent Requirement\*\*

Lecture/Lab  
See Note #

Prerequisites\*

\*Only the last prerequisite in a sequence is listed. All earlier prerequisites must also be satisfied before taking the course.

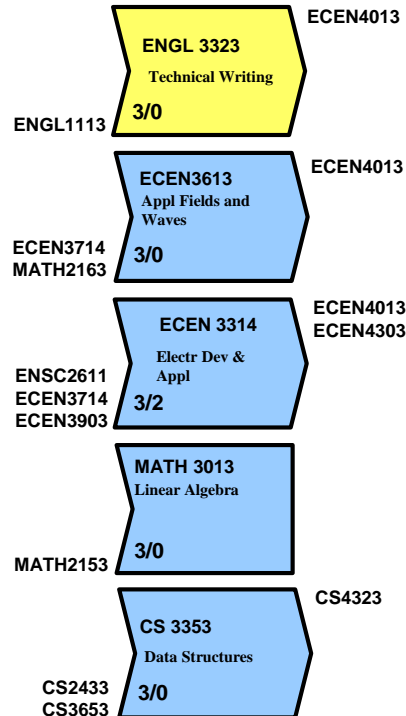
\*\*See your Advisor, the ECE Advising Document, and Banner for additional information.

OSU Requirement    CEAT Requirement    ECE Requirement    Elective

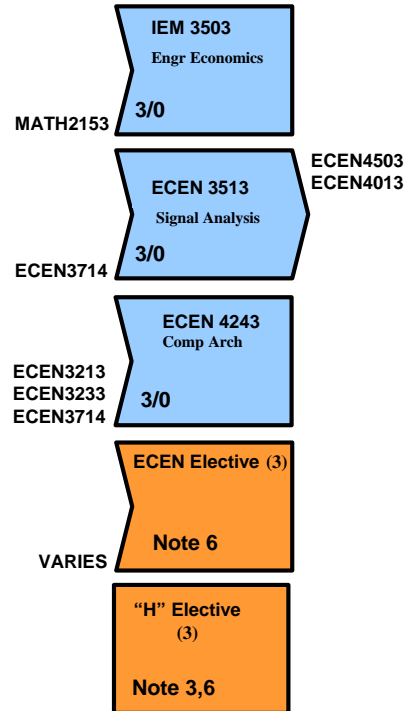
**Suggested Course Plan**  
The anticipation at OSU and most institutions of higher education is that for one semester credit hour (SCH) the student spends one hour per week in lecture (two for lab courses) and two hours studying outside of class (one for lab courses). A three credit hour class requires about nine hours per week. This study plan is recommended for students who will devote full time to university studies and do not have excessive extracurricular activities or other obligations.

- NOTES:**
- 1) CHEM 1515 may be substituted for CHEM 1414 and should be taken by all students considering medical school.
  - 2) Students with less than a "B" in ENGL 1113 or 1313 must take ENGL 1213 or 1413 prior to ENGL 3323.
  - 3) A total of at least 6 hours designated "H" and 3 hours designated "S" are required. Of these, 3 hrs must meet the International Dimension "I" component and 3 hrs must meet the Diversity "D" component.
  - 4) ECEN 2714 replaces ENSC 2613 effective fall 2018.
  - 5) General Physics I and II are key prerequisites and should be taken at the earliest possible time.
  - 6) Must be at least 3 SCH.
  - 7) MATH 2233 and PHYS 2114 must be taken prior to or at the same time as ECEN 2714.
  - 8) Either CS 4323 or ECEN 4283 (if not previously used) is acceptable. Refer to the CpE Course Advising Sheet.

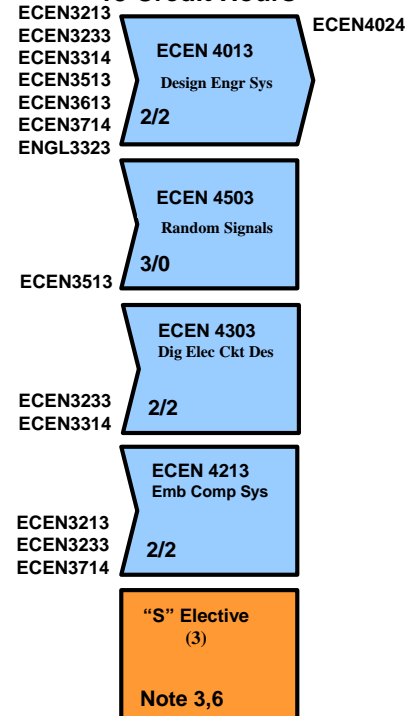
**Semester 5**  
**16 Credit Hours**



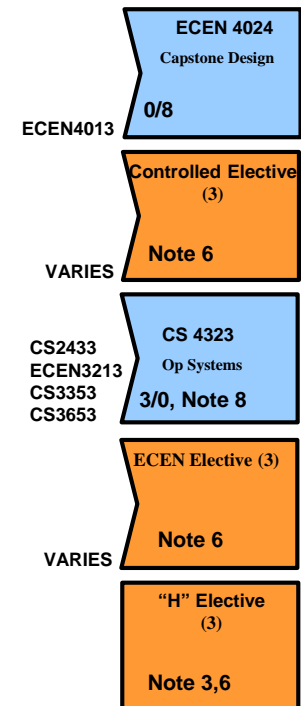
**Semester 6**  
**15 Credit Hours**



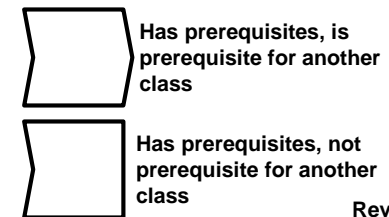
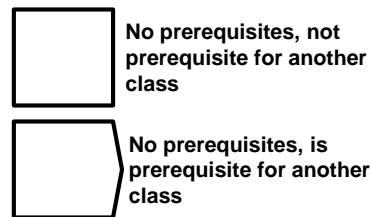
**Semester 7**  
**15 Credit Hours**



**Semester 8**  
**16 Credit Hours**



• This flowchart represents one path of many to graduation. Students are not required to follow the chart, but prerequisites limit path options.  
 • This flowchart is only an advising instrument. When conflicts occur, the official 2021-2022 Degree Requirement Sheet takes precedence. Always check for the most current version of this flowchart.  
 • Be sure to pay careful attention to the prerequisite requirements, grade requirements, and other official information on Banner. Some prerequisites also have minimum grade requirements. Grade requirements are not shown on this flowchart.  
 • Consult your Advisor if you have any questions or need clarification.





**Computer Engineering plus Software Engineering Option (128 CH)  
Course Advising Sheet<sup>1</sup>**

**I. Required Courses (107 CH):**

- ENGL 1113, POLS 1113, HIST 1103, ENGL 3323
- ENGR 1111, ENSC 2611, IEM 3503
- CS 1113, CS 2433, CS 2351, CS 3353, CS 3653, CS 4323
- MATH 2144, MATH 2153, MATH 2233, MATH 2163, MATH 3013
- CHEM 1414, PHYS 2014, PHYS 2114
- ECEN 2714, ECEN 3213, ECEN 3233, ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714, ECEN 3903, ECEN 4013, ECEN 4024, ECEN 4213, ECEN 4243, ECEN 4303, ECEN 4503

**II. BSCpE/SOFT Requirement (12 CH):**

- CS 3363 - Organization of Programming Languages
- ECEN 4273 - Software Engineering
- ECEN 4283 - Computer Networks
- Choose one of the following:
  - CS 4153 - Mobile Applications Development
  - CS 4243 - Introduction to Computer Security
  - CS 4623 - Introduction to Cyber Physical Systems

**III. Humanities, Social Science, International, & Diversity Electives (9 CH):** A total of at least 6 credits designated as “H” and 3 credits designated as “S” is required. Of these, 3 CH must meet the International Dimensions “I” component and 3 CH must meet the Diversity “D” component.

**IV. Co-Op Experience (3 CH maximum):** With department pre-approval, student may enroll in ECEN 4030 to get degree credit for their co-op experience. Depending on the agreement with a participating organization, a student may receive between one to three credit hours for their experience. Multiple experiences are allowed with permission. Up to three credit hours of co-op experience, provided that the experience is software intensive, may be applied to the BSCpE/SOFT requirement in lieu of CS 3363, CS, 4153, CS 4243, or CS 4623.

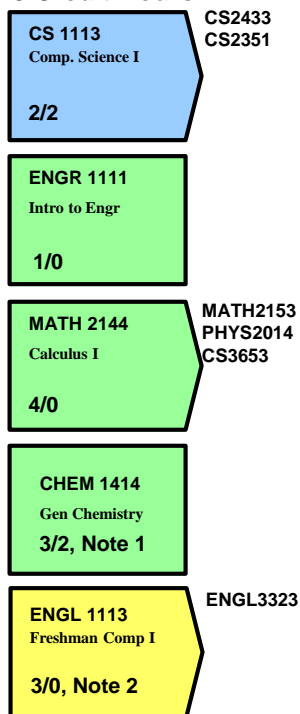
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<sup>1</sup> Revision Date: September 13, 2021

# Computer Engineering – Software Engineering (SOFT) *Years 1 and 2*

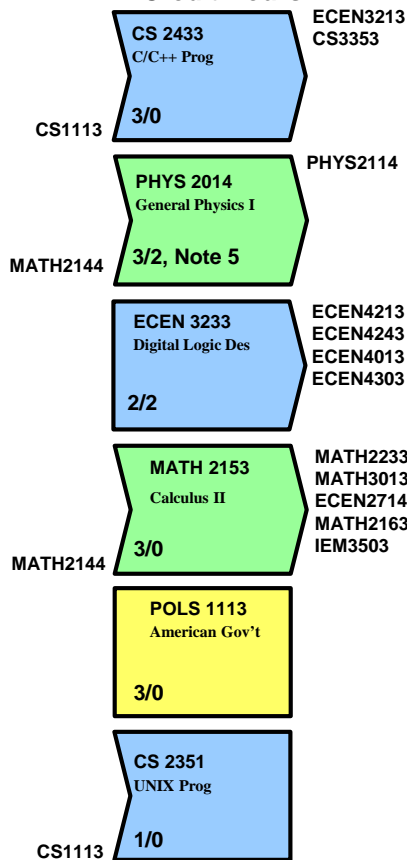
## Course Plan (CpE)

### Semester 1 15 Credit Hours



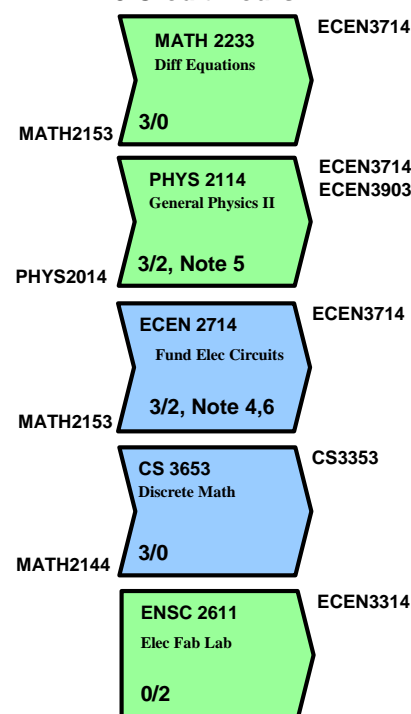
CS2433  
CS2351  
  
 MATH2153  
PHYS2014  
CS3653  
  
 ENGL3323

### Semester 2 17 Credit Hours



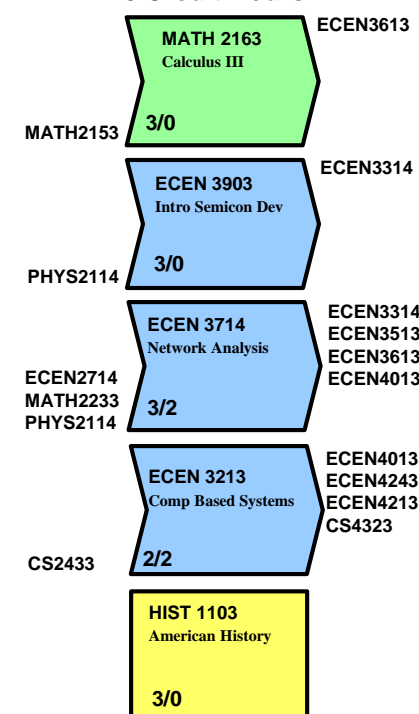
ECEN3213  
CS3353  
  
 CS1113  
  
 PHYS2114  
  
 MATH2144  
  
 ECEN4213  
ECEN4243  
ECEN4013  
ECEN4303  
  
 MATH2233  
MATH3013  
ECEN2714  
MATH2163  
IEM3503  
  
 CS1113

### Semester 3 15 Credit Hours

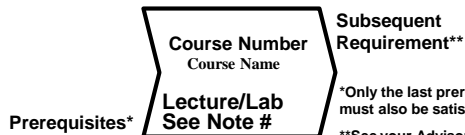


ECEN3714  
  
 MATH2153  
  
 PHYS2014  
  
 ECEN3714  
ECEN3903  
  
 ECEN3714  
  
 MATH2153  
  
 MATH2144  
  
 ECEN3314

### Semester 4 16 Credit Hours

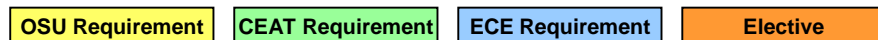


ECEN3613  
  
 MATH2153  
  
 PHYS2114  
  
 ECEN3314  
  
 ECEN2714  
MATH2233  
PHYS2114  
  
 CS2433



\*Only the last prerequisite in a sequence is listed. All earlier prerequisites must also be satisfied before taking the course.

\*\*See your Advisor, the ECE Advising Document, and Banner for additional information.



**Suggested Course Plan (128 hours)**  
 The anticipation at OSU and most institutions of higher education is that for *one* semester credit hour (SCH) the student spends one hour per week in lecture (two for lab courses) and two hours studying outside of class (one for lab courses). A three credit hour class requires about nine hours per week. This study plan is recommended for students who will devote full time to university studies and do not have excessive extracurricular activities or other obligations.

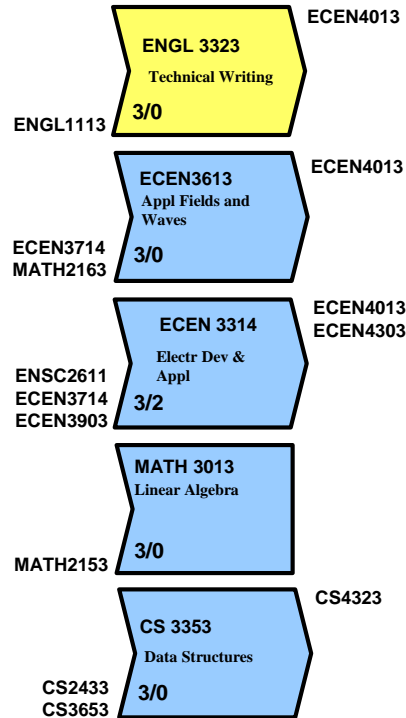
**NOTES:**

- 1) CHEM 1515 may be substituted for CHEM 1414 and should be taken by all students considering medical school.
- 2) Students with less than a "B" in ENGL 1113 or 1313 must take ENGL 1213 or 1413 prior to ENGL 3323.
- 3) A total of at least 6 hours designated "H" and 3 hours designated "S" are required. Of these, 3 hrs must meet the International Dimension "I" component and 3 hrs must meet the Diversity "D" component.
- 4) ECEN 2714 replaces ENSC 2613 effective fall 2018.
- 5) General Physics I and II are key prerequisites and should be taken at the earliest possible time.
- 6) MATH 2233 and PHYS 2114 must be taken prior to or at the same time as ECEN 2714.

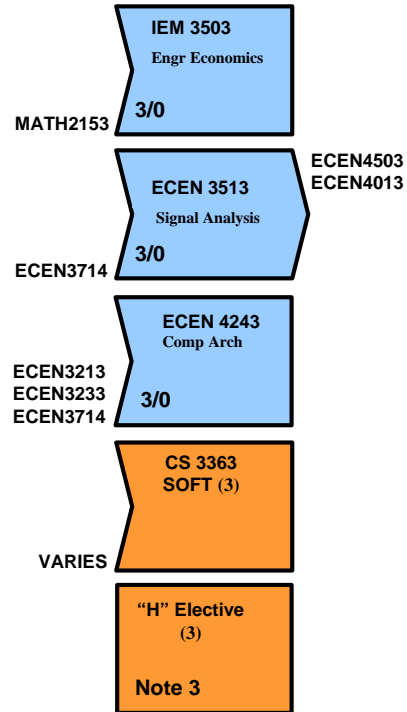
# Computer Engineering – Software Engineering (SOFT) *Years 3 and 4*

## 2021-2022 Course Plan (CpE)

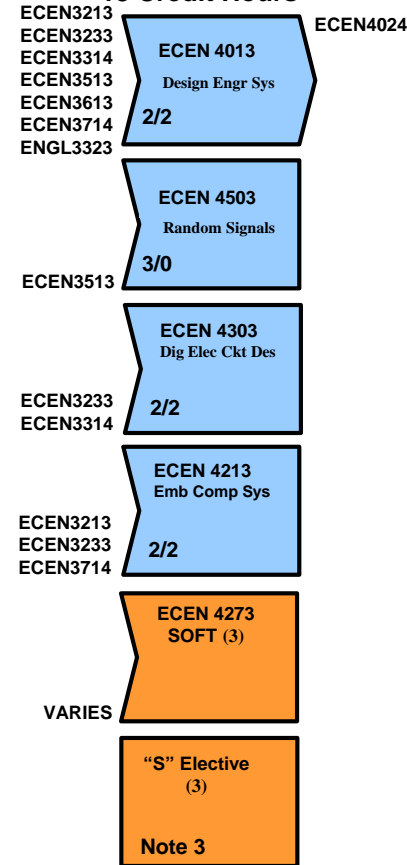
### Semester 5 16 Credit Hours



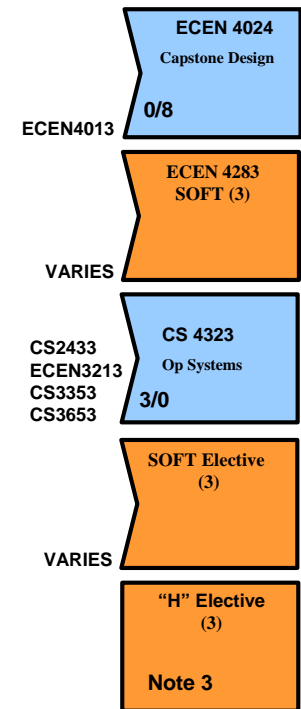
### Semester 6 15 Credit Hours



### Semester 7 18 Credit Hours



### Semester 8 16 Credit Hours

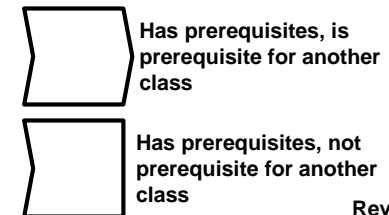
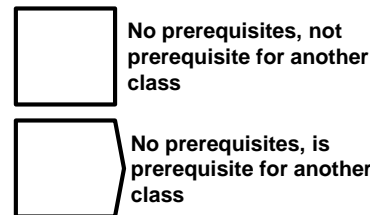


• This flowchart represents one path of many to graduation. Students are not required to follow the chart, but prerequisites limit path options.

• This flowchart is only an advising instrument. When conflicts occur, the official 2021-2022 Degree Requirement Sheet takes precedence. Always check for the most current version of this flowchart.

• Be sure to pay careful attention to the prerequisite requirements, grade requirements, and other official information on Banner. Some prerequisites also have minimum grade requirements. Grade requirements are not shown on this flowchart.

• Consult your Advisor if you have any questions or need clarification.



**Computer Engineering and Electrical Engineering Dual Degree (137 CH)  
Course Advising Sheet<sup>1</sup>**

**I. Required Courses (110 CH):**

- ENGL 1113, POLS 1113, HIST 1103, ENGL 3323
- ENGR 1111, ENSC 2113, ENSC 2611, IEM 3503
- CS 1113, CS 2433, CS 2351, CS 3353, CS 3653; CS 4323 or ECEN 4283.
- MATH 2144, MATH 2153, MATH 2233, MATH 2163, MATH 3013
- CHEM 1414, PHYS 2014, PHYS 2114
- ECEN 2714, ECEN 3213, ECEN 3233, ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714, ECEN 3903, ECEN 4013, ECEN 4024, ECEN 4213, ECEN 4243, ECEN 4303, ECEN 4503

**II. ECEN Junior Elective (3 CH):** Choose one course from the following list. (Depending departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices

**III. ECEN BSEE Electives (9 CH):** Choose three ECEN courses, not previously chosen, from the following list. (Depending departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester. Note that ECEN 3723 is a prerequisite to ECEN 4413. All of other courses listed below only have required courses as prerequisites.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices
- ECEN 4133 - Power Electronics
- ECEN 4153 - Power System Analysis and Design
- ECEN 4313 - Linear Electronics Circuit Design
- ECEN 4353 - Communication Electronics
- ECEN 4413 - Automatic Control Systems
- ECEN 4523 - Communication Theory
- ECEN 4533 - Data Communications
- ECEN 4613 - Microwave Engineering

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<sup>1</sup> Revision Date: September 13, 2021

- ECEN 4743 - Introduction to Biomedical Engineering Modeling and Systems
- ECEN 4763 - Introduction to Digital Signal Processing
- ECEN 4773 - Real Time Digital Signal Processing
- ECEN 4823 - Design of Optical Systems
- ECEN 4843 - Design of Lasers and Systems

IV. ECEN BSCpE Electives (6 CH): Choose two ECEN courses, not previously chosen, from the following list. (Depending departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices
- ECEN 4133 - Power Electronics
- ECEN 4153 - Power System Analysis and Design
- ECEN 4233 - High Speed Computer Arithmetic
- ECEN 4273 - Software Engineering
- ECEN 4283 - Computer Networks
- ECEN 4313 - Linear Electronics Circuit Design
- ECEN 4353 - Communication Electronics
- ECEN 4413 - Automatic Control Systems
- ECEN 4523 - Communication Theory
- ECEN 4533 - Data Communications
- ECEN 4613 - Microwave Engineering
- ECEN 4743 - Introduction to Biomedical Engineering Modeling and Systems
- ECEN 4763 - Introduction to Digital Signal Processing
- ECEN 4773 - Real Time Digital Signal Processing
- ECEN 4823 - Design of Optical Systems
- ECEN 4843 - Design of Lasers and Systems

V. Controlled Elective: Automatically satisfied under the EE requirement when ENSC 2113 is completed; see Section I.

VI. Humanities, Social Science, International, & Diversity Electives (9 CH): A total of at least 6 credits designated as “H” and 3 credits designated as “S” is required. Of these, 3 CH must meet the International Dimensions “I” component and 3 CH must meet the Diversity “D” component.

VII. Co-Op Experience (3 CH maximum): With department pre-approval, student may enroll in ECEN 4030 to get degree credit for their co-op experience. Depending on the agreement with a participating organization, a student may receive between one to three credit hours for their experience. Multiple experiences are allowed with permission. Up to three credit hours of co-op experience may be applied to the ECEN Elective degree requirement.

**Electrical Engineering, Computer Engineering, and Software Engineering  
Multiple Degree Program (143 CH)  
Course Advising Sheet<sup>1</sup>**

I. Required Courses (110 CH):

- ENGL 1113, POLS 1113, HIST 1103, ENGL 3323
- ENGR 1111, ENSC 2113, ENSC 2611, IEM 3503
- CS 1113, CS 2433, CS 2351, CS 3353, CS 3653, CS 4323
- MATH 2144, MATH 2153, MATH 2233, MATH 2163, MATH 3013
- CHEM 1414, PHYS 2014, PHYS 2114
- ECEN 2714, ECEN 3213, ECEN 3233, ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714, ECEN 3903, ECEN 4013, ECEN 4024, ECEN 4213, ECEN 4243, ECEN 4303, ECEN 4503

II. ECEN Junior Elective (3 CH): Choose one course from the following list. (Depending departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices

III. ECEN BSEE Electives (9 CH): Choose three ECEN courses, not previously chosen, from the following list. (Depending departmental resources and instructor availability, courses on this list may or may not be offered in any given academic year or semester. Note that ECEN 3723 is a prerequisite to ECEN 4413. All of other courses listed below only have required courses as prerequisites.)

- ECEN 3113 - Energy, Environment and Economics
- ECEN 3623 - Applied Fields and Waves II
- ECEN 3723 - Systems I
- ECEN 3913 - Solid State Electronic Devices
- ECEN 4133 - Power Electronics
- ECEN 4153 - Power System Analysis and Design
- ECEN 4313 - Linear Electronics Circuit Design
- ECEN 4353 - Communication Electronics
- ECEN 4413 - Automatic Control Systems
- ECEN 4523 - Communication Theory
- ECEN 4533 - Data Communications

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<sup>1</sup> Revision Date: September 13, 2021

- ECEN 4613 - Microwave Engineering
- ECEN 4743 - Introduction to Biomedical Engineering Modeling and Systems
- ECEN 4763 - Introduction to Digital Signal Processing
- ECEN 4773 - Real Time Digital Signal Processing
- ECEN 4823 - Design of Optical Systems
- ECEN 4843 - Design of Lasers and Systems

IV. BSCpE/SOFT Requirement (12 CH):

- CS 3363 (Organization of Programming Languages)
- ECEN 4273 (Software Engineering)
- ECEN 4283 (Computer Networks)
- Choose one of the following:
  - CS 4153 (Mobile Applications Development)
  - CS 4243 (Introduction to Computer Security)
  - CS 4623 (Introduction to Cyber Physical Systems)

V. Controlled Elective: Automatically satisfied under the EE requirement when ENSC 2113 is completed; see Section I.

VI. Humanities, Social Science, International, & Diversity Electives (9 CH): A total of at least 6 credits designated as “H” and 3 credits designated as “S” is required. Of these, 3 CH must meet the International Dimensions “I” component and 3 CH must meet the Diversity “D” component.

VII. Co-Op Experience (3 CH maximum): With department pre-approval, student may enroll in ECEN 4030 to get degree credit for their co-op experience. Depending on the agreement with a participating organization, a student may receive between one to three credit hours for their experience. Multiple experiences are allowed with permission. Depending on the nature of the experience, up to three credit hours of co-op experience may be applied to the ECEN Electives and/or CpE/SOFT requirement as specified by ty the staff adviser and the instructor of ECEN 4030.

# ELECTR & COMPUTER ENGINEERING (ECEN)

## ECEN 2011 Experimental Methods I

**Prerequisites:** PHYS 2114 with a "C" or better or concurrent enrollment advisor permission required.

**Description:** Laboratory associated with ECEN 2714 taken mostly by transfer students who have completed a similar course as ECEN 2714 without the accompanying laboratory. Previously offered as ECEN 3013.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Elec & Computer Engr

## ECEN 2714 Fundamentals of Electric Circuits

**Prerequisites:** MATH 2153 with a "C" or better and (PHYS 2114 and MATH 2233 with a "C" or better or concurrent enrollment).

**Description:** Circuit analysis techniques including equivalent networks and mesh/node formulation of network equations; operational amplifiers; RL, RC and RLC transient and steady-state circuit analysis; energy and power; electrical measurements and instrumentation.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

## ECEN 3020 Supervised Research Project

**Prerequisites:** Consent of instructor and ECEN department head.

**Description:** Supervised research project for qualified students. May be repeated no more than three times for a total of three credit hours. Offered for variable credit, 1-3 credit hours, maximum of 3 credit hours.

**Credit hours:** 1

**Contact hours:** Contact: 1 Other: 1

**Levels:** Undergraduate

**Schedule types:** Independent Study

**Department/School:** Elec & Computer Engr

## ECEN 3113 Energy, Environment and Economics

**Prerequisites:** ECEN 3714 with a "C" or better.

**Description:** Topics relevant to understanding the close relationship between energy use, its impact on the environment, and overall economic implications. Green energy technologies (wind, solar, hydro) will be considered along with conventional techniques. Both conventional and non-conventional energy technologies will be discussed.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

## ECEN 3213 Computer Based Systems in Engineering

**Prerequisites:** CS 2433 with a "C" or better.

**Description:** A comprehensive introduction to technology and applications of microprocessors. Topics include computer hardware, software, programming, computation, interfacing, I/O, communication, data acquisition, data representation, and numerical analysis.

Applications of general-purpose and application-specific processors in various disciplines of engineering and engineering problem solving. Previously offered as ENSC 3213.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

## ECEN 3233 Digital Logic Design

**Description:** Boolean algebra, optimization of logic networks. Design using SSI, and MSI, LSI components. ROM and PLA applications.

Analysis and design of clock sequential logic networks. Flip-flops, counters, registers. Asynchronous circuit design and analysis. Laboratory experience in implementing combinational and sequential logic devices.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

## ECEN 3314 Electronic Devices and Applications

**Prerequisites:** ECEN 3714 and ENSC 2611 with a "C" or better and (PHYS 3313 or ECEN 3903 with a "C" or better).

**Description:** Semiconductor electronic components including MOSFETs, BJTs, JFETs, and OpAmps. Emphasis on device models and use of solid state electronic devices to analyze, synthesize and design amplifiers and switching circuits. SPICE simulations are extensively utilized. Basic building blocks for analog and digital applications. Theoretical concepts and methods are demonstrated and reinforced through laboratory exercises. Course previously offered as ECEN 3313.

**Credit hours:** 4

**Contact hours:** Lecture: 3 Lab: 2 Contact: 5

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

## ECEN 3513 Signal Analysis

**Prerequisites:** ECEN 3714 with a "C" or better.

**Description:** Deterministic signals. Fourier series and Fourier transforms. Impulse response, convolution and correlation. Sampling theorem. Analog modulation techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr



**ECEN 3613 Applied Fields and Waves I****Prerequisites:** MATH 2163 and ECEN 3714 with a "C" or better.**Description:** Circuit model of transmission lines, wave propagation, energy transfer, impedance mismatch, and transients. Field analysis of voltage, current, resistance, capacitance, and inductance. Coupled circuits.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 3623 Applied Fields and Waves II****Prerequisites:** ECEN 3613.**Description:** Continuation of ECEN 3613. Plane-wave propagation in free space, power flow, reflection and transmission. Guided waves and resonators. Radiation and introduction to antenna systems. Boundary value problem analysis.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 3714 Network Analysis****Prerequisites:** MATH 2233 and ECEN 2714 and PHYS 2114 with a grade of "C" or better.**Description:** Advanced mathematical analysis techniques used in circuit analysis including Laplace transforms, Fourier transforms, and Fourier series. Circuit frequency response, Bode plots, and filters, including passive, active, low-pass, high-pass, and band-pass filters. Theory of linear circuits; two-port circuit models and parameters. Course previously offered as ECEN 3713.**Credit hours:** 4**Contact hours:** Lecture: 3 Lab: 2 Contact: 5**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 3723 Systems I****Prerequisites:** ENSC 3714 and ENSC 2113 with a "C" or better and (MATH 3013 with a "C" or better or concurrent enrollment).**Description:** Physical and mathematical modeling of electrical and mechanical dynamic systems. Transient response of first and second order systems. Laplace transform techniques for solving differential equations, transfer functions, frequency response and resonance. Course previously offered as ECEN 3413.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 3903 Introduction to Semiconductor Devices****Prerequisites:** PHYS 2114 with a "C" or better.**Description:** Crystal structure, the quantum theory of solids. The physics of semiconductor materials and the junction, with an emphasis on applications to semiconductor devices. Same course as PHYS 3313.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 3913 Solid State Electronic Devices****Prerequisites:** ECEN 3714 with a "C" or better and (PHYS 3313 or ECEN 3903 with a "C" or better).**Description:** Solid state physics basis of modern electronic devices. Introductory quantum mechanics. Energy bands in solids. Electronic properties of semiconductors. Junction diodes. Bipolar transistors. Field effect transistor.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4010 Special Topics****Prerequisites:** ECEN 3233, and (ECEN 3213 or ENSC 3213) and ECEN 3714 with a "C" or better or advisor permission.**Description:** Engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned.

Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.

**Credit hours:** 1-12**Contact hours:** Contact: 1-12 Other: 1-12**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 4013 Design of Engineering Systems****Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233, and ECEN 3714 with a grade of "C" or better and ECEN 3613, ECEN 3513, ECEN 3314 and (ENGL 3323 with a grade of "C" or better or concurrent enrollment).**Description:** Complete design cycle for several small design projects, each including establishing objectives, synthesis, analysis, construction, testing and evaluation. Use of modern lab equipment and fabrication techniques. Development of communication skills.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 4024 Capstone Design****Prerequisites:** ECEN 4013.**Description:** Continuation of ECEN 4013. Student project teams design, build, test and present results for realistic projects from university and industrial sponsors. Formulation of specifications, consideration of alternative solutions, feasibility considerations, detailed system descriptions, economic factors, safety, reliability, aesthetics, ethics and social impact. Course previously offered as ECEN 4023.**Credit hours:** 4**Contact hours:** Lab: 8 Contact: 8**Levels:** Undergraduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 4030 Undergraduate Professional Practice****Prerequisites:** Approval of ECEN department head.**Description:** Experience in application of electrical engineering principles to typical problems encountered in industry. Solutions to the problems by student participation in the role of engineer or engineering intern. Offered for variable credit, 1-8 credit hours, maximum of 8 credit hours.**Credit hours:** 1-8**Contact hours:** Contact: 1-8 Other: 1-8**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr

**ECEN 4133 Power Electronics**

**Prerequisites:** ECEN 3714 with a grade of "C" or better.

**Description:** Power electronic devices, components, and their characteristics; DC to AC conversion; fundamentals of inverters and waveshaping devices; application aspects; control aspects; characteristics and state-of-the-art of advanced power inverter and power conditioning topologies.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4153 Power System Analysis and Design**

**Prerequisites:** ECEN 3714, "C" or better.

**Description:** Power system component models from circuit theory. Formulation and design of the load flow model and the optimum economic generator allocation problem utilizing computer methods.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4213 Embedded Computer Systems Design**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233 and ECEN 3714 with a "C" or better.

**Description:** Design of microprocessor-based systems through proper integration of hardware and software. Serial and parallel communications, sensor interfacing, computer control of external devices, and color graphics hardware. Design of PASCAL and assembly language modules for optimum real-time system performance.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 4233 High Speed Computer Arithmetic**

**Prerequisites:** ECEN 3233, (ECEN 3213 or ENSC 3213) and ECEN 3714 with a "C" or better.

**Description:** Course covers computer arithmetic as applied to general purpose and application-specific processors. Focus is on developing high-speed arithmetic algorithms and understanding their implementation in VLSI technology at the gate level.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4243 Computer Architecture**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233, and ECEN 3714 with a "C" or better.

**Description:** Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPU's, memory system design including cache, virtual memory, error detection and correction, I/O operations, including direct memory access and peripheral interface design.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Lab: 2 Contact: 4

**Levels:** Undergraduate

**Schedule types:** Lab, Lecture, Combined lecture and lab

**Department/School:** Elec & Computer Engr

**ECEN 4273 Software Engineering**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233, CS 3653, and ECEN 3714 with a "C" or better.

**Description:** Functional organization and hardware design of digital computer systems with emphasis on microprocessor-based systems. CPU organization, features of microprocessors including advanced 32-bit CPU's memory system design including cache, virtual memory, error detection and correction, I/O operations, including direct memory access and peripheral interface design. Same course as CS 4273.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4283 Computer Networks**

**Prerequisites:** (ECEN 3213 or ENSC 3213), ECEN 3233 and ECEN 3714 with a "C" or better.

**Description:** Computer networks, distributed systems and their systematic design. Introduction to the use, structure, and architecture of computer networks. Networking experiments to describe network topology. ISO reference model. Same course as CS 4283.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4303 Digital Integrated Circuit Design**

**Prerequisites:** ECEN 3314 and (ECEN 3233 with a "C" or better).

**Description:** Theory of digital and electronics circuits. Digital logic families TTL, IIL, ECL, NMOS, CMOS, GaAs. Large signal models for transistors. Implementation at RAM and ROM. Circuit design for LSI and VLSI.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 4313 Linear Electronics Circuit Design****Prerequisites:** ECEN 3314.**Description:** Class A and B small-signal, push-pull power, complementary symmetry, differential and operational amplifiers, utilizing field-effect transistors, bipolar transistors, tunnel diodes and integrated circuits. Emphasis on amplification in electronic devices, design and analysis of wide-band amplifier circuitry.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4353 Communication Electronics****Prerequisites:** ECEN 3314.**Description:** Design of tuned voltage and power amplifiers, oscillators and mixers, modulation and detection, and parametric amplifiers.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4413 Automatic Control Systems****Prerequisites:** ECEN 3723 or (MAE 3723 or MAE 3724).**Description:** Properties of feedback control systems, mathematical models of basic components, state-variable models of feedback systems, time-domain analysis, stability, transform analysis, frequency domain techniques, root-locus design of single input single output systems and simple compensation techniques. Same course as MAE 4053.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4503 Random Signals and Noise****Prerequisites:** ECEN 3513.**Description:** Analysis of electrical systems using elementary concepts of probability, random variables and random processes. Frequency and time domain response of linear systems driven by random inputs. Statistical properties of electrical noise. Analysis and design of optimum linear systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4523 Communication Theory****Prerequisites:** ECEN 4503.**Description:** Noise in modulation systems. Digital data transmission. Design of optimal receivers. Introduction to information theory.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4533 Data Communications****Prerequisites:** ECEN 4503 prerequisite or concurrent enrollment.**Description:** Signal detection in noise. Tradeoffs between bandwidth signal-to-noise ratio and rate of information transfer. Transmission multiplexing and error handling. Elements of computer network design. Data link protocols.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4613 Microwave Engineering****Prerequisites:** ECEN 3613.**Description:** Review of EM and transmission line theory. Microwave network theory: Impedance and admittance matrices, scattering matrix and S-parameters, ABCD and transfer matrices. Signal-flow diagrams. Matching circuits and microwave filters. Passive microwave devices: power dividers, hybrids, couplers, resonators, isolators, and circulators. Class projects such as radar, communication, imaging, or sensing systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4743 Introduction to Biomedical Engineering Modeling and Systems****Prerequisites:** ECEN 4763.**Description:** An overview of the field of biomedical engineering and an introduction of the modeling approaches implemented in biomedical engineering. Topics include bio-electronics, biomechanics, compartmental modeling, bio-signal processing, biomedical optics, etc. The course will demonstrate a few of major fields of activity in which biomedical engineers are engaged and modeling approaches are implemented.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4763 Introduction to Digital Signal Processing****Prerequisites:** ECEN 3513.**Description:** Introduction to discrete linear systems using difference equations and z-transforms. Discrete Fourier analysis. Design of digital filters. Sampling theorem. Applications of digital signal processing.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 4773 Real Time Digital Signal Processing****Prerequisites:** ECEN 4763.**Description:** DSP Processor architectures and programming. A/D, D/A, polled and interrupt-driven I/O. Realtime implementation of FIR/IIR filters, the FFT, and other DSP algorithms on special purpose DSP hardware from Motorola, Texas Instruments and others. Link between DSP theory and practical implementation.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4823 Design of Optical Systems****Prerequisites:** ECEN 3714 with a "C" or better.**Description:** Introduction to optics through the design, construction, and characterization of optical systems. Emphasis on geometrical optics and spectroscopy. Course previously offered as ECEN 3813.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 4843 Design of Lasers and Systems****Prerequisites:** ECEN 3613.**Description:** Introduction of the design of lasers and optical systems based on lasers including the design, construction, and characterization of lasers. Gaussian beams and optics, laser gain materials, laser cavities, advanced topics. Course previously offered as ECEN 4813.**Credit hours:** 3**Contact hours:** Lecture: 2 Lab: 2 Contact: 4**Levels:** Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 5000 Thesis or Report****Description:** A student studying for the master's degree will enroll in this course for a maximum of six credit hours. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5030 Professional Practice****Description:** Experience in application of electrical engineering principles to typical problems encountered in industry and government engineering design and development projects. Solutions to the problems require participation by the student in the role of junior engineer or engineer-intern. Problem solutions involve economics and ecological considerations as well as technology and must be adequately documented. Offered for variable credit, 1-8 credit hours, maximum of 8 credit hours.**Credit hours:** 1-8**Contact hours:** Contact: 1-8 Other: 1-8**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5060 Special Topics****Prerequisites:** Advisor permission.**Description:** Engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5070 Directed Studies****Prerequisites:** Consent of instructor.**Description:** Investigation outside of the classroom of topics not normally covered in lecture courses. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 5080 Fundamental Topics****Prerequisites:** Advisor permission.**Description:** Fundamental topics that are typically introduced in the senior year curriculum with additional depth and breadth commensurate with the graduate program. Repeat credit may be earned with difference course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 9 credit hours.**Credit hours:** 1-6**Contact hours:** Lecture: 1-6 Contact: 1-6**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5113 Power Systems Analysis by Computer Methods****Description:** Quasi-static control of power systems and analysis of power systems under abnormal operating conditions. Transient stability studies. Models formulated and solutions outlined for implementation on the computer.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5123 Engineering Systems Reliability Evaluation****Description:** Techniques and concepts needed for evaluating the long-term and short-term reliability of a system. Topics include static and spinning generation capacity; transmission, composite, interconnected, and dc system reliability evaluations; and power system security. Applications to systems other than power systems included. For students with little or no background in probability or statistics.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 5133 Power Electronics and Renewables**

**Description:** Modeling and control aspects of power electronics for integrating renewable energy systems. Topics covered here will focus on power converter dynamics, indirect converter topologies, PWM technique, sliding mode control of converters, game theory based control, Maximum power point tracking, control of generators for different renewable energy systems. Simulation tools will be discussed as appropriate.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5153 Direct Energy Conversion**

**Description:** Energy conversion techniques and applications; thermo-electrics, thermionics, fuel cells, MHD and other processes involving electrical, mechanical and thermal energies. State-of-the-art developments in direct energy conversion using selected papers from journals and other publications. Gives the student a proper perspective of the possibilities and problems associated with satisfying future energy requirements.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5163 Cyber Physical Systems and Smart Grid**

**Prerequisites:** ECEN 5193.

**Description:** Introduction to smart grid technologies and applications; advance metering infrastructures, demand response, renewable generation, electric vehicles, and cyberattacks.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5193 Power Economics and Regulation**

**Prerequisites:** Vector calculus, familiarity with complex numbers.

**Description:** Natural monopoly, regulated mono-polities. Power pricing. Deregulation and the Energy Policy Act of 1992. Bulk power markets, transmission access and wheeling. Economic dispatch and system operations. Security and reliability. Environmental externalities and Clean Air Act compliance. Procurement of new capacity and integrated resource planning. Co-generators and independent power producers.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5223 Digital Systems Testing**

**Prerequisites:** ECEN 3233.

**Description:** Testing of combinational and sequential circuits. Test generation techniques. Design of reliable and testable circuits and systems. Testing for LSI and VLSI.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5233 Embedded Sensor Networks**

**Prerequisites:** Graduate standing or consent of instructor.

**Description:** Analysis and design of wireless networks, including the integration of sensing, computation, and wireless communication within an embedded system. Mobile sensor networks and body sensor networks. Real world application and new innovations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5253 Digital Computer Design**

**Prerequisites:** ECEN 4243 or graduate standing.

**Description:** Arithmetic algorithms and the design of the arithmetic/logic unit (ALU). Serial and parallel data processing; control and timing systems; microprogramming; memory organization alternatives; input/output interfaces. Same course as CS 5253.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5263 VLSI Digital Systems Design**

**Prerequisites:** ECEN 4303; ECEN 5253 recommended or graduate standing.

**Description:** Design of very large-scale digital systems on a single chip. Review of MOS technology. Design rules imposed by fabrication techniques. Systematic structures for control and data flow; system timing; highly concurrent systems. Experimental opportunities available.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5283 Computer Vision**

**Description:** The development of machine vision and advanced image understanding techniques for robotics, automated inspection, biomedicine. Object recognition, motion analysis, object tracking, segmentation, representation, and 3-D analysis.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5313 Analog Integrated Circuits**

**Description:** Advanced studies of analog CMOS IC design with an emphasis on EDA. Topics include bandgap reference, oscillators, PLL, linear regulators, DC-DC converters, low voltage, low power, and energy harvesting techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5333 Semiconductor Devices**

**Prerequisites:** ECEN 3314 and PHYS 3313 or equivalent.

**Description:** Semiconductor crystal structure and device fabrication, carrier distribution and transport, pn junction and diode, metal-semiconductor heterojunction, MOSFET, BJT and optoelectronic devices.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5363 Mixed-Signal Integrated Circuits**

**Description:** Analysis and design of CMOS mixed-signal IC for VLSI systems. Topics include comparators, switched-capacitor circuits, sample-and-hold, Nyquist and oversampling ADC/DAC, delta-sigma modulation, and digital calibration techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5373 RF Microwave Circuit Design**

**Prerequisites:** ECEN 3314, ECEN 4613 and ECEN 5333 or equivalent.

**Description:** Smith chart, single- and multi-port network, filter design, RF/microwave components and modeling, matching and biasing network, amplifier, oscillators and mixers.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5413 Optimal Control**

**Prerequisites:** ECEN 5713 or MAE 5713.

**Description:** Optimal control theory for modern systems design. Specification of optimum performance indices. Dynamic programming, calculus of variations and Pontryagin's minimum principle. Iterative numerical techniques for trajectory optimization. Same course as MAE 5413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5433 Robotics Kinematics, Dynamics and Control**

**Prerequisites:** ECEN 4413 or MAE 4053 or consent of instructor.

**Description:** Kinematic and dynamic analysis of robot manipulators. Inverse kinematics, motion planning and trajectory generation. Industrial practice in robot servo control. Dynamics and control in the presence of constraints. Actuators and sensors. Force sensors and vision systems. Robotic force control and its applications in industry. Passivity-based control algorithms. Advanced control techniques for motion and force control. Same course as MAE 5433.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5463 Nonlinear System Analysis and Control**

**Prerequisites:** ECEN 4413 or MAE 4053.

**Description:** Failure of superposition of effects; phase-plane analysis; limit-cycles; Lyapunov stability; hyperstability and input-output stability; controllability and observability of nonlinear systems; feedback linearization; robust nonlinear control system design. Same course as MAE 5463. Course previously offered as ECEN 5723.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5473 Digital Control Systems**

**Prerequisites:** ECEN 4413 or MAE 4053.

**Description:** Input-output and state-space representation of linear discrete-time systems. Approximate methods in discrete-time representation. Stability methods. Controllability, observability, state estimation, and parameter identification. Design and analysis of feedback control system using frequency-domain and state-space methods. Introduction to optimal control. Same course as MAE 5473. Course previously offered as ECEN 6413.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5483 Advanced Mechatronics Design**

**Prerequisites:** MAE 4733 or similar course and consent of instructor.

**Description:** Optimizing C programming code for microcontrollers using the assembly language instruction set. RS-232 microcontroller communication protocol. Controller Area Network (CAN) communication protocol plus hands-on CAN bus development boards, advanced topics which could include but are not limited to sensor design, real time operating systems, and advanced communication protocols. Same course as MAE 5483.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5513 Stochastic Systems**

**Prerequisites:** ECEN 3513 and ECEN 4503 or STAT 4033.

**Description:** Theory and applications involving probability, random variables, functions of random variables, and stochastic processes, including Gaussian and Markov processes. Correlation, power spectral density, and non-stationary random processes. Response of linear systems to stochastic processes. State-space formulation and covariance analysis. Same course as MAE 5513.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5533 Modern Communication Theory****Prerequisites:** ECEN 5513.**Description:** Noise as a random process, analog and digital signal detection in the presence of noise, optimum receiver design using signal space concepts and introduction to information theory. Trade-offs between bandwidth, signal-to-noise ratio and the rate of information transfer. Example system designs include earth satellite, deep space and terrestrial communication systems and computer communication networks.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5543 Data Transportation and Protection****Description:** Data and its representation; finite field matrices, pseudorandom sequences; information protection; space division networks; synchronization; and channel and error control.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5553 Telecommunications Systems****Prerequisites:** Graduate standing or consent of instructor.**Description:** Surveys the ways and means that voice, data and video are moved long distances. Covers computer networks (Ethernet LAN's, Internet WAN's); telephone systems (PSTN, VoIP and cellular telephony); video (MPEG, H.323, and IPTV); and last mile delivery systems.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5573 Wireless Communication****Description:** Wireless channel characterization: large-scale and small scale fading. Techniques to combat fading; diversity techniques, coding techniques, CDMA, OFDM, MIMO. Cellular concept.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5613 Electromagnetic Theory****Prerequisites:** ECEN 3613.**Description:** First graduate level treatment of classical electromagnetic theory. Wave equation, potential theory, boundary conditions. Rectangular, cylindrical and spherical wave functions. Conducting and dielectric guiding structures. Scattering and radiation. Introduction to numerical techniques.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5623 Antenna Theory****Prerequisites:** ECEN 3613.**Description:** Fundamental antenna parameters, including directivity, efficiency, radiation resistance, and pattern. Analysis of dipole, loop, aperture, broad-band, and traveling wave antennas. Array theory. Introduction to numerical techniques used in modern antenna design.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5633 Radar Theory****Prerequisites:** ECEN 3613; ECEN 4503 or ECEN 5513.**Description:** Theoretical treatment of radar principles. Overview of radar systems and techniques, radar equation, integration of signals. Radar cross-section of single and multiple targets. Waveform design, resolution, ambiguities and accuracy. Range, speed and angular measurements. Detection of targets in noise. Statistical description of clutter. Signal processing techniques.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5643 Antennas and Propagation for Wireless Communications****Prerequisites:** ECEN 3613, ECEN 4503.**Description:** Aspects of radiowave propagation for fixed and mobile communication systems. Review of Maxwell's equations and plane wave propagation, antenna principles. Reflection, refraction, diffraction, fading and scintillation, attenuation, ducting, diversity. Propagation in a cellular environment. Satellite communications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5683 Biomedical Optics****Description:** Biomedical optics, also often termed as biophotonics, is highly interdisciplinary subject on applying light for diagnostic detection and manipulation of biological tissue. This course introduces fundamental concepts and principal technologies of biomedical optics or biophotonics to graduate students and upper-level undergraduate students. The course includes three parts: The first part discusses light-tissue interaction. The second part introduces approaches to modeling photon propagation in tissue. The third part details several representative light-based sensing and imaging technologies for probing biological tissues at different spatial, spectral, and temporal scales for either morphological or functional diagnosis. Topics of therapeutic use of light will also be discussed.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 5713 Linear Systems**

**Prerequisites:** Graduate standing or consent of instructor.  
**Description:** Introduction to the fundamental theory of finite-dimensional linear systems with emphasis on the state-space representation. Mathematical representations of systems; linear dynamic solutions; controllability, observability, and stability; linearization and realization theory; and state feedback and state observer. Same course as MAE 5713.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5733 Neural Networks**

**Prerequisites:** Graduate standing.  
**Description:** Introduction to mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems in image and signal processing and control systems. Same course as CHE 5733 & MAE 5733.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5763 Digital Signal Processing**

**Description:** Introduction to discrete linear systems; frequency-domain design of digital filters; quantization effects in digital filters; digital filter hardware, discrete Fourier transforms; high-speed convolution and correlation with application to digital filtering; introduction to Walsh-Fourier theory.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5773 Intelligent Systems**

**Prerequisites:** ECEN 5733.  
**Description:** Introduction to the state-of-the art intelligent control and system successfully deployed to industrial and defense applications. Emerging intelligent algorithms (e.g., NN, FS, GA, EP, DES); intelligent control architecture (e.g., bottom-up, top-down, semiotics); reinforcement learning and hybrid systems; and case studies and design projects. Same course as MAE 5773.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5783 Medical Imaging**

**Prerequisites:** ECEN 3513, ECEN 4743 or consent of instructor.  
**Description:** A comprehensive introduction to the standard medical imaging modalities used today. Topics include radiation, radiation-interaction with matter, X-ray radiography, ultrasound, computer topography, image reconstruction and analysis, MRI, nuclear medicine, and radiation therapy. The fundamental mathematics underlying each imaging modality is reviewed and the hardware needed to implement each system is examined.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5793 Digital Image Processing**

**Prerequisites:** ECEN 4763 or ECEN 5763.  
**Description:** Digital image processing including image acquisition and characterization, transforms, coding and compression, enhancement, restoration and segmentation. Use of modern image processing software on Sun and IBM work stations.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5803 Geometrical Optics**

**Prerequisites:** PHYS 3213 or consent of instructor.  
**Description:** Foundations of geometrical optics, geometrical theory of optical imaging, geometrical theory aberrations, image forming instruments. Same course as PHYS 5123.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5823 Physical Optics**

**Prerequisites:** PHYS 3213 or consent of instructor.  
**Description:** Multiple beam interference, diffractions, imaging, near field optical probes of matter, surface plasmons, light scattering from random media, optical coherence tomography- biomedical applications, negative materials, perfect lenses and super resolution. Same course as PHYS 5303.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 5833 Fiber-Optic Communication Systems**

**Prerequisites:** Graduate standing or consent of instructor.  
**Description:** Five generations of fiber-optic communication systems described in detail. Technical advances and increased capability of each system. Historical framework of how technical capability at the time forced technical decisions. A systems engineering point of view, emphasizing optimization of all components of the optical fiber link.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr



**ECEN 5843 Microelectronic Fabrication****Prerequisites:** ECEN 3314.**Description:** Contamination control and clean-room, vacuum systems, wafer manufacturing. Photolithography and alternative lithographic techniques. Physical and chemical vapor deposition, oxidation, etching, doping, packaging, formation of semiconductor devices and circuits. A series of Fabrication lab projects is conducted starting from bare silicon wafers to fabricate Optoelectronic circuits. Additional flat fee of \$120.00 applies.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5853 Ultrafast Optoelectronics****Prerequisites:** Graduate standing or consent of instructor.**Description:** Combining ultra fast laser pulses with electronic circuitry. Increased device performance. Optoelectronic/electrical pulses as short as 0.2 psec. High performance areas illustrating the power of advanced techniques in applications.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 5923 Introduction to MEMS****Prerequisites:** ECEN 5843 or consent of instructor.**Description:** Fundamentals of Microsystems. Topics include: energy transduction mechanisms, energy dissipation modeling, energy methods, mechanics of small scale, fabrication process design, micromachining, electronic interface.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6000 Research****Prerequisites:** Consent of major professor.**Description:** Independent research for students continuing graduate study beyond the level of the MS degree. Offered for variable credit, 1-16 credit hours, maximum of 36 credit hours.**Credit hours:** 1-16**Contact hours:** Contact: 1-16 Other: 1-16**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6001 PhD Seminar Series****Prerequisites:** Approval of ECEN department head.**Description:** Seminar series for PhD studies and research.**Credit hours:** 1**Contact hours:** Lecture: 1 Contact: 1**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6050 Preliminary PhD Research and Proposal****Prerequisites:** Consent of adviser.**Description:** Independent research and report of an advanced electrical engineering problem. Work performed serves as foundation of the oral PhD preliminary exam.**Credit hours:** 3**Contact hours:** Contact: 3 Other: 3**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6060 Special Topics****Prerequisites:** Advisor permission.**Description:** Advanced engineering topics not normally included in existing courses. Repeat credit may be earned with different course subtitles assigned. Offered for variable credit, 1-6 credit hours, maximum of 6 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6070 Advanced Directed Studies****Prerequisites:** Admission into PhD program and consent of instructor.**Description:** Investigation outside of the classroom of topics not normally covered in lecture courses. Offered for variable credit, 1-6 credit hours, maximum of 12 credit hours.**Credit hours:** 1-6**Contact hours:** Contact: 1-6 Other: 1-6**Levels:** Graduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 6123 Special Topics in Power Systems****Prerequisites:** ECEN 5113.**Description:** Selected relevant current topics related to power system operation and planning.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6253 Advanced Topics in Computer Architecture****Prerequisites:** ECEN 5253 or CS 5253.**Description:** Innovations in the architecture and organization of computers, with an emphasis on parallelism. Topics may include pipelining, multiprocessors, data flow, and reduction machines. Same course as CS 6253.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6263 Advanced VLSI Design and Applications****Prerequisites:** ECEN 5223 and ECEN 5263.**Description:** System timing. Designing testable integrated circuits. Specialized parallel processing architectures. Application examples.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

**ECEN 6453 Adaptive Control**

**Prerequisites:** ECEN 5473 or ECEN 5713 or MAE 5473 or MAE 5713.

**Description:** Analysis and design of control techniques that modify their performance to adapt to changes in system operation. Review of systems analysis techniques, including state variable representations, linearization, discretization, covariance analysis, stability, and linear quadratic Gaussian design. On-line parameter estimation, model reference adaptive systems, self-tuning regulators, stable adaptive systems. Same course as MAE 6453. Course previously offered as ECEN 6450.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 6483 Robust Multivariate Control Systems**

**Prerequisites:** ECEN 5713 or MAE 5713.

**Description:** Introduction to multivariable systems: SISO robustness vs. MIMO robustness; multivariable system poles and zeros; MIMO transfer functions; multivariable frequency response analysis; multivariable Nyquist theorem; performance specifications; stability of feedback systems; linear fractional transformations (LFT's); parameterization of all stabilizing controllers; structured singular value; algebraic ricatti equations; H2 optimal control; H-infinity controller design. Same course as MAE 6483.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 6523 Information Theory**

**Prerequisites:** ECEN 5513 or consent of instructor.

**Description:** Mathematical theory of information (Shannon theory) including information measure and transmission rates and capacities. Source coding theory including algebraic and error-correcting codes. Design of waiver-forms for noise immunity. Information transfer in learning systems.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 6803 Photonics I: Advanced Optics**

**Prerequisites:** ECEN 3813 or PHYS 3213 or consent of instructor.

**Description:** Advanced optics including spectral and time characteristics of detectors, characteristics of lasers, time, spectral and spatial parameters of laser emission, interferometric techniques, and nonlinear effects such as two-photon absorption and second and third harmonic generations. Emphasis on ultrashort laser pulses. Same course as CHEM 6803 & PHYS 6803.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 6810 Photonics II: THz Photonics and THz-TD**

**Prerequisites:** ECEN 6803.

**Description:** Concepts and techniques of driving electronic circuitry with ultra short laser pulses to generate and detect freely propagating pulses of THz electromagnetic radiation using several operational research systems. Same course as CHEM 6810 & PHYS 6810. Course previously offered as ECEN 6811. Offered for fixed credit, maximum of 4 credit hours.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Graduate

**Schedule types:** Lab

**Department/School:** Elec & Computer Engr

**ECEN 6820 Photonics II: Spectroscopy II**

**Prerequisites:** ECEN 6803.

**Description:** Operating principles and applications of laser spectroscopy of atoms, molecules, solids and complex fluids. Absorption, emission, photon correlation, coherence, time resolved Fourier transform. Raman spectroscopy and non-linear optical. Same course as CHEM 6820 & PHYS 6820. Course previously offered as ECEN 6821. Offered for fixed credit, maximum of 4 credit hours.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Graduate

**Schedule types:** Lab

**Department/School:** Elec & Computer Engr

**ECEN 6823 Advanced Optical Techniques**

**Prerequisites:** ECEN 5853.

**Description:** State-of-the-art optical devices and research methodologies. Investigation and discussion of contemporary developments in non-linear optical devices and laser applications. Includes both analytical and experimental techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Graduate

**Schedule types:** Lecture

**Department/School:** Elec & Computer Engr

**ECEN 6830 Photonics II: Spectroscopy III**

**Prerequisites:** ECEN 6803.

**Description:** Advanced spectroscopic instruments and methods used for investigation of semi-conductors and solid state material. Stimulated emission characterized both in wavelength and in time. Time-resolved fluorescence measurements. Multiphotonic excitations. Fast measuring techniques, including subnanosecond detectors, picosecond streak cameras, and ultra fast four-wave mixing and correlation techniques. Time-dependent photoconductivity measurements. Same course as CHEM 6830 & PHYS 6830. Course previously offered as ECEN 6831. Offered for 1 fixed credit hour, maximum of 4 credit hours.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Graduate

**Schedule types:** Lab

**Department/School:** Elec & Computer Engr

**ECEN 6840 Photonics III: Microscopy I****Prerequisites:** CHEM 3553 or consent of instructor.**Description:** The structure and imaging of solid surfaces. Basics of scanning probe microscopy (SPM). Contact and non-contact atomic force microscopy (AFM). Scanning tunneling microscopy (STM) in air. Same course as CHEM 6840 & PHYS 6840. Course previously offered as ECEN 6841. Offered for fixed credit hours, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6843 Advanced Microelectronic Fabrication****Prerequisites:** ECEN 5843.**Description:** Photolithography, wet and dry etching, thermal and electron beam evaporation, photomask design using L-Edit, silicon devices processing, quartz devices processing, silicon-on-sapphire devices processing. GaAs devices processing and MEMS devices processing.**Credit hours:** 3**Contact hours:** Lecture: 3 Contact: 3**Levels:** Graduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 6850 Photonics III: Microscopy II****Prerequisites:** CHEM 3553 or consent of instructor.**Description:** Advanced techniques of scanning probe microscopy (SPM). Magnetic force microscopy, Kelvin force microscopy, scanning probe microscopy (STM) in vacuum. Characterization of materials with SPM. Nanolithography with SPM. Device manufacturing and analysis. Same course as CHEM 6850 & PHYS 6850. Course previously offered as ECEN 6851. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6860 Photonics III: Microscopy III and Image Processing****Prerequisites:** ECEN 5793.**Description:** Digital image processing, including projects. Image acquisition and display, image enhancement, geometric operations, linear and nonlinear filtering, image restoration, edge detection, image analysis, morphology, segmentation, recognition, and coding/compression. Same course as CHEM 6860 & PHYS 6860. Offered for fixed credit hours, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6870 Photonics IV: Synthesis and Devices I****Prerequisites:** ECEN 6803 and ECEN 6840.**Description:** Preparation of functional nanostructures and related optical/electronic devices. Physical and chemical methods of thin film deposition. Engineering of prototypes of light emitting diodes, sensors, optical limiting coatings, lithographic patterns. Same course as CHEM 6870 & PHYS 6870. Course previously offered as ECEN 6871. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6880 Photonics IV: Semiconductor Devices, Testing and Characterization****Prerequisites:** ECEN 6803 and ECEN 6840.**Description:** Test and characterization of semiconductor and optoelectronic devices. Hall effect, four point probe, CV and IV measurements, optical pump-probe, photoluminescence and electro-optics sampling. Same course as CHEM 6880 & PHYS 6880. Course previously offered as ECEN 6881. Offered for 1 fixed credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr**ECEN 6890 Photonics IV: Semiconductor Synthesis and Devices III****Prerequisites:** ECEN 6803.**Description:** Processing, fabrication and characterization of semiconductor optoelectronic devices in class 100/10000 cleanrooms. Cleanroom operation including general procedure for material processing and device fabrication. Device processing using a variety of processing such as mask aligner, vacuum evaporators and rapid thermal annealer. Testing using optical and electrical testing apparatus such as I-V, C-V, Hall, and optical spectral measurement systems. Same course as CHEM 6890 & PHYS 6890. Course previously offered as ECEN 6891. Offered for fixed 1 credit hour, maximum of 4 credit hours.**Credit hours:** 1**Contact hours:** Lab: 2 Contact: 2**Levels:** Graduate**Schedule types:** Lab**Department/School:** Elec & Computer Engr

# ENGINEERING SCIENCE (ENSC)

## ENSC 2113 Statics

**Prerequisites:** Either MATH 2133 or MATH 2144 and either PHYS 1114 or PHYS 2014 with grades of "C" or better.

**Description:** Resultants of force systems, static equilibrium of rigid bodies, statics of structures, and fluid statics. Shear and moment diagrams.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Dean of Engineering

## ENSC 2123 Elementary Dynamics

**Prerequisites:** ENSC 2113 with a grade of "C" or better.

**Description:** Kinematics and kinetics of particles, systems of particles, and rigid bodies from a Newtonian viewpoint using vector algebra and calculus. Work-energy and impulse-momentum principles. Planar and three-dimensional kinetics and kinematics of rigid bodies.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Dean of Engineering

## ENSC 2141 Strength of Materials Lab

**Prerequisites:** Concurrent enrollment in ENSC 2143 or GENT 3323 or permission of the instructor.

**Description:** Study the sensing, conditioning and acquisition of load, deformation and strain data and the inference of stress. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. Perform material tensile tests and acquire stress and strain data. Study the behavior of engineering materials in service and failure. Operate 3D printers and mills to manufacture samples and structures for testing. Test engineered designs of beams, pressure vessels, truss and frames structures, etc. to failure and compare to design predictions from ENSC 2143. Preparation of formal reports, including the presentation of plots, figures and table.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Dean of Engineering

## ENSC 2143 Strength of Materials

**Prerequisites:** ENSC 2113 with grade of "C" or better.

**Description:** Bending moments, deformation and displacement in elastic and plastic deformable bodies. Axial, torsional and shear loads. Buckling stress transformations and combined loads.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Dean of Engineering

## ENSC 2213 Thermodynamics

**Prerequisites:** A grade of "C" or better in CHEM 1314, CHEM 1414 or CHEM 1515, MATH 2144, PHYS 2014.

**Description:** Properties of substances and principles governing changes in form of energy. First and second laws.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Dean of Engineering

## ENSC 2611 Electrical Fabrication Lab

**Prerequisites:** ENSC 2613 or concurrent enrollment in ENSC 2613 or ECEN 2714 or concurrent enrollment in ECEN 2714 or permission of instructor.

**Description:** This course will cover electrical fabrication techniques including schematic capture, printed circuit board layout, circuit board milling, cabling, heat sinks, soldering and package design. An emphasis on a hands-on experience with modern PCB fabrication tools and equipment will be central to this course.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Dean of Engineering

## ENSC 2613 Introduction to Electrical Science

**Prerequisites:** MATH 2153 and PHYS 2114.

**Description:** Elements of electrical engineering; AC and DC circuits, mesh and node formulation of network equations, steady-state response to sinusoids, energy, power and power factor.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Dean of Engineering

## ENSC 3231 Fluids and Hydraulics Lab

**Prerequisites:** Concurrent enrollment in ENSC 3233 or MET 3313 or FPST 2483 or MAE 3333 or permission of instructor.

**Description:** Laboratory providing hands-on experience with standard measurement techniques of fluid mechanics and their applications. Develop and conduct appropriate experimentation, analyses and interpret data to draw conclusions using engineering judgment. Comparison of analytical models introduced in an introductory fluid mechanics course to the actual behavior of real fluid flows. Preparation of formal reports, including the presentation of plots, figures, and tables.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Dean of Engineering

## ENSC 3233 Fluid Mechanics

**Prerequisites:** ENSC 2113 and MATH 2153 with a grade of "C" or better.

**Description:** The study of fluid properties, statics, conservation equations, dimensional analysis and similitude, viscous flow in ducts, inviscid flow, boundary layer theory, open channel flow, turbomachinery and fluid measurement techniques.

**Credit hours:** 3

**Contact hours:** Lecture: 2 Contact: 3 Other: 1

**Levels:** Undergraduate

**Schedule types:** Discussion, Combined lecture & discussion, Lecture

**Department/School:** Dean of Engineering

**ENSC 3313 Materials Science**

**Prerequisites:** CHEM 1314 or CHEM 1414 or CHEM 1515.

**Description:** Introductory level. Relationship between structure and properties of materials and engineering applications. Atomic, microscopic and macroscopic properties.

**Credit hours:** 3

**Contact hours:** Lecture: 3 Contact: 3

**Levels:** Undergraduate

**Schedule types:** Lecture

**Department/School:** Dean of Engineering

**ENSC 3431 Thermodynamics and Heat Transfer Lab**

**Prerequisites:** Concurrent enrollment in ENSC 2213 or MET 3433 or MAE 3233 or MET 3453 or MET 4433 or permission of the instructor.

**Description:** Laboratory providing hands-on experience with engineering topics related to fundamental principles of Thermodynamics and Heat Transfer.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Dean of Engineering

**ENSC 3451 Heat Transfer Lab**

**Prerequisites:** Concurrent enrollment in MAE 3233 or MET 3453 or MET 4433 or permission of the instructor.

**Description:** Laboratory providing hands-on experience with engineering topics related to fundamental principles of Heat Transfer.

**Credit hours:** 1

**Contact hours:** Lab: 2 Contact: 2

**Levels:** Undergraduate

**Schedule types:** Lab

**Department/School:** Dean of Engineering

## ECE Faculty Contact List<sup>1</sup>

### Power and Energy

- Prof. Hantao Cui, 204 GAB ([h.cui@okstate.edu](mailto:h.cui@okstate.edu))
- Prof. Hamidreza Nazaripouya, 219 GAB ([hanazar@okstate.edu](mailto:hanazar@okstate.edu))

### Computer Engineering

- Prof. Bingzhe Li, 206 GAB ([bingzhe.li@okstate.edu](mailto:bingzhe.li@okstate.edu))
- Prof. Weihua Sheng, 211 GAB ([weihua.sheng@okstate.edu](mailto:weihua.sheng@okstate.edu))
- Prof. James Stine, 215B GAB ([james.stine@okstate.edu](mailto:james.stine@okstate.edu))

### Electronics

- Prof. Wooyeol Choi, 210 GAB ([wchoi@okstate.edu](mailto:wchoi@okstate.edu))
- Prof. John Hu, 222 GAB ([john.hu@okstate.edu](mailto:john.hu@okstate.edu))

### Control Systems, Communications and Signal Processing

- Prof. Sabit Ekin, 223 GAB ([sabit.ekin@okstate.edu](mailto:sabit.ekin@okstate.edu))
- Prof. Guoliang Fan, 220 GAB ([guoliang.fan@okstate.edu](mailto:guoliang.fan@okstate.edu))
- Prof. Gary Yen, 205 GAB ([gyen@okstate.edu](mailto:gyen@okstate.edu))

### Microwaves and Photonics

- Prof. Chuck Bunting, 206 GAB ([reverb@okstate.edu](mailto:reverb@okstate.edu))
- Prof. John O'Hara, 224 GAB ([oharaj@okstate.edu](mailto:oharaj@okstate.edu))
- Prof. Daqing Piao, 218 GAB ([daqing.piao@okstate.edu](mailto:daqing.piao@okstate.edu))
- Prof. James West, 216 GAB ([jwest@okstate.edu](mailto:jwest@okstate.edu))
- Prof. Jeffrey Young, 215A GAB ([jl.young@okstate.edu](mailto:jl.young@okstate.edu))
- Prof. Weili Zhang, 221 GAB ([wwzhang@okstate.edu](mailto:wwzhang@okstate.edu))

### Senior Design

- Prof. Nate Lannan, 203 GAB ([lannan@ostatemail.okstate.edu](mailto:lannan@ostatemail.okstate.edu))

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<sup>1</sup> Revised September 13, 2021