

**Electrical and Computer Engineering
Undergraduate Advising Handbook
for
ECE Undergraduate Students¹**

¹Revision Date: February 18, 2019

Table of Contents

Introduction

Electrical Engineering Degree: Course Advising Sheet

Electrical Engineering Degree: Flow Chart

Computer Engineering Degree: Course Advising Sheet

Computer Engineering Degree: Flow Chart

Electrical Engineering and Computer Engineering Dual Degree: Course Advising Sheet

Participation in Interdisciplinary Design by ECE Students

Summary: Electrical and Computer Engineering 2000, 3000, and 4000 level courses

Catalog: ECEN Course List for the BSEE and BSCpE Programs

Electrical and Computer Engineering Faculty List

Introduction

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. Students will receive advice throughout their stay at OSU from both faculty and staff. Pre-Professional School students will receive advice from the Pre-Professional School Advisor in CEAT Student Services. Professional School students will receive advice from the ECE Professional School Advisor and from ECE faculty. That advice along with this handbook will help students to 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 (BSEE) or the BS in Computer Engineering (BSCpE) 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.”**

Each Professional School student is assigned for advisement to an ECE faculty member. That assignment can be found using Banner (<https://my.okstate.edu>). Students are strongly encouraged to discuss all aspects of the curriculum, career, and technologies of electrical engineering or computer engineering with their faculty adviser. The ECE Professional School Advisor will assist students with non-ECE course selections, prerequisite compliance, degree audit, graduation requirements, and other nuances associated with the ECE programs.

Students pursuing the BS degree in Electrical Engineering are required, prior to graduation¹, to have taken a set of area courses in a single sub-discipline in ECE. Sub-disciplines include a) communications (Com), control systems, and digital signal processing (DSP), b) power and energy, c) computer and digital, d) electronics and solid state, and e) microwaves and photonics. The set of area courses is listed in this handbook and includes one 3000 level prerequisite course and three 4000 level depth courses. Students are encouraged to select an area that is closely aligned with their career goals. ECE faculty can provide advice about the alignment of career goals with any given area. To facilitate a conversation between BSEE students and faculty, the following list provides a brief overview of each area:

- Communications: wireless technologies, internet, information theory, data networks, encryption, security, digital and analog modulation, encoding and decoding, noise, telecommunications, GPS
- Control Systems: Robotics, mechatronics, autonomous vehicles, embedded control, feedback, compensation, stability, neural networks, optimization, intelligent systems

¹ Area selection is not needed, or necessarily encouraged, upon entry into Professional School.

- Digital Signal Processing: Machine vision, pattern and voice recognition, speech synthesis, video and image processing, digital filters, analog/digital interfaces, data mining, graphical processors
- 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
- Computers and Digital: 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, sequential and combinational logic, peripherals
- Electronics and Solid State: 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 are by default taking a set of area courses in Computers and Digital along with additional topics in computer science, including discrete mathematics, programming, data structures, and operating systems.

Students also have the option to pursue a dual degree in electrical engineering and computer engineering. This dual degree program requires 136 credit hours to complete (i.e., 12 credit hours beyond the BSCpE program). In principle, it can be completed in four years by taking approximately 17 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 dual and “4+1” programs with their faculty, pre-professional school, and professional 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.

Course advising sheets for the BSEE program, BSCpE program, and the dual degree program are available in this Handbook. Flow charts are also provided to show the flow of all courses for the BS degrees in electrical engineering or computer engineering.

This handbook also lists the 2000, 3000, and 4000 level courses offered by the School along with their corresponding course catalog entries. In most cases, the ECEN course numbering scheme adheres to the following guidelines: 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 → Power and Energy
- B = 2 → Computers and Digital Electronics
- B = 3 → Analog Electronics and Solid State
- 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.

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

Electrical Engineering (123 CH): Course Advising Sheet¹

Ia. Pre-Professional School Core Requirement (13 CH): ECEN 2714, ECEN 3233, ENSC 2113, ENSC 3213

Ib. Pre-Professional School Computer Science Requirement (6 CH): CS1113 and either CS 2133 or CS 2433

II. Junior Breadth Requirement (14 CH): ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714.

III. Area Requirement (12 CH): Choose a set of area courses from columns A, B, C, D, OR, E in the table below. An “Area” does not need to be selected upon entering Professional School; an “Area” needs to be completed upon graduation. Substitutions are allowed with ECE approval.

	A	B	C	D	E
	Com/Controls/ DSP	Power/Energy	Computer/ Digital	Electronics/ Solid State	Microwaves/ Photonics
Area Prereq.	ECEN 3723	ECEN 3723 or ECEN 3913	ECEN 3723 or ECEN 3913	ECEN 3913	ECEN 3623
Area Depth	ECEN 4413	ECEN 3113	ECEN 4213	ECEN 4313	ECEN 4613
Area Depth	ECEN 4523 or ECEN 4533	ECEN 4133	ECEN 4243	ECEN 4353	ECEN 4823
Area Depth	ECEN 4763	ECEN 4153	ECEN 4303	ECEN 4413	ECEN 4353 or ECEN 4843

IV. Senior Breadth Requirement (6 CH): Choose any two ECEN 4000 level courses. Exclusions or with ECE approval: ECEN 4010, ECEN 4030. (Other courses, 3000 level or above, in engineering, engineering science, math, physics, chemistry, computer science, or statistics may be allowed with ECE approval.)

V. Controlled Elective (3 CH): Choose a) ENSC 2123, ENSC 2143, or ENSC 2213, b) any ENSC or ENGR course that is 3000 level or above, OR, c) choose 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):

¹ Revision Date: May 26, 2018

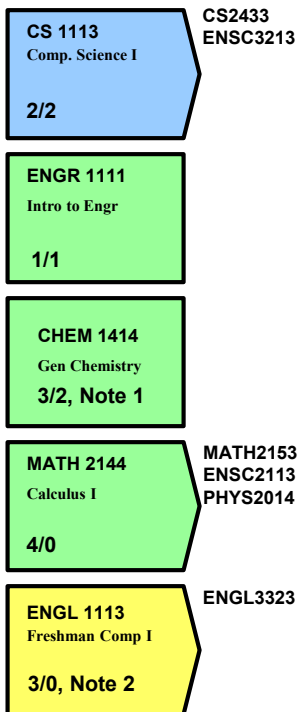
- ECEN 4030
- BAE 4001, BAE 4012, BAE 4400
- CHEM 4990
- CIVE 4010, CIVE 4041, CIVE 4043
- CS 3570, CS 4570, CS 4993
- IEM 4010, IEM 4020, IEM 4913, IEM 4931
- MAE 4010, MAE 4342, MAE 4344, MAE 4353, MAE 4354, MAE 4363, MAE 4374
- MATH 3403, MATH 3603, MATH 3910, MATH 3933, MATH 4033, MATH 4590, MATH 4900, MATH 4910
- PHYS 4010, PHYS 4712, PHYS 4993
- STAT 4053, STAT 4063, STAT 4910, STAT 4981, STAT 4991, STAT 4993

VI. Professional School Advanced Engineering Math and Design Requirements (10 CH): ECEN 4503, ECEN 4013, ECEN 4024.

Electrical Engineering Course Plan (EE) Pre-Professional School

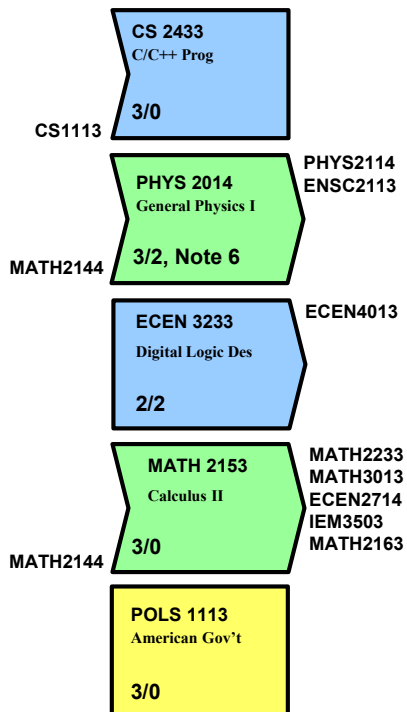
2019-2020

Semester 1 15 Credit Hours



CS2433
ENSC3213

Semester 2 16 Credit Hours

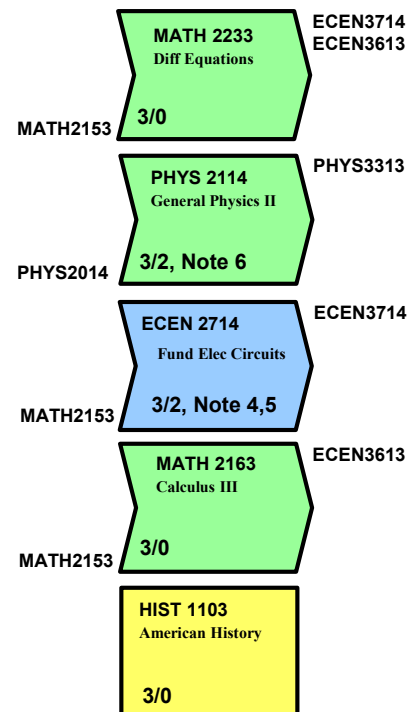


CS1113

MATH2144

MATH2144

Semester 3 17 Credit Hours



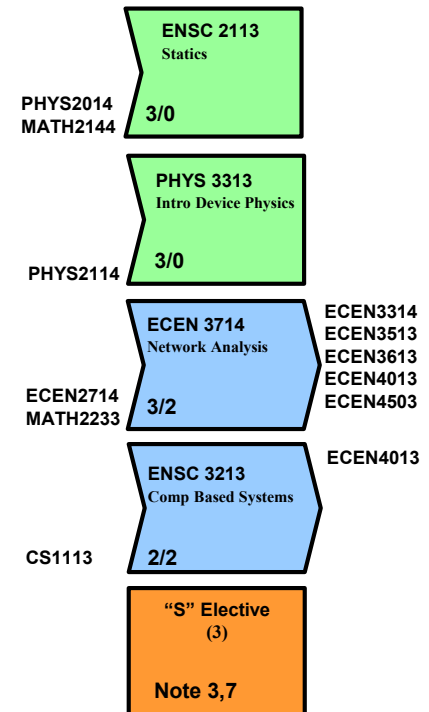
MATH2153

PHYS2014

MATH2153

MATH2153

Semester 4 16 Credit Hours



PHYS2014
MATH2144

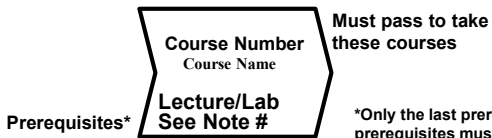
PHYS2114

ECEN2714
MATH2233

CS1113

ECEN3314
ECEN3513
ECEN3613
ECEN4013
ECEN4503

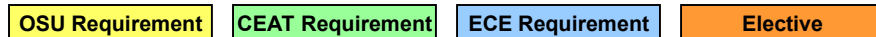
ECEN4013



Must pass to take these courses

Prerequisites*

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



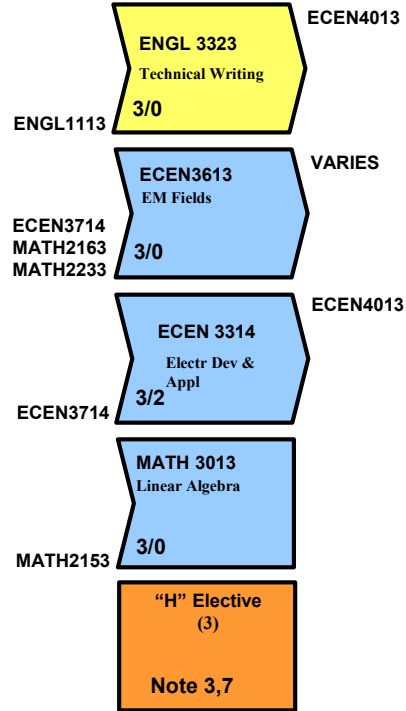
NOTES:

- 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 6 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) 3 SCH chosen from the Area (Prereq) Requirement on the EE Course Advising Sheet.
- 9) 9 SCH during the senior year to meet Area (Depth) Requirement on the EE Course Advising Sheet.
- 10) 6 SCH during the senior year to meet the Senior Breadth requirement on the EE Course Advising Sheet.
- 11) 3 SCH during the senior year to meet the Controlled Elective requirement on the EE Course Advising Sheet.

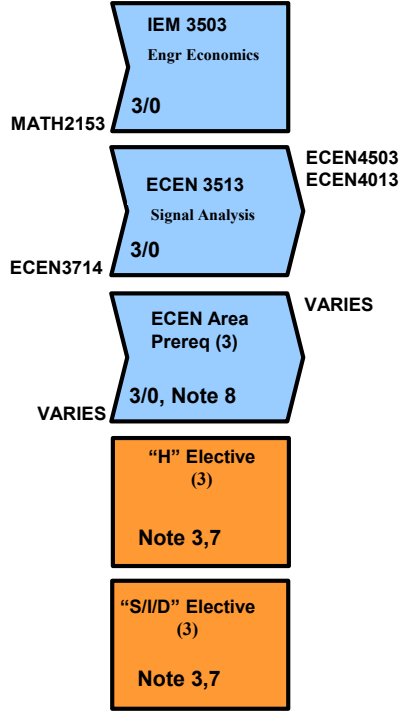
Suggested Course Plan

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, on average, 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.

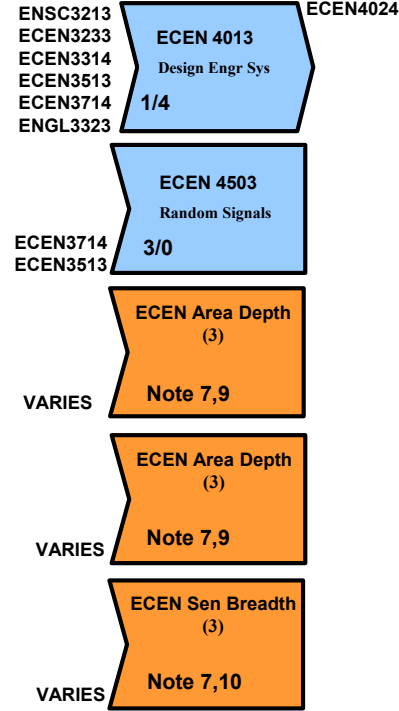
Semester 5
16 Credit Hours



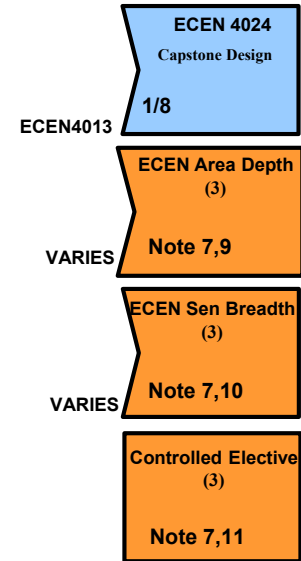
Semester 6
15 Credit Hours



Semester 7
15 Credit Hours



Semester 8
13 Credit Hours

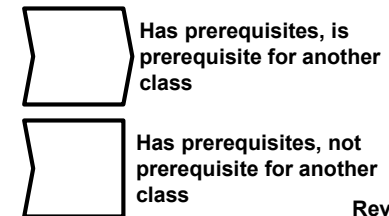
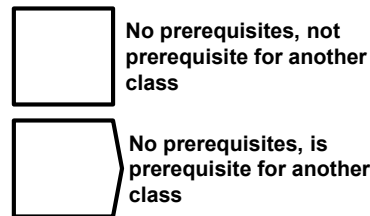


Professional School Entry Requirements:

- Completion of at least 60 college level semester credit hours (SCH).
- Completion of at least 12 SCH from OSU.
- Completion of MATH 2144, 2153, 2163, 2233; PHYS 2014 and 2114; CHEM 1414; ENGR 1111; ENSC 2113, 3213; ECEN 2714, 3233; ENGL 1113 or 1313; CS 1113, 2433.
- A grade of "C" or better in each of those courses listed above.
- GPA Requirements for Professional School: Technical GPA: 2.70, OSU GPA: 2.60, OSU Technical GPA: 2.70.

•This flowchart is only an advising instrument. When conflicts occur, the official 2019-2020 Degree Requirement Sheet takes precedence. Always check for the most current version of this flowchart.

•Admission to Professional School is required to take upper level ECEN-prefix courses. Please refer to the OSU Catalog corresponding to your matriculation date for detailed admission requirements.



Computer Engineering (124 CH): Course Advising Sheet

Ia. Pre-Professional School Core Requirement (10 CH): ECEN 2714, ECEN 3233, ENSC 3213.

Ib. Pre-Professional School Computer Science Requirement (7 CH): CS1113, CS 2133, CS 2351

II. Junior Breadth Requirement (14 CH): ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714.

III. Area Requirement (18 CH): ECEN 4213, ECEN 4243, ECEN 4303, CS 3353, CS 3653, CS 4323.

IV. Senior Breadth Requirement (3 CH): Choose one of the following courses: ECEN 4233, ECEN 4273, ECEN 4283.

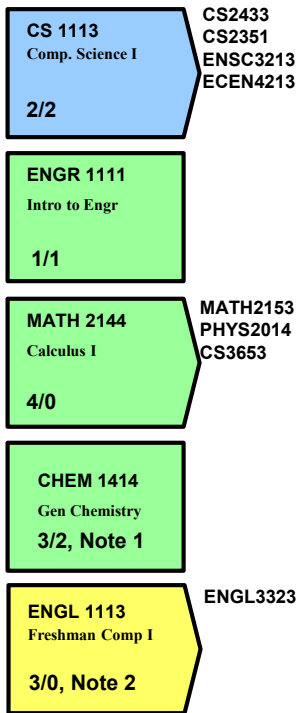
V. Controlled Elective (3 CH): Choose a) ENSC 2113, ENSC 2123, ENSC 2143, or ENSC 2213, b) any ENSC or ENGR course that is 3000 level or above, OR, c) choose any course, 3000 level or above, from ECEN, BAE, MAE, CIVE, IEM, PHYS, MATH, CHEM, STAT, or CS. Exclusions or with ECE approval (and in some cases, approval from other departments):

- ECEN 4030
- 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

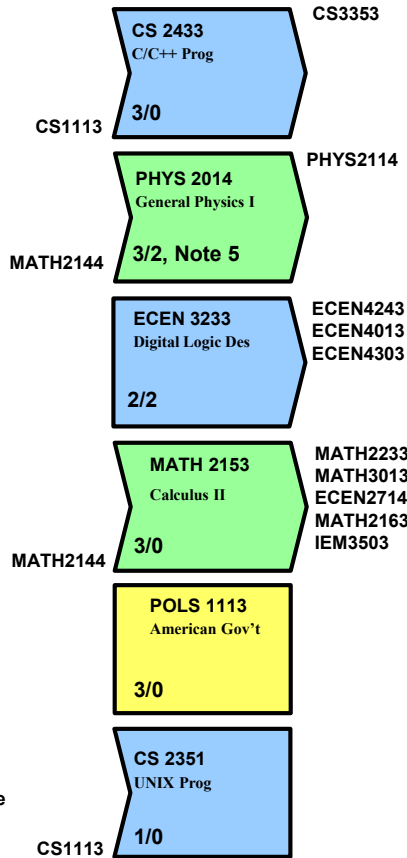
VI. Professional School Advanced Engineering Math and Design Requirements (10 CH): ECEN 4503, ECEN 4013, ECEN 4024.

Computer Engineering Course Plan (CpE) *Pre-Professional School* 2019-2020

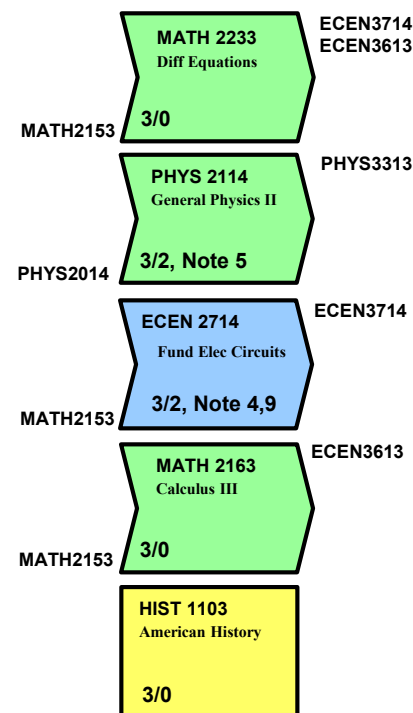
Semester 1 15 Credit Hours



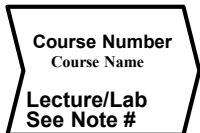
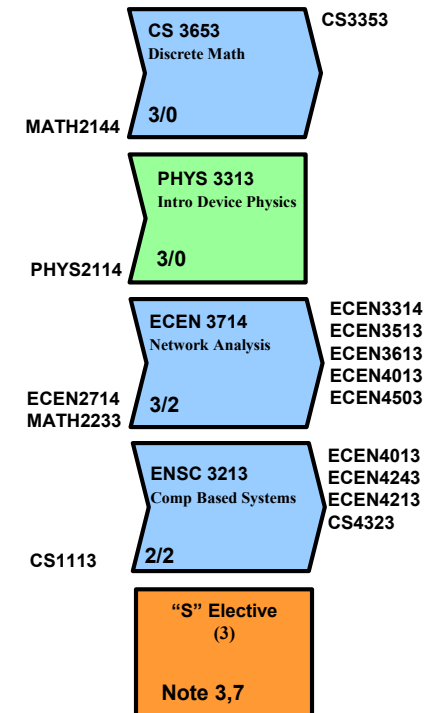
Semester 2 17 Credit Hours



Semester 3 17 Credit Hours



Semester 4 16 Credit Hours



Must pass to take these courses

Prerequisites*

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



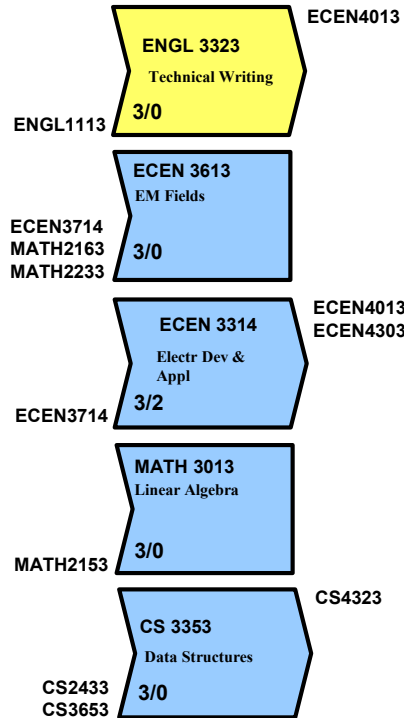
- NOTES:**
- CHEM 1515 may be substituted for CHEM 1414 and should be taken by all students considering medical school.
 - Students with less than a "B" in ENGL 1113 or 1313 must take ENGL 1213 or 1413 prior to ENGL 3323.
 - A total of at least 6 hours designated "H" and 6 hours designated "S" are required. Of these, 3 hrs must meet the International Dimension "I" component and 3 hrs must meet the Diversity "D" component.
 - ECEN 2714 replaces ENSC 2613 effective fall 2018.
 - General Physics I and II are key prerequisites and should be taken at the earliest possible time.
 - Choose from courses specified on the CpE Course Advising Sheet, section IV.
 - Must be at least 3 SCH.
 - 3 SCH during the senior year to meet the Controlled Elective requirement on the CpE Course Advising Sheet, section V.
 - MATH 2233 and PHYS 2114 must be taken prior to or at the same time as ECEN 2714.

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, on average, 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.

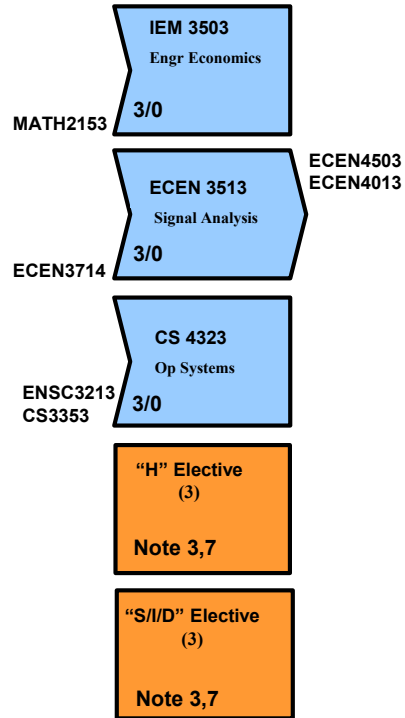
Computer Engineering Course Plan (CpE) *Professional School*

2019-2020

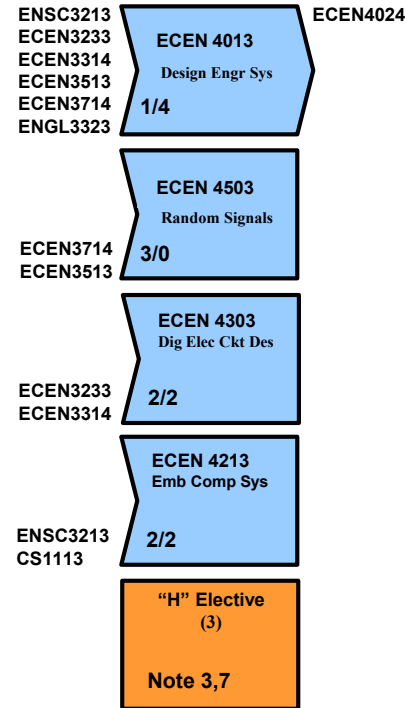
Semester 5 16 Credit Hours



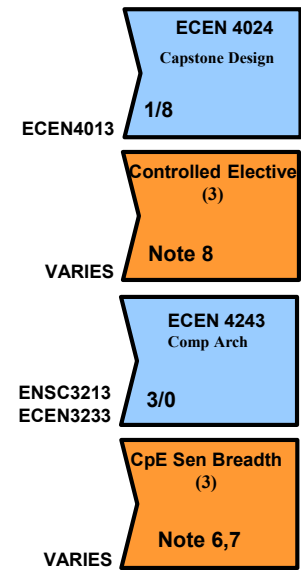
Semester 6 15 Credit Hours



Semester 7 15 Credit Hours



Semester 8 13 Credit Hours

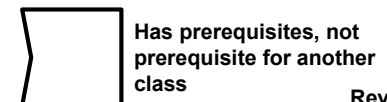
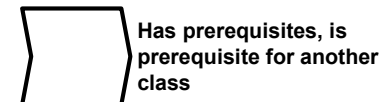
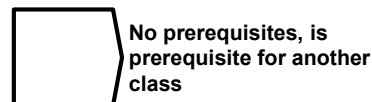
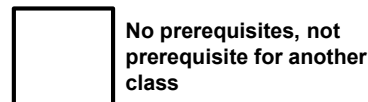


Professional School Entry Requirements:

- Completion of at least 60 college level semester credit hours (SCH).
- Completion of at least 12 SCH from OSU.
- Completion of MATH 2144, 2153, 2163, 2233; PHYS 2014 and 2114; CHEM 1414; ENGR 1111; ENSC 3213; ECEN 2714, 3233; ENGL 1113 or 1313; CS 1113, 2433, 2351.
- A grade of "C" or better in each of those courses listed above.
- GPA Requirements for Professional School: Technical GPA: 2.70, OSU GPA: 2.60, OSU Technical GPA: 2.70.

•**This flowchart is only an advising instrument. When conflicts occur, the official 2019-2020 Degree Requirement Sheet takes precedence. Always check for the most current version of this flowchart.**

•**Admission to Professional School is required to take upper level ECEN-prefix courses.** Please refer to the OSU Catalog corresponding to your matriculation date for detailed admission requirements.



Computer Engineering and Electrical Engineering Dual Degree (136 CH)

Course Advising Sheet

Ia. Pre-Professional School Core Requirement (13 CH): ECEN 2714, ECEN 3233, ENSC 2113, ENSC 3213

Ib. Pre-Professional School Computer Science Requirement (7 CH): CS 1113, CS 2133, CS 2351

II. Junior Breadth Requirement (14 CH): ECEN 3314, ECEN 3513, ECEN 3613, ECEN 3714.

IIIa. Computer Engineering Area Requirement (18 CH): ECEN 4213, ECEN 4243, ECEN 4303, CS 3353, CS 3653, CS 4323.

IIIb. Electrical Engineering Area Requirement (12 CH): Choose any four area courses from columns A, B, D, OR, E in the table below. An “Area” does not need to be selected upon entering Professional School; an “Area” needs to be completed upon graduation. Substitutions, except ECEN 32XX and ECEN 42XX (i.e., computer engineering courses), are allowed with ECE approval.

	A	B	C	D	E
	Com/Controls/ DSP	Power/Energy	Computer/ Digital	Electronics/ Solid State	Microwaves/ Photonics
Area Prereq.	ECEN 3723	ECEN 3723 or ECEN 3913	ECEN 3723 or ECEN 3913	ECEN 3913	ECEN 3623
Area Depth	ECEN 4413	ECEN 3113	ECEN 4213	ECEN 4313	ECEN 4613
Area Depth	ECEN 4523 or ECEN 4533	ECEN 4133	ECEN 4243	ECEN 4353	ECEN 4823
Area Depth	ECEN 4763	ECEN 4153	ECEN 4303	ECEN 4413	ECEN 4353 or ECEN 4843

IVa. Computer Engineering Senior Breadth Requirement (3 CH): Choose one of the following courses: ECEN 4233, ECEN 4273, ECEN 4283.

IVb. Electrical Engineering Senior Breadth Requirement (6 CH): This requirement is automatically satisfied by the requirements listed in Section IIIa.

Va. Computer Engineering Controlled Elective (3 CH): This requirement is automatically satisfied by the requirements listed in Section Ia (i.e., ENSC 2113).

Vb. Electrical Engineering Controlled Elective (3 CH): This requirement is automatically satisfied by the requirements listed in Section IIIa or IVa.

VI. Professional School Advanced Engineering Math and Design Requirements (10 CH): ECEN 4503, ECEN 4013, ECEN 4024.

Participation in Interdisciplinary Design by ECE Students

Opportunities may exist for ECE BSEE and CpE students to participate in interdisciplinary design projects sponsored by CEAT. These team-based projects are typically intended for senior level students. ECE students may receive course credit for such a project in two ways:

1. **Preferable:** An interdisciplinary design project offered under an ENGR 4000 level number may be used as three hours of Controlled Elective as shown on the appropriate Course Advising Sheet in the ECE Undergraduate Advising Handbook available on the ECE web site. A maximum of three credit hours may be counted even if the course offers more credit hours¹. Approval is granted by the academic adviser and appropriately documented during the advising session.
2. **Allowable:** Approval from ECE may be requested to use a four credit hour CEAT interdisciplinary design project in place of the normal ECE capstone project in ECEN4024. In this case, the student will enroll in ECEN4024 as per the EE and CpE degree requirements and then request permission to substitute the CEAT interdisciplinary project for a project in ECEN4024². Requests for approval of an interdisciplinary design project may be submitted to the faculty instructor for ECEN4024, who will serve as the point of contact within ECE. If participation in the interdisciplinary project is approved, the student will remain enrolled in ECEN4024, since it is a requirement for the degree, but will participate on the interdisciplinary project. Appropriate documentation must be maintained by the academic adviser and the ECEN 4024 instructor that justifies the substitution. It is also critical that ABET assessment materials associated with the interdisciplinary design project be transferred to the ECEN 4024 instructor.

¹ This applies primarily to the EE and CpE BS degree programs. There are no free Controlled Elective hours available in the ECE EE+CpE BS Dual Degree program, so this would add three hours beyond the listed requirements.

² Availability of appropriate interdisciplinary design projects may be limited and not all interdisciplinary projects may be approved as suitable substitutes for EE or CpE students. Students may request to participate on specific EE, CpE or interdisciplinary projects, but approval is given on a case-by-case basis.

ECEN Courses for the BSEE and BSCpE Degrees

- ECEN 2714 - Fundamentals of Electric Circuits
- ECEN 3113 - Energy, Environment and Economics
- ECEN 3233 - Digital Logic Design
- ECEN 3314 - Electronic Devices and Applications
- ECEN 3513 - Signal Analysis
- ECEN 3613 - Electromagnetic Fields
- ECEN 3623 - Mathematical Foundations of Electromagnetics and Photonics
- ECEN 3714 - Network Analysis
- ECEN 3723 - Systems I
- ECEN 3903 - Introduction to Semiconductor Devices
- ECEN 3913 - Solid State Electronic Devices
- ECEN 4013 - Design of Engineering Systems
- ECEN 4024 - Capstone Design
- 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
- ECEN 4413 - Automatic Control Systems
- ECEN 4503 - Random Signals and Noise
- ECEN 4523 - Communication Theory
- ECEN 4533 - Data Communications
- ECEN 4613 - Microwave Engineering
- ECEN 4703 - Active Filter Design
- 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

ELECTRICAL & COMPUTER ENGINEERING (ECEN)

ECEN 2011 Experimental Methods I

Prerequisites: PHYS 2114; Co-requisite(s): ENSC 2613

Description: Basic electrical measurements and instrumentation techniques and devices. Use of voltmeters, ammeters, oscilloscopes, impedance bridges to study resistive, inductive, and capacitive circuit elements in steady state and transient operation. Reinforces ENSC 2613 and introduces design of instrumentation networks. Serves as introduction for non-majors. Previously offered as ECEN 3013.

Credit hours: 1

Contact hours: Lab: 2

Levels: Undergraduate

Schedule types: Lab

Department/School: Elec & Computer Engr

ECEN 2714 Fundamentals of Electric Circuits

Prerequisites: MATH 2153 and PHYS 2114.

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

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: Other: 1

Levels: Undergraduate

Schedule types: Independent Study

Department/School: Elec & Computer Engr

ECEN 3113 Energy, Environment and Economics

Prerequisites: ECEN 3714, degree program requires admission to Professional School prior to enrollment.

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

Levels: Undergraduate

Schedule types: Lecture

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

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and lab

Department/School: Elec & Computer Engr

ECEN 3314 Electronic Devices and Applications

Prerequisites: ECEN 3714, degree program requires admission to Professional School prior to enrollment.

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

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and lab

Department/School: Elec & Computer Engr

ECEN 3513 Signal Analysis

Prerequisites: ECEN 3714.

Description: Degree program requires admission to Professional School prior to enrollment. Deterministic signals. Fourier series and Fourier transforms. Impulse response, convolution and correlation. Sampling theorem. Analog modulation techniques.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 3613 Electromagnetic Fields

Prerequisites: ENSC 2714 with a minimum grade of "C" or better, MATH 2163 and MATH 2233.

Description: Time-harmonic and transient response of transmission lines. Maxwells equations and their applications to engineering problems in electrostatics, magnetostatics, time-harmonic fields and plane wave propagation.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 3623 Mathematical Foundations of Electromagnetics and Photonics

Prerequisites: ECEN 3613 and degree program requires admission to Professional School prior to enrollment.

Description: Mathematical and computational treatment of fundamental electromagnetic theory, with applications to microwave engineering, photonics and semiconductor design. Energy and power; Laplace and Poisson equations; wave equation, including reflection, refraction, and diffraction; and classical electromagnetic radiation at macroscopic and microscopic levels.

Credit hours: 3

Contact hours: Lecture: 2 Lab: 2

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and lab

Department/School: Elec & Computer Engr

ECEN 3714 Network Analysis

Prerequisites: ECEN 2714 with a minimum grade of "C" or better and MATH 2233.

Description: Laplace transform, transfer functions, magnetically coupled circuits and two-port networks. Theoretical concepts and methods are demonstrated and reinforced through laboratory exercises. Course previously offered as ECEN 3713.

Credit hours: 4

Contact hours: Lecture: 3 Lab: 2

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and lab

Department/School: Elec & Computer Engr

ECEN 3723 Systems I

Prerequisites: ENSC 2113 and ECEN 2714 with a minimum grade of "C" or better, and MATH 2233.

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

Levels: Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 3903 Introduction to Semiconductor Devices

Prerequisites: PHYS 2114 or equivalent.

Description: Crystal structure, the quantum theory of solids. The physics of semiconductor materials and the p-n junction, with an emphasis on applications to semiconductor devices. Same course as PHYS 3313.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 3913 Solid State Electronic Devices

Prerequisites: ECEN 2714 with a minimum grade of "C" or better and either PHYS 3313 or ECEN 3903. Degree program requires admission to Professional School prior to enrollment.

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

Levels: Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4010 Technical Problems and Engineering Design

Prerequisites: Consent of instructor.

Description: Individual independent study projects selected in consultation with the instructor; analysis or design problems, literature searches and computer simulations may be involved. Offered for variable credit, 1-12 credit hours, maximum of 12 credit hours.

Credit hours: 1-12

Contact hours: Other: 1

Levels: Graduate, Undergraduate

Schedule types: Independent Study

Department/School: Elec & Computer Engr

ECEN 4013 Design of Engineering Systems

Prerequisites: ECEN 3513, ECEN 3714, ECEN 3314, ECEN 3233 and ENSC 3213. ENGL 3323 as co-requisites. Degree program requires admission to professional school prior to 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: 1 Lab: 4

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and lab

Department/School: Elec & Computer Engr

ECEN 4024 Capstone Design

Prerequisites: ECEN 4013; degree program requires admission to Professional School prior to enrollment.

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: Lecture: 3 Lab: 2

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and 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:** Other: 1**Levels:** Undergraduate**Schedule types:** Independent Study**Department/School:** Elec & Computer Engr**ECEN 4133 Power Electronics****Prerequisites:** Degree program requires admission to Professional School prior to enrollment.**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**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4153 Power System Analysis and Design****Prerequisites:** Degree program requires admission to Professional School prior to enrollment.**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**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4213 Embedded Computer Systems Design****Prerequisites:** ENSC 3213 and CS 1113.**Description:** Degree program requires admission to Professional School prior to enrollment. 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**Levels:** Graduate, Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 4233 High Speed Computer Arithmetic****Prerequisites:** ECEN 3233; degree program requires admission to Professional School prior to enrollment.**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**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4243 Computer Architecture****Prerequisites:** ENSC 3213 and ECEN 3233.**Description:** Degree program requires admission to Professional School prior to enrollment. 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**Levels:** Graduate, Undergraduate**Schedule types:** Lab, Lecture, Combined lecture and lab**Department/School:** Elec & Computer Engr**ECEN 4273 Software Engineering****Prerequisites:** ENSC 3213 or CS 1113, CS 3443.**Description:** Degree program requires admission to Professional School prior to enrollment. 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**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4283 Computer Networks****Prerequisites:** ENSC 3213 or CS 3443.**Description:** Degree program requires admission to Professional School prior to enrollment. 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**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr**ECEN 4303 Digital Integrated Circuit Design****Prerequisites:** ECEN 3233 and ECEN 3314; degree program requires admission to Professional School prior to enrollment.**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**Levels:** Graduate, Undergraduate**Schedule types:** Lecture**Department/School:** Elec & Computer Engr

ECEN 4313 Linear Electronics Circuit Design

Prerequisites: ECEN 3314; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4353 Communication Electronics

Prerequisites: ECEN 3314; degree program requires admission to Professional School prior to enrollment.

Description: Design of tuned voltage and power amplifiers, oscillators and mixers, modulation and detection, and parametric amplifiers.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4413 Automatic Control Systems

Prerequisites: ECEN 3723 or MAE 3723; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4503 Random Signals and Noise

Prerequisites: ECEN 3513, ECEN 3714; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4523 Communication Theory

Prerequisites: ECEN 3513 and ECEN 4503. Degree program requires admission to Professional School prior to enrollment.

Description: Noise in modulation systems. Digital data transmission. Design of optimal receivers. Introduction to information theory.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4533 Data Communications

Prerequisites: ECEN 4503 as co-requisite.

Description: Degree program requires admission to Professional School prior to enrollment. 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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4613 Microwave Engineering

Prerequisites: ECEN 3613; degree program requires admission to Professional School prior to enrollment.

Description: Aspects of propagation, transmission, and radiation of microwave energy. Plane wave propagation; lossless and lossy media, reflection, refraction, and polarization. Transmission line theory; lumped element model, characteristic impedance, impedance matching, and transient response. Theory of waveguides and cavity resonators. Microwave network theory and S-parameters. Introduction to radiating systems.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4703 Active Filter Design

Prerequisites: ECEN 3613; degree program requires admission to Professional School prior to enrollment.

Description: Introduction to passive filters; operational amplifiers as network elements; filter specifications; design of active filters. Laboratory design projects and computer simulations.

Credit hours: 3

Contact hours: Lecture: 3

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4743 Introduction to Biomedical Engineering Modeling and Systems

Prerequisites: ECEN 3714, ECEN 4763; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4763 Introduction to Digital Signal Processing

Prerequisites: ECEN 3513; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4773 Real Time Digital Signal Processing

Prerequisites: ECEN 4763 or equivalent; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ECEN 4823 Design of Optical Systems

Prerequisites: PHYS 2114; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, Undergraduate

Schedule types: Lab, Lecture, Combined lecture and lab

Department/School: Elec & Computer Engr

ECEN 4843 Design of Lasers and Systems

Prerequisites: ECEN 3613; degree program requires admission to Professional School prior to enrollment.

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

Levels: Graduate, 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: Other: 1

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: Other: 1

Levels: Graduate

Schedule types: Independent Study

Department/School: Elec & Computer Engr

ECEN 5060 Special Topics

Prerequisites: Consent of instructor.

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 30 credit hours.

Credit hours: 1-6

Contact hours: Other: 1

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: Other: 1

Levels: Graduate

Schedule types: Independent Study

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

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

Levels: Graduate

Schedule types: Lecture

Department/School: Elec & Computer Engr

ENGINEERING SCIENCE (ENSC)

ENSC 2113 Statics

Prerequisites: MATH 2144 and either PHYS 1114 or PHYS 2014 with grade 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 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 Other: 1

Levels: Undergraduate

Schedule types: Discussion, Combined lecture & discussion, Lecture

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 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 Other: 1

Levels: Undergraduate

Schedule types: Discussion, Combined lecture & discussion, Lecture

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: 3

Levels: Undergraduate

Schedule types: Lecture

Department/School: Dean of Engineering

ENSC 3213 Computer Based Systems in Engineering

Prerequisites: CS 1113 or ENGR 1412 and sophomore or higher standing.

Description: A comprehensive introduction to technology and application of microprocessors, concepts of computer and computation, interfacing and communication, data acquisition and representation. Applications of general-purpose and embedded processors in various disciplines of engineering and engineering problem solving.

Credit hours: 3

Contact hours: Lecture: 2 Lab: 2

Levels: Undergraduate

Schedule types: Lab, Lecture, Combined lecture and 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 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

Levels: Undergraduate

Schedule types: Lecture

Department/School: Dean of Engineering

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