ELECTRICAL AND COMPUTER ENGINEERING

Majors:

- Bachelor of Electrical Engineering (p. 2)
- Bachelor of Science in Computer Engineering (p. 3)

Concentrations:

- Electrical Energy Systems (p. 4)
- Robotics (p. 4)

Minors:

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The Department of Electrical and Computer Engineering offers two ABET accredited undergraduate programs leading to the Bachelor of Electrical Engineering and the Bachelor of Science in Computer Engineering. The department offers masters and doctoral degrees in electrical and computer engineering and is closely coupled to the graduate program in electro-optics where both master's and doctoral degrees are offered. The electrical and computer engineering department offers an accelerated 5 year B.S.-M.S. program, where students completing their baccalaureate degree can attain their Master of Science in Electrical Engineering or Computer Engineering within one additional year. The department also offers an undergraduate concentration in Robotics and in Electrical Energy Systems.

The mission of the Department of Electrical and Computer Engineering is to provide an educational experience of the highest quality to produce the discipline's most valued graduates, with the skills and knowledge to learn, lead, and serve in electrical and computer engineering related professions and in their communities.

Our electrical engineering and computer engineering graduates will be prepared to:

1. find rewarding careers as engineering professionals. As electrical engineers they will be prepared to design and develop new products, technologies, and processes that incorporate one or more of the following elements: analog and digital circuits, signals and systems, propagation and processing of signals, and control systems. As computer engineers they will be prepared to design and develop new products, technologies, and processes that incorporate one or more of the following elements: analog and digital circuits, signals and systems, computer design, software development, and hardware/software integration.
2. continue their professional education either formally, in graduate school, professional schools, or through industrial training programs; or informally, through activities such as continuing education, attendance in short courses, professional workshops, and conferences.
3. exercise and further develop their skills in professional communication through activities such as project briefings, conference presentations, technical reports and manuals, and journal publications.
4. participate in activities for the betterment of society, and carry on the traditions of the University of Dayton by maintaining high ethical standards in their professional activities, and by serving their country and community through service, leadership and mentoring.

Electrical engineering is an exciting field within the engineering discipline. It offers the opportunity to enter some of the most rewarding and challenging careers available. The latest developments in the computer, communication, automotive, medical, entertainment, and aerospace industries, as well as homeland security have resulted from advances in the electronics field. Electrical engineers are equipped to enter this dynamic arena as well as equally challenging and rewarding careers in the fields of electro-optics, communication, radar, signal and image processing, biomedicine, controls, robotics and instrumentation, and many more. Electrical engineers work in all phases of technological programs. They are involved from the conception of the basic ideas through design, fabrication, verification, manufacturing, and marketing of the final product.

Computer engineering represents perhaps the most sought-after professional component of an engineering team which develops the technological possibilities inherent in the design, construction, and operation of computer systems. The computer engineer performs a wide variety of tasks involving hardware, software, peripherals, computer-controlled systems, and hardware-software integration, as well as computer applications in the multitude of areas listed above.

Both electrical engineering and computer engineering are broad-based engineering disciplines that provide for a wide range of career choices within the engineering field as well as providing an excellent basis for careers in such diverse areas as business, law, and medicine.

The electrical engineering curriculum is designed to provide an understanding of basic electrical engineering principles with emphasis on the development of problem solving skills. The computer engineering curriculum draws from software courses taken in computer science and hardware related courses taken from Electrical and Computer Engineering, culminating in the integration of hardware and software in systems design. An extensive laboratory experience is integrated with the classroom work to assure that the student develops a working knowledge of the fundamentals. Upper level courses integrate the knowledge base with current technology and computational tools resulting in a graduate capable of making a contribution to the engineering profession by either entering the work force or pursuing a graduate education.

Faculty

Eric Balster, Chairperson
Professors Emeriti: Evers, Kee, Loomis, Penno, Rogers, Scarpino, Thiele, Williamson
Professors: Asari, Balster, Cao, Chatterjee, Chodavarapu, Duncan, Hardie, Hirakawa, Neidhard-Doll, Ordonez, Rigling, Subramanyam, Taha
Associate Professor: Ratliff
Adjunct Professors: Aldaouab, Aspiras, Atahary, Browning, Diskin, Grote, Harbour, Kaufman, Kebede, Kladitis, Kumar, Malas, McGuiness, Mehmood, Mohamed, Mrebit, Narayanan, Ouchen, Sargent, Shin, Skeans, Wetzel, Wung, Yakopcic, Zhang

Bachelor of Electrical Engineering (ELE) minimum 126 hours

The Common Academic Program (CAP) is an innovative curriculum that is the foundation of a University of Dayton education. It is a learning experience that is shared in common among all undergraduate students, regardless of their major. Some CAP requirements must be fulfilled by courses taken at UD (e.g., Capstone and Diversity and Social Justice). Some major requirements must also be fulfilled by courses taken at UD. Students should consult with their advisor regarding applicability of transfer credit to fulfill CAP and major program requirements.

Common Academic Program (CAP) [1]

First-Year Humanities Commons [2]		12 cr. hrs.
HST 103	Introduction to Global Historical Studies	
REL 103	Introduction to Religious and Theological Studies	
PHL 103	Introduction to Philosophy	
ENG 100	Writing Seminar I [3]	
Second-Year Writing Seminar [4]		0-3 cr. hrs.
ENG 200	Writing Seminar II	
Oral Communication		3 cr. hrs.
CMM 100	Principles of Oral Communication	
Mathematics		3 cr. hrs.
Social Science		3 cr. hrs.
Arts		3 cr. hrs.
Natural Sciences [5]		7 cr. hrs.
Crossing Boundaries		up to 12 cr. hrs.
Faith Traditions		
Practical Ethical Action		
Inquiry		
Integrative		
Advanced Study		
Philosophy and/or Religious Studies (6 cr. hrs.)		
Historical Studies (3 cr. hrs.) [6]		
Diversity and Social Justice [7]		3 cr. hrs.
Major Capstone [8]		0-6 cr. hrs.

1. The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student's degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student's major.
2. May be completed with ASI 110 and ASI 120 through the Core Program.
3. May be completed with ENG 100A and ENG 100B, by placement.
4. May be completed with ENG 114 or ENG 198 or ASI 120.
5. Must include two different disciplines and at least one accompanying lab.
6. May be completed with ASI 110 and ASI 120 through the Core Program.
7. May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student's major.
8. The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

Major in Electrical Engineering, BEE

MATHEMATICS AND SCIENCE REQUIREMENTS		
MTH 168	Analytic Geometry & Calculus I	4
MTH 169	Analytic Geometry & Calculus II	4
MTH 218	Analytic Geometry & Calculus III	4
MTH 219	Applied Differential Equations	3
Math Elective [3]		3
CHM 123	General Chemistry	3
PHY 206	General Physics I - Mechanics	3
PHY 210L	General Physics Laboratory I	1
PHY 207	General Physics II - Electricity & Magnetism	3
PHY 232	The Physics of Waves	3
CORE ELECTRICAL ENGINEERING COURSES		
EGR 102	Introduction to the University Experience for Engineers	0
EGR 103	Engineering Innovation	2
EGR 150	Enrichment Workshop I	0
EGR 200	Career Launchpad: Preparing for Success	0
or COP 200	Introduction to Engineering Cooperative Education	
EGR 270	Data Analytics Fundamentals	3
EGR 300	Professional Development for Juniors	0
EGR 400	Professional Development for Seniors	1
CPS 150	Algorithms & Programming I	4
REQUIRED TECHNICAL COURSES		
ECE 101	Introduction to Electrical & Computer Engineering II	0
ECE 201 & 201L	Circuit Analysis and Circuit Analysis Laboratory	4
ECE 204 & 204L	Electronic Devices and Electronic Devices Laboratory	4
ECE 215 & 215L	Introduction to Digital Systems and Digital Systems Laboratory	4

ECE 303 & 303L	Signals & Systems and Signals & Systems Laboratory	4
ECE 314 & 314L	Fundamentals of Computer Architecture and Fundamentals of Computer Architecture Laboratory	4
ECE 334	Discrete Signals & Systems	3
ECE 340	Engineering Probability & Random Processes	3
ECE 415	Control Systems	3
ECE 431L	Multidisciplinary Design I	2
ECE 432L	Multidisciplinary Design II	3
ELECTIVES [1]		
ECE Electives [2]		6
Engineering and Computer Science Elective [2]		6
Technical Electives		6
Total Hours		**93**

[1] Any course, 300 level and above in ECE

[2] Select from list approved by the Department of Electrical and Computer Engineering.

[3] MTH 301, 308, 404, or CPS 341 (MTH 301 preferred).

Bachelor of Science in Computer Engineering (CPE) minimum 127 hours

The Common Academic Program (CAP) is an innovative curriculum that is the foundation of a University of Dayton education. It is a learning experience that is shared in common among all undergraduate students, regardless of their major. Some CAP requirements must be fulfilled by courses taken at UD (e.g., Capstone and Diversity and Social Justice). Some major requirements must also be fulfilled by courses taken at UD. Students should consult with their advisor regarding applicability of transfer credit to fulfill CAP and major program requirements.

Common Academic Program (CAP) [1]		
First-Year Humanities Commons [2]		12 cr. hrs.
HST 103	Introduction to Global Historical Studies	
REL 103	Introduction to Religious and Theological Studies	
PHL 103	Introduction to Philosophy	
ENG 100	Writing Seminar I [3]	
Second-Year Writing Seminar [4]		0-3 cr. hrs.
ENG 200	Writing Seminar II	
Oral Communication		3 cr. hrs.
CMM 100	Principles of Oral Communication	
Mathematics		3 cr. hrs.
Social Science		3 cr. hrs.
Arts		3 cr. hrs.
Natural Sciences [5]		7 cr. hrs.
Crossing Boundaries		up to 12 cr. hrs.
Faith Traditions		
Practical Ethical Action		
Inquiry		
Integrative		
Advanced Study		
Philosophy and/or Religious Studies (6 cr. hrs.)		
Historical Studies (3 cr. hrs.) [6]		
Diversity and Social Justice [7]		3 cr. hrs.
Major Capstone [8]		0-6 cr. hrs.

[1] The credit hours listed reflect what is needed to complete each CAP component. However, they should not be viewed as a cumulative addition to a student's degree requirements because many CAP courses are designed to satisfy more than one CAP component (e.g., Crossing Boundaries and Advanced Studies) and may also satisfy requirements in the student's major.

[2] May be completed with ASI 110 and ASI 120 through the Core Program.

[3] May be completed with ENG 100A and ENG 100B, by placement.

[4] May be completed with ENG 114 or ENG 198 or ASI 120.

[5] Must include two different disciplines and at least one accompanying lab.

[6] May be completed with ASI 110 and ASI 120 through the Core Program.

[7] May not double count with First-Year Humanities Commons, Second-Year Writing, Oral Communication, Social Science, Arts, or Natural Sciences CAP components, but may double count with courses taken to satisfy other CAP components and/or courses taken in the student's major.

[8] The course or experience is designed by faculty in each major; it may, or may not, be assigned credit hours.

Major in Computer Engineering, BSC

MATHEMATICS AND SCIENCE REQUIREMENTS		
MTH 168	Analytic Geometry & Calculus I	4
MTH 169	Analytic Geometry & Calculus II	4
MTH 218	Analytic Geometry & Calculus III	4
MTH 219	Applied Differential Equations	3
CHM 123	General Chemistry	3
PHY 206	General Physics I - Mechanics	3
PHY 210L	General Physics Laboratory I	1
PHY 232	The Physics of Waves	3
CORE COMPUTER ENGINEERING COURSES		

EGR 102	Introduction to the University Experience for Engineers	0
EGR 103	Engineering Innovation	2
EGR 150	Enrichment Workshop I	0
EGR 200	Career Launchpad: Preparing for Success	0
or COP 200	Introduction to Engineering Cooperative Education	
EGR 270	Data Analytics Fundamentals	3
EGR 300	Professional Development for Juniors	0
EGR 400	Professional Development for Seniors	1
CPS 150	Algorithms & Programming I	4
CPS 151	Algorithms & Programming II	4
CPS 341	Discrete Structures	3
or MTH 308	Foundations & Discrete Mathematics	
CPS 350	Data Structures & Algorithms	3
CPS 356	Operating Systems: Modern Mobile Devices and Massive Concurrency	3
REQUIRED TECHNICAL COURSES		
ECE 101	Introduction to Electrical & Computer Engineering II	0
ECE 201 & 201L	Circuit Analysis and Circuit Analysis Laboratory	4
ECE 204 & 204L	Electronic Devices and Electronic Devices Laboratory	4
ECE 215 & 215L	Introduction to Digital Systems and Digital Systems Laboratory	4
ECE 303 & 303L	Signals & Systems and Signals & Systems Laboratory	4
ECE 314 & 314L	Fundamentals of Computer Architecture and Fundamentals of Computer Architecture Laboratory	4
ECE 334	Discrete Signals & Systems	3
ECE 340	Engineering Probability & Random Processes	3
ECE 431L	Multidisciplinary Design I	2
ECE 432L	Multidisciplinary Design II	3
ECE 449	Computer Systems Engineering	3
ELECTIVES		
Technical Elective [2]		6
Total Hours		**88**

[1] Any course 300 level and above in ECE

[2] Select from list approved by the Department of Electrical and Computer Engineering.

Concentration in Electrical Energy Systems (ENS)

The Electrical Energy Systems Concentration will prepare our Electrical and Computer Engineering students in all aspects of Electrical Energy Systems including generation, transmission, distribution, utilization, and storage, as well as enabling technologies for the smart grid.

Required ECE courses:

ECE 316	Introduction to Electrical Energy Systems	3
or ECE 499	Special Problems in Electrical & Computer Engineering	
ECE 414	Electromechanical Devices	3
ECE 471	Contemporary Power Systems & the Smart Grid	3
Select one course from:		3
ECE 472	Smart Grid Technologies	
MEE 473	Renewable Energy Systems	
Total Hours		**12**

Concentration in Robotics (ROB)

Robotics (CPE Majors)		**15**
ECE 415	Control Systems	3
ECE 416	Introduction to Industrial Robotic Manipulators	3
ECE 447	Digital Control Systems	3
Select two courses from:		6
CPS 480	Artificial Intelligence	
ECE 414	Electromechanical Devices	
ECE 444	Advanced Digital Design	
ECE 445	Signal Processing	
MEE 321	Theory of Machines	
MEE 434	Mechatronics	
MEE 438	Applied Robotics	
Robotics (ELE Majors)		**12**
ECE 416	Introduction to Industrial Robotic Manipulators	3
ECE 447	Digital Control Systems	3
Select two courses from:		6
CPS 480	Artificial Intelligence	
ECE 414	Electromechanical Devices	
ECE 444	Advanced Digital Design	
ECE 445	Signal Processing	
MEE 321	Theory of Machines	
MEE 434	Mechatronics	
MEE 438	Applied Robotics	

Minor in Computer Systems (COS)

This minor is open to chemical, civil, and mechanical engineering majors, and other students with appropriate prerequisite background who receive permission from the ECE Department Chairperson. The program builds strength in the area of computer systems and digital design, with emphasis on computer hardware. Only one course may double count for both the student's major and minor.

Computer Systems (non-MEE majors)		**16**
CPS 150	Algorithms & Programming I	4
or ECE 444	Advanced Digital Design	
ECE 215 & 215L	Introduction to Digital Systems and Digital Systems Laboratory	4
ECE 314 & 314L	Fundamentals of Computer Architecture and Fundamentals of Computer Architecture Laboratory	4
EGR 203	Electrical & Electronic Circuits	3
EGR 203L	Electrical and Electronic Circuits Lab	1
Computer Systems (MEE majors)		**15**
CPS 150	Algorithms & Programming I (or equivalent)	4

ECE 215 & 215L	Introduction to Digital Systems and Digital Systems Laboratory	4
ECE 314 & 314L	Fundamentals of Computer Architecture and Fundamentals of Computer Architecture Laboratory	4
ECE 444	Advanced Digital Design	3

Only one course may double count for both the student's major and minor.

Minor in Signals and Systems (SAS)

This minor is open to chemical, civil, and mechanical engineering majors, and other students with appropriate prerequisite background who receive permission from the ECE Department Chairperson. The program provides the essential background in signals and systems theory including continuous and discrete systems. An advanced course is selected by the students to allow them to specialize in controls or signal processing. Only one course may double count for both the student's major and minor.

ECE 203	Introduction to MATLAB Programming	1
ECE 303 & 303L	Signals & Systems and Signals & Systems Laboratory	4
ECE 334	Discrete Signals & Systems	3
ECE 415	Control Systems	3
or ECE 445	Signal Processing	
EGR 203	Electrical & Electronic Circuits	3
Total Hours		**14**

Only one course may double count for both the student's major and minor.

Electrical Engineering

First Year

Fall	Hours	Spring	Hours
ENG 100 (Satisfies CAP Writing Seminar)	3	REL 103 (Satisfies CAP First Year Humanities Common)	3
PHL 103 (Satisfies CAP First Year Humanities Common)	3	HST 103	3
PHY 206 (Satisfies CAP Natural Science)	3	CPS 150	4
MTH 168 (Satisfies CAP Math Requirement)	4	PHY 207	3
EGR 103	2	MTH 169	4
EGR 150	0	ECE 101	0
EGR 102	0		
	15		**17**

Second Year

Fall	Hours	Spring	Hours
ENG 200 (Satisfies CAP Second Year Writing Seminar)	3	CHM 123	3
CMM 100	3	PHY 210L	1
ECE 201	3	ECE 204	3
ECE 201L	1	ECE 204L	1
MTH 218	4	ECE 215	3
EGR 270	3	ECE 215L	1
EGR 200	0	MTH 219	3
	17		**15**

Third Year

Fall	Hours	Spring	Hours
SSC 200	3	ECE EL	3
PHY 232	3	ECE EL	3
MTH Elective	3	ECE 334	3
ECE 303	3	ECE 340	3
ECE 303L	1	ECE 415	3
ECE 314	3	ECE 300	0
ECE 314L	1		
	17		**15**

Fourth Year

Fall	Hours	Spring	Hours
CAP ADVANCED HISTORY ELECTIVE	3	CAP ADVANCED PHL/ REL (MAY ALSO SATISFY ADDITIONAL CA	3
CAP ADVANCED PHL/ REL (MAY ALSO SATISFY ADDITIONAL CAP COMPONENTS)	3	CAP Arts (may also satisfy additional CAP components)	3
ENGINEERING EL	3	TECH Elective	3
ENGINEERING EL	3	TECH Elective	3
ECE 431L	2	ECE 432L	3
EGR 400	1		
	15		**15**

Total credit hours: 126

Computer Engineering

First Year

Fall	Hours	Spring	Hours
ENG 100 (Satisfies CAP Writing Seminar)	3	REL 103 (Satisfies CAP First Year Humanities Common)	3
PHL 103 (Satisfies CAP First Year Humanities Common)	3	HST 103	3
CPS 150	4	CPS 151	4
PHY 206	3	MTH 169	4
MTH 168 (Satisfies CAP Math Requirement)	4	EGR 103	2
EGR 150	0	ECE 101	0
EGR 102	0		
	17		**16**

Second Year

Fall	Hours	Spring	Hours
ENG 200 (Satisfies CAP Second Year Writing Seminar)	3	CHM 123	3
CMM 100 (Satifies CAP Communication)	3	PHY 210L	1
ECE 201	3	ECE 204	3
ECE 201L	1	ECE 204L	1
MTH 218	4	ECE 215	3
EGR 270	3	ECE 215L	1
EGR 200	0	MTH 219	3
	17		**15**

Third Year

Fall	Hours	Spring	Hours
CPS 341	3	CAP Advanced PHL/REL (may also satisfy additional CAP components)	3
CPS 350	3	SSC 200 (satisfies CAP Social Science)	3
PHY 232	3	CPS 356	3
ECE 303	3	ECE 334	3
ECE 303L	1	ECE 340	3
ECE 314	3		
ECE 314L	1		
ECE 300	0		
	17		**15**

Fourth Year

Fall	Hours	Spring	Hours
CAP Advanced PHL/REL (may also satisfy additional CAP components)	3	CAP Arts (may also satisfy additional CAP components)	3
ECE/CPS EL	3	CAP Advanced HST (may also satisfy additional CAP components)	3
ECE/CPS EL	3	TECH Elect	3
ECE 431L	2	TECH ELECT	3
ECE 449	3	ECE 432L (Satisfies CAP Capstone Requirement)	3
EGR 400	1		
	15		**15**

Total credit hours: 127

Courses

ECE 101. Introduction to Electrical & Computer Engineering II. 0 Hours
Introduction to electrical and computer engineering faculty, facilities, and curriculum. Career opportunities in electrical and computer engineering and areas of specialization are discussed. Second semester seminar.

ECE 201. Circuit Analysis. 3 Hours
Principles of linear circuit analysis and problem solving techniques associated with circuits containing both passive and active components. Includes analysis of linear circuits with direct current (DC) and alternating current (AC) excitation, as well as a study of transient behavior. Course includes an additional mandatory supervised weekly problem session. Prerequisite(s): MTH 168 and sophomore status. Corequisite(s): ECE 201L.

ECE 201L. Circuit Analysis Laboratory. 1 Hour
Laboratory course stressing experimental techniques, laboratory reporting, safety, and instrumentation. Experimental investigation of linear circuit component behavior and the DC, AC, and transient response of linear circuits. Corequisites: ECE 201 or EGR 203.

ECE 203. Introduction to MATLAB Programming. 1 Hour
MATLAB system and development environment, vector and matrix operations using MATLAB, linear algebra and calculus using MATLAB, MATLAB graphics, flow control, symbolic math toolbox. Prerequisite(s): (CPS 132 or CPS 150) or equivalent.

ECE 204. Electronic Devices. 3 Hours
Study of the terminal characteristics of electronic devices and basic single stage amplifier configurations using bipolar junction transistors and field-effect transistors. Analysis of the devices includes a qualitative physical description, volt-ampere curves, and the development of small- and large-signal equivalent circuit models. Prerequisites: EGR 203 or ECE 201. Corequisites: ECE 204L.

ECE 204L. Electronic Devices Laboratory. 1 Hour
Laboratory investigation of electronic devices: diodes, bipolar junction transistors, field-effect transistors and operational amplifiers. Prerequisites: ECE 201 or EGR 203. Corequisites: ECE 204.

ECE 205. Introduction to Semiconductor Engineering. 3 Hours
Microprocessors and Integrated Circuits (ICs) have billions of tiny transistors that serve as unit cells for computing or data storage. This course will introduce students to the basics of semiconductors, semiconductor manufacturing processes, tools, and how different processes are sequenced together to create useful electronic functions. Prerequisites: ECE 201 or ECT 110 or EGR 203 or MEE 205 or PHY 207.

ECE 215. Introduction to Digital Systems. 3 Hours
Introduction to binary systems, logic circuits, Boolean algebra, simplification methods, combinational circuits and networks, programmable logic devices, flip flops, registers, counters, memory elements, and analysis and design of sequential circuits. Corequisites: (EGR 203 or ECE 201 or MEE 205) and ECE 215L.

ECE 215L. Digital Systems Laboratory. 1 Hour
Laboratory investigation of digital logic circuits and systems covered in ECE 215. Logic gate characteristics; combinational logic design and analysis; latches and flip-flops; synchronous and asynchronous sequential logic; simple digital systems. Experiments include design and analysis of digital systems using breadboarding, FPGA boards, modeling and simulation tools, hardware description languages, and logic synthesis tools. Corequisites: (ECE 201 or EGR 203 or MEE 205) and ECE 215.

ECE 300. Professional Development Seminar II. 0 Hours
Junior level professional development seminar. Presentations on contemporary and professional engineering subjects by students, faculty, and engineers in active practice. The seminar addresses topics in key areas that complement traditional courses and prepare distinctive graduates, ready for life and work. Registration required for all junior ECE students. Prerequisite(s): EGR 200 or COP 200.

ECE 303. Signals & Systems. 3 Hours
Mathematical framework associated with the analysis of linear systems including signal representation by orthogonal functions, convolution, Fourier and Laplace analysis, and frequency response of circuits and systems. Prerequisites: (ECE 201 or EGR 203) and (ECE 203 or MEE 114L). Corequisites: MTH 219 and ECE 303L.

ECE 303L. Signals & Systems Laboratory. 1 Hour
Laboratory investigation of signals and systems including signal decomposition, system impulse response, convolution, frequency analysis of systems, and filter design and realization. Prerequisites: (ECE 201 or EGR 203) and (ECE 203 or MEE 114L). Corequisites: ECE 303.

ECE 304. ELECTRONIC SYSTEMS. 3 Hours
Study of cascaded amplifiers, feedback amplifiers, linear integrated circuits, and oscillators including steady state analysis and analysis of frequency response. Prerequisites: ECE 204 and MTH 219. Corequisites: ECE 303 and ECE 304L.

ECE 304L. Electronic Systems Laboratory. 1 Hour
Design, construction and verification of multistage amplifiers, differential amplifiers, feedback amplifiers, passive and active filters, and oscillators. Prerequisites: ECE 204 and MTH219. Corequisites: ECE 303 and ECE 304.

ECE 305. Introduction to Semiconductor Engineering. 3 Hours
Microprocessors and Integrated Circuits (ICs) have billions of tiny transistors that serve as unit cells for computing or data storage. This course will introduce students to the basics of semiconductors, semiconductor manufacturing processes, tools, and how different processes are sequenced together to create useful electronic functions. Prerequisites: ECE 201 or ECT 110 or EGR 203 or MEE 205 or PHY 207.

ECE 314. Fundamentals of Computer Architecture. 3 Hours
Study of computer systems organization, representation of data and instructions, instruction set architecture, processor and control units, memory devices and hierarchy, I/O devices and interfacing peripherals, high- to low-level language mapping, system simulation and implementation, applications and practical problems. Prerequisite(s): CPS 150; ECE 215. Corequisite(s): ECE 314L.

ECE 314L. Fundamentals of Computer Architecture Laboratory. 1 Hour
Laboratory investigation of digital computer architecture covered in ECE 314. Computer sub-systems such as central processing units, control units, I/O units, and hardware/software interfaces will be experimentally considered. Simulation and implementation will be used to study applications and practical problems. Prerequisites: ECE 215 and CPS 150. Corequisites: ECE 314.

ECE 316. Introduction to Electrical Energy Systems. 3 Hours
A broad introduction to electric energy concepts. Generation, transmission, distribution, and utilization of electric energy. Renewable energy, three phase systems, transformers, power electronics, motors and generators. Contemporary topics. Prerequisite(s): ECE 201 or EGR 203 or equivalent.

ECE 332. Electromagnetics. 3 Hours
Study of vector calculus, electro- and magneto-statics, Maxwell's equations, and electromagnetic plane waves and their reflection and transmission from discontinuities. Prerequisites: PHY 206, MTH 218.

ECE 333. Applied Electromagnetics. 3 Hours
Electromagnetic theory applied to problems in the areas of waveguides, radiation, electro-optics and electromagnetic interference and electromagnetic compatibility. Prerequisites: ECE 332 or (PHY 232 and PHY 207).

ECE 334. Discrete Signals & Systems. 3 Hours
Introduction to discrete signals and systems including sampling and reconstruction of continuous signals, digital filters, frequency analysis, the z-transform, and the discrete Fourier transform. Prerequisites: ECE 303 and MTH 219.

ECE 340. Engineering Probability & Random Processes. 3 Hours
Axiomatic probability, derived probability relationships, conditional probability, statistical independence, total probability and Bayes' Theorem, counting techniques, common random variables and their distribution functions, transformations of random variables, moments, autocorrelation, power spectral density, cross correlation and covariance, random processes through linear and nonlinear systems, linear regression, and engineering decision strategies. Prerequisites: MTH 219. Corequisites: ECE 303.

ECE 398. Multidisciplinary Research & Innovation Laboratory. 1-6 Hours
Students participate in 1.) selection and design, 2.) investigation and data collection, 3.) analysis, and 4.) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

ECE 400. Professional Development for Seniors. 0 Hours
Career planning for electrical and computer engineering majors. The job search process, resume preparation, the job interview, professional development. Required of all electrical and computer engineering majors in their junior or senior year. Prerequisites: ECE 300 or COP 101.

ECE 401. Communication Systems. 3 Hours
Study of amplitude, angle, pulse, and digital communication systems including generation, detection, and analysis of modulated signals and power, bandwidth, and noise considerations. Prerequisites: ECE 304 and ECE 303. Corequisites: ECE 340 and ECE 401L.

ECE 401L. Communication Systems Laboratory. 1 Hour
Design, fabrication, and laboratory investigation of modulators, detectors, filters, and associated communication components and systems. Prerequisites: ECE 304 and ECE 303. Corequisites: ECE 401.

ECE 402. Power Electronics. 3 Hours
ECE 402 is a course addressing the power electronic circuit solutions and controls for the emerging energy conversion systems. It will include the applications of such power circuits for renewable energy sources (fuel cell, solar, wind), electric vehicles and airplanes, and power supplies like wireless charger etc. The course introduces the characteristics of different power semiconductor devices and their application to power conversion area, different types of electric power converters topologies and controls like ac-dc rectifiers, dc-dc converters, and dc-ac inverters. Prerequisites: ECE 303 and ECE 304.

ECE 404. Semiconductor Characterization and Metrology. 3 Hours
The course introduces students to the various electrical and optical metrology methods used in semiconductor manufacturing at different stages of the fabrication process, such as Critical Dimension (CD) uniformity and control, wafer and reticle defect inspection, bright field and dark field imaging and inspection. The course introduces students to critical and non-critical defects, printed and non-printed defects. Prerequisites: ECE 205.

ECE 405. Semiconductor Device Fabrication Lab. 3 Hours
Silicon wafer handling; hazardous chemical handling and safety training; MOSFET fabrication process flow design; photomask design; silicon wafer cleaning; UV photolithography process; photoresist spin coating, photomask alignment and exposure; critical dimension inspections; thin film dielectric deposition methods; plasma and wet chemical etching processes; thermal diffusion and ion implantation doping; microscopy inspection and metrology; dicing, die-bonding and wire bonding; probe testing. Prerequisites: ECE 205.

ECE 406. Advanced Semiconductor Manufacturing. 3 Hours
In-depth study in a selected area of semiconductor manufacturing. Topics include advanced lithography and patterning, 3D transistors, flash memory technologies, thin film transistors, inspection, MEMS technology, yield & defect analysis. Students will work one-on-one with faculty to conduct a comprehensive study on a selected semiconductor manufacturing technique through design, modeling and simulation. Prerequisites: ECE 205 and (EOP 404 or ECE 404 or EOP 405 or ECE 405).

ECE 414. Electromechanical Devices. 3 Hours
Properties and theory of electromechanical devices: nonlinear electromagnetic actuators; rotating machine analysis; field and circuit concepts and direct current, synchronous, and induction machines: special-purpose machines and fractional horsepower machines. Prerequisite(s): ECE 316 or equivalent.

ECE 415. Control Systems. 3 Hours
Study of mathematical models for control systems and analysis of performance characteristics and stability. Design topics include pole-placement, root locus, and frequency domain techniques. Prerequisites: ECE 303 and MTH 219.

ECE 416. Introduction to Industrial Robotic Manipulators. 3 Hours
Topics include homogeneous transformations, direct and inverse kinematics, trajectory generation, and selected topics of robot vision. Prerequisites: ECE 303 and MTH 219.

ECE 420. The Internet of Things. 3 Hours
Introduction to the multi-disciplinary topic of Internet of Things (IoT), a blend of engineering and science. The course begins with a fundamental technical understanding of the IoT architecture. From this foundation, students experience hands-on labs in a team environment with theoretical justification. The applied work features environmental sensor networking with geospatial data. Each surface area in IoT is explored from sensors and embedded devices to protocols and virtual servers highlighted by current trends within IoT. Lastly, the history, software and influential people will be discussed to provide class context. Ultimately, students scaffold their knowledge through a series of labs, team challenges and supporting lectures to create a final business proposal for a real client IoT value proposition.

ECE 431L. Multidisciplinary Design I. 2 Hours
Application of engineering fundamentals to sponsored multidisciplinary-team design projects. In a combination of lecture and lab experiences, students learn the product realization process and project management. Product realization topics include idea generation, proposal development, design specifications, conceptualization and decision analysis. Project management topics include cost estimation and intellectual property management. Design projects progress to the proof of concept and prototype development stages. Prerequisites: MEE students: EGM 303, MEE 321 and (MEE 344 or RCL 578, or MEE 401 or MEE 409), ECE students: ECE 303 and (ECE 304 or ECE 314).

ECE 432L. Multidisciplinary Design II. 3 Hours
One hour lecture and five hours of lab per week. Detailed evaluation of the Product Realization Process focusing on conceptual design, embodiment design, final design and prototyping is taught. Analysis of the design criteria for safety, ergonomics, environment, cost and sociological impact is covered. Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. Prerequisites: MEE majors: MEE 431L; CPE majors: ECE 431L and (2 of the following: ECE 334, CPS 444, ECE 340, CPS 356, ECE 449); ELE majors: ECE 431L and (2 of the following: ECE 401, ECE 415, ECE 333, ECE 334, ECE 340).

ECE 441. Digital Integrated Circuit Design. 3 Hours
Integrated circuit design and layout concepts, design methodology, fabrication process and limitations, MOSFET models for digital design, inverter and logic gates, interconnect and delay, combinational circuits, sequential circuits, datapath subsystems, memory circuits, digital phase lock loops. Prerequisites: ECE 303 and ECE 304.

ECE 444. Advanced Digital Design. 3 Hours
An introduction to modern digital hardware logic design using a hierarchical system approach including top-down development process. An introduction to alternative design implementation forms including hardware description languages (HDLs) for the design of simple and complex combinatorial logic circuits and sequential logic designs with finite state machines. Good HDL coding practices such as readability, re-configurability, and efficient execution are emphasized along with the use of programmable logic circuits including Field-Programmable Gate Arrays (FPGAs). Prerequisite(s): ECE 215.

ECE 445. Signal Processing. 3 Hours
Selected topics in digital signal and image processing with design projects. The design projects are determined by the instructor and may come from a variety of signal processing applications including medical image processing, video processing, computer vision, statistical signal processing, speech processing, radar signal processing, etc. Prerequisite(s): ECE 334.

ECE 446. CMOS Analog Circuit Design. 3 Hours
Integrated circuit design concepts and layout; system perspective on analog design; MOS device theory and processing technology; current mirrors and biasing circuits; voltage and current references; single-stage, differential and operational amplifiers; CAD utilization to realize the design process. Prerequisites: ECE 303, ECE 304.

ECE 447. Digital Control Systems. 3 Hours
Analysis and synthesis of feedback control systems including digital compensators. Topics include performance and stability analysis, regulator and servomechanism design using time and frequency domain methods, and digital implementation case studies. Prerequisite(s): ECE 415; ECE 334 or equivalent.

ECE 448. Fiber Optic Communications. 3 Hours
General light guidance principles; ray optics; dispersion; single mode, multimode, and graded index fibers; basic laser and LED source principles; photodetectors; error probability in digital optical systems; rise time analysis; loss budget analysis; local area networks and long haul communication links. Prerequisite(s): ECE 333. Corequisites: ECE 401.

ECE 449. Computer Systems Engineering. 3 Hours
An introduction to advanced computer architecture and computer systems design. Topics include: exploration of principle architecture features of modern computers, pipelining, memory hierarchy, I/O devices, interconnection networks, introduction to parallel and multiprocessor systems, and the use of hardware description languages (HDLs) in system implementation. Prerequisite(s): ECE 314 and CPS 356.

ECE 450L. Projects Laboratory. 1-3 Hours
Project-oriented laboratory applying engineering skills in the design, development, and demonstration of electrical and electronic systems. Prerequisite(s): Permission of project advisor.

ECE 465. Fundamentals of Solid-State Batteries. 3 Hours
Introduction to the fundamental of solid-state, safe, durable, batteries, including working principles of a battery, state-of-the-art battery (Li-ion battery based on liquid-state electrolytes- advantages/disadvantages), battery safety, need for a safe battery system for low-high power applications (electric vehicles / unmanned-/manned aircrafts, space vehicles, etc.), different design of solid-state batteries (planner-stacked, 3 dimensional, etc.), engineering the structural battery (dual functionality system that can carry mechanical load and store energy), characterization methods to evaluate structure / electrical / electrochemical properties of all solid-state battery materials (cathode, anode, electrolytes), interfaces (electrodes/electrolyte), and electrical/ electrochemical testing of complete battery cells. Also, electrical test methods to evaluate solid-state Li-ion battery (including structural battery) performances, etc.), and understanding degradation mechanism of solid-state battery systems (including structural battery) will be discussed. Prerequisites: ECE 303 and ECE 304 or equivalent.

ECE 466. Fundamentals of Hybrid Electrochemical Power. 3 Hours
Introduction to the fundamental of hybrid electrochemical power (battery + capacitor + fuel cell – integrated systems) including working principles of battery, capacitor, lithium-ion capacitor, and fuel cell, advantages/ disadvantages, necessity to hybridize battery / fuel cell / capacitor, electrical hybridization methods, electrochemical testing of hybrid power systems, degradation mechanism, and applications. Hybrid electrochemical power is highly desirable to meet requirements for wide range products (powering electronic gadget to transportation vehicles to space vehicles) requiring low to high power/energy, cycle-life, fast/slow charge/discharge, etc. Prerequisites: ECE 303 and ECE 304 or equivalent.

ECE 471. Contemporary Power Systems & the Smart Grid. 3 Hours
Introduction to electrical power systems; generation, transmission and utilization; power system analysis; power system control; energy management; and an introduction to smart grid technologies. Prerequisite(s): ECE 316 or equivalent.

ECE 472. Smart Grid Technologies. 3 Hours
An introductory study of enabling technologies and energy issues necessary for full realizaton of the Smart Grid. Course topics vary. This course can be taken multiple times. Prerequisite(s): ECE 471 or equivalent.

ECE 476. Introduction to Radar. 3 Hours
Introduction to the radar range equation, fields and Waves, antennas and phased arrays, beamforming, targets, and clutter radar cross-section, fast time, slow time, detection processing, tracking, space-time adaptive processing, FMCW radar, SAR and ISAR, electronic warfare, transmitters, receivers, and signal processors. Prerequisites: ECE 334.

ECE 477. Artificial Neural Networks. 3 Hours
This course introduces the fundamental concepts, mathematical models, design architectures, and learning algorithms of artificial neural networks (ANNs) which learn from examples. ANNs are biologically inspired systems that mimic the structural and perceptual behavior of human brain. The main topics include the structure of an artificial neuron, single layer perceptron and multi-layer perceptron, delta rule and back-propagation learning, radial basis function neural network, support vector machines, recurrent neural networks, auto-associative and hetero-associative memories, adaptive resonance theory, and self-organizing feature map. Prerequisites: (ECE 203 or MEE114L), ECE 334.

ECE 486. Computer Networks. 3 Hours
Introduction to the fundamental of computer networks, including the Open Systems Interconnection reference model, transmission media, medium access protocol, data link protocols, routing, congestion control, applications, and network security. Recommended prerequisite: ECE303.

ECE 487. Wireless Security. 3 Hours
Wireless security is a very important topic and attracting more and more attention from industry, research, and academia. This course gives a comprehensive overview on the recent advances in wireless network and system security. It will cover security issues and solutions in emerging wireless access networks and systems as well as multi-hop wireless networks. Prerequisites: ECE 203 or MEE 114L.

ECE 490. Biomedical Engineering and Healthcare Electronics. 3 Hours
This survey course will introduce students to the interdisciplinary field of Biomedical Engineering. Students will learn about the application of electrical and computer engineering in healthcare solutions. This course is project oriented, covering topics such as: bioethics, anatomy and physiology, biomimetics, skeletal and cardiac biomechanics, biomaterials & prosthetics, biosensors, bioinstrumentation, neuroscience and traumatic brain injury, rehabilitation engineering/assistive technology, biomedical modeling and medical additive manufacturing. Students may have the opportunity to attend industry site visits with internal and external partners in the medical field to apply knowledge learned in the classroom to real-world experiences. Prerequisites: (ECE 201 or EGR 203) or (MEE 298 or MEE 205) or equivalent.

ECE 491. Medical Imaging. 3 Hours
This course will introduce students to the field of Medical Imaging. Students will learn about the different modalities (Ultrasound, X-ray, CT, MRI, Nuclear Medicine) utilized in healthcare and gain an understanding about which techniques are most appropriate for various medical pathology through open-ended clinical case studies. Students may have the opportunity to attend industry site visits with internal and external community partners in the medical field through collaboration with a local community hospital to apply knowledge learned in the classroom to real-world experiences. This course is project oriented, covering topics such as bioinstrumentation, medical image processing, medical additive manufacturing and sustainable healthcare solutions for developing countries. Prerequisites: (ECE 201 or EGR 203 or MEE 205 or equivalent) and (ECE 203 or MEE114L or equivalent).

ECE 493. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program.

ECE 494. Honors Thesis. 3 Hours
Selection, design, investigation, and completion of an independent, original research study resulting in a document prepared for submission as a potential publication and a completed undergraduate thesis. Restricted to students in University Honors Program. Prerequisite(s): ECE 493.

ECE 498. Multidisciplinary Research & Innovation Laboratory. 1-6 Hours
Students participate in 1.) selection and design, 2.) investigation and data collection, 3.) analysis, and 4.) presentation of a research project. Research can include, but is not limited to, developing an experiment, collecting and analyzing data, surveying and evaluating literature, developing new tools and techniques including software, and surveying, brainstorming, and evaluating engineering solutions and engineering designs. Proposals from teams of students will be considered.

ECE 499. Special Problems in Electrical & Computer Engineering. 1-6 Hours
Particular assignments to be arranged and approved by the department chairperson.