Electrical Engineering (ELEG)

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Department of Electrical Engineering Website (http://electrical-engineering.uark.edu/)

Electrical engineering is a professional engineering discipline that in its broader sense covers the study and application of electricity, electronics and electromagnetism. Electrical engineers are in charge of designing and utilizing electrical and electronic components, integrated circuits and computer chips, and electronic assemblies to benefit mankind. Fields of electrical engineering include analog and mixed-signal circuit design/test, biomedical, communications, computer hardware and digital circuit design, control systems, electronic packaging, embedded systems design, microwave and radar engineering, nanophotonics, nanotechnology/microelectronics/optoelectronics, pattern recognition and artificial intelligence, power electronics, and renewable energy/power.

The electrical engineering graduate is at the forefront of technologies leading to accelerated use of electric power, applications of real time embedded control systems for smart highways, smart vehicles and smart gadgets, global communications, the dominating influence of the computer and electronics on modern society, the use of electronic equipment for medical diagnosis, the use of wireless chemical and biological nanosensors for hazard detection, the miniaturization of electronics, microwave and optical technology for national defense, and a host of other developments. Therefore, the use of electrical and electronic equipment has spread into such diverse areas as agricultural production, automotives, computer hardware and networks, health care, information technology, manufacturing, marketing, recreation, renewable energy resources, outer space and underwater exploration, transportation, and many others. As a result, electrical engineering is the largest of all scientific disciplines and assures a continuing demand for electrical engineering graduates throughout private industry and government.

Undergraduate Program

The department also actively participates in the Honors Program to challenge superior students with a more in-depth academic program and research experience. The Honors program enables students to work more closely with faculty members and other students in a team environment. Please see the requirements given below.

In line with all the opportunities of our graduates, the Electrical Engineering Department has the mission and educational objectives to produce graduates who:

1. Are recruited in a competitive market and valued as reliable and competent employees by a wide variety of industries; in particular, electrical engineering industries,
2. Succeed in graduate studies such as engineering, science, law, medicine, business, and other professions, should they chose to pursue those studies.
3. Understand the need for life-long learning and continued professional development for a successful and rewarding career, and
4. Accept responsibility for leadership roles, in their profession, in their communities, and in the global society.

Accreditation

The Electrical Engineering Department offers undergraduate, graduate, and doctoral degrees. The department has offered a Bachelor of Science degree in Electrical Engineering (B.S.E.E.) for over 100 years. The B.S.E.E. degree is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org). Completion of the degree requirements provides graduates with the following learning outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics,
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors,
3. an ability to communicate effectively with a range of audiences,
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts,
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives,
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions,
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Graduate Program in Electrical Engineering

The graduate program offers a Master of Science degree in Electrical Engineering (on campus and online) and a Doctor of Philosophy degree in Engineering. The graduate program provides additional instruction and hands-on experience beyond the undergraduate level, and produces graduates who are prepared to promptly address critical issues and assume advanced positions in the profession, including management, design, teaching, research and development.

The research mission of the department is conducted mainly through the graduate program. Internal and external funded research projects serve to:

1. Discover new knowledge, address technical problems, and develop new electrical/electronic technologies;
2. Provide the tools and resources which keep the faculty at the cutting edge of electrical engineering;
3. Provide financial support for graduate students and gifted undergraduate students; and
4. Improve the quality of life for citizens of Arkansas and the world.

The graduate program supports the undergraduate program by giving top undergraduate students access to research laboratories with state-of-the-art equipment and software. Topics covered in graduate courses often migrate into senior undergraduate technical elective courses and eventually into required undergraduate courses.

Departmental Service Mission

Faculty, administrators, and staff work to provide the education necessary to establish the best foundation for electrical engineering students at all degree levels, and prepare them to be competitive local and national leaders, skillful at undertaking the current and future challenges facing our world. Everyone is encouraged to provide services to both the community and the profession. Hence, they are active in local, state, national, and international professional and service organizations, as well as public and private schools involving grades K-12

Degree Program Changes

A student must meet all requirements of the degree program and is expected to stay informed concerning current regulations, policies, and program requirements in a chosen field of study. Changes made in the electrical engineering curriculum at a level beyond that at which a student is enrolled may become graduation requirements for that student. Changes made in the curriculum at a level lower than the one at which a student is enrolled are not normally required for that student. Students should consult their adviser for additional information.

Potential Minors

Although electrical engineering students can pursue any minor they desire, there are several minors that require a minimal number of extra courses, such as Computer Science, Mathematics, Physics, etc. Students are advised to review the specific rules pertaining to the minor of interest in the section of the UA Catalog of Studies corresponding to the department granting that minor.

Undergraduate Program in Electrical Engineering

The Electrical Engineering Department maintains the following student learning outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics,
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental, and economic factors,
3. An ability to communicate effectively with a range of audiences,
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts,
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives,
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions,
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

For more information visit www.abet.org (http://www.abet.org/).

The electrical engineering curriculum is designed to provide students with knowledge of scientific principles and methods of engineering analysis to form a solid foundation for a career in design, research and development, manufacturing and processing, measurement and characterization, or management. Students progressively build their design experience throughout the curriculum and demonstrate this ability in the senior electrical engineering design laboratories. The curriculum also introduces students to subjects in the humanities, social sciences, and ethics so they may better understand the interaction of technology and society.

The electrical engineering curriculum is divided into three phases. The first year concentrates on the development of a sound understanding of basic sciences and mathematics. The second and third years further develop scientific principles and cover the basic core of electrical engineering. The fourth year is composed primarily of senior-level elective courses. At this time, the students, in consultation with their advisers, may choose classes related to one or more of the major areas of electrical engineering detailed (e.g., analog and mixed-signal circuit design/test, biomedical, communications, computer hardware and digital circuit design, control systems, electronic packaging, embedded systems design, microwave and radar engineering, nanophotonics, nanotechnology/microelectronics/optoelectronics, pattern recognition and artificial intelligence, power electronics, and renewable energy and power). This final year permits the student to tailor a program suited to her or his individual career objectives. The graduation requirement in electrical engineering is 125 semester hours as given below.

Recommended Technical Studies

Students in electrical engineering are required to complete 21 semester hours of technical electives of which a minimum of 9 semester hours must be 4000- or 5000-level electrical engineering elective courses. A student may select the remaining 12 semester hours from 4000- or 5000-level electrical engineering elective courses or upper-division technical courses in mathematics, engineering, and the sciences with the approval of an adviser. One of these courses may be an approved Math/Science Elective and another may be an approved Engineering Science Elective. History and social science courses taught by Math and Science departments are not eligible for technical elective credit. Not more than 6 semester hours total of ELEG 488V and ELEG 400VH may be credited toward technical electives. Students who have taken full-time co-op experiences under GNEG 3811, and whose grades in these courses were A or B, may get credit for not more than three hours of non-ELEG technical electives if the work performed is of comparable quality to a technical elective; consult with the Department Co-op Coordinator. Descriptions of all electrical engineering courses are in the Course Descriptions chapter of this Catalog of Studies. The schedule of technical electives offered in a given semester is determined the previous semester since the selection depends on a number of varying factors such as student interest in a particular topic, the importance of a particular technology for the student's professional career, and teaching faculty availability.

Electrical Engineering B.S.E.E. Eight-Semester Degree Program

The following section contains the list of courses required for the Bachelor of Science in Electrical Engineering and a suggested eight-semester sequence. See the Eight-Semester Degree Policy (http://catalog.uark.edu/undergraduatecatalog/academicregulations/eightsemesterdegreecompletionpolicy/) for more details. Not all courses are offered every semester, so students who deviate from the suggested sequence must pay careful attention to course scheduling and course prerequisites.

First Year	Fall	Spring
GNEG 1111 Introduction to Engineering I	1	
ENGL 1013 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)	3	
MATH 2554 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)[1]	4	
CHEM 1103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)	3	
Select one of the following (Satisfies General Education Outcome 4.2):	3	
HIST 2003 History of the American People to 1877 (ACTS Equivalency = HIST 2113)		
HIST 2013 History of the American People, 1877 to Present (ACTS Equivalency = HIST 2123)		
PLSC 2003 American National Government (ACTS Equivalency = PLSC 2003)		
GNEG 1121 Introduction to Engineering II		1
ENGL 1033 Technical Composition II (ACTS Equivalency = ENGL 1023) (Satisfies General Education Outcome 1.2)		3
MATH 2564 Calculus II (ACTS Equivalency = MATH 2505)		4
PHYS 2054 University Physics I (ACTS Equivalency = PHYS 2034) (Satisfies General Education Outcome 3.4)		4
Sophomore Science Elective[2]		4
Year Total:	14	16

Second Year	Fall	Spring
ELEG 2104	4	
MATH 2584 Elementary Differential Equations	4	
PHYS 2074 University Physics II (ACTS Equivalency = PHYS 2044 Lecture)	4	
Humanities Elective (Satisfies General Education Outcome 3.2 & 5.1)[3]	3	
CSCE 2004 Programming Foundations I		4
ELEG 2114		4
MATH 2574 Calculus III (ACTS Equivalency = MATH 2603)		4
ELEG 2904 Digital Design		4
Year Total:	15	16

Third Year	Fall	Spring
ELEG 3124 System & Signal Analysis	4	
ELEG 3214	4	
ELEG 3924 Microprocessor Systems Design	4	
ELEG 3704 Applied Electromagnetics	4	
ELEG 3143 Probability & Stochastic Processes		3
ELEG 3224		4
ELEG 3304 Energy Systems		4
Social Sciences Elective (Satisfies General Education Outcome 3.3 & 4.1)[4]		3
Math/Science/Technical Elective[9]		3
Year Total:	16	17

Fourth Year	Fall	Spring
Engineering Science/Technical Elective[5]	3	
Two Electrical Engineering Technical Elective[6]	6	
ELEG 4063 Electrical Engineering Design I	3	
Select one of the following:	3	
ECON 2013 Principles of Macroeconomics (ACTS Equivalency = ECON 2103)		
ECON 2023 Principles of Microeconomics (ACTS Equivalency = ECON 2203)		
ECON 2143 Basic Economics: Theory and Practice		
Electrical Engineering Technical Elective[6]		3
ELEG 4071 Electrical Engineering Design II (Satisfies General Education Outcome 6.1)		1
Two Technical Elective[10]		6
Social Sciences Elective [7]		3
Fine Arts Elective (Satisfies General Education Outcome 3.1)[8]		3
Year Total:	15	16

Total Units in Sequence:	**125**

1 Students have demonstrated successful completion of the learning indicators identified for learning outcome 2.1, by meeting the prerequisites for MATH 2554.

2 CHEM 1123/CHEM 1121L or BIOL 1543/BIOL 1541L or BIOL 2213/BIOL 2211L, or PHYS 2094 or GEOS 1113/GEOS 1111L

3 The Humanities Elective courses that satisfy General Education Outcomes 3.2 and 5.1 include: CLST 1003, CLST 1003H, CLST 1013, HUMN 1124H, PHIL 2003, PHIL 2003C, PHIL 2003H, PHIL 2103, or PHIL 2103C.

4 The Social Sciences Elective courses that satisfy General Education Outcomes 3.3 and 4.1 include: ANTH 1023, COMM 1023, HDFS 1403, HDFS 2413, HIST 1113, HIST 1113H, HIST 1123, HIST 1123H, HIST 2093, HUMN 1114H, HUMN 2114H, INST 2013, INST 2813, INST 2813H, PLSC 2013, PLSC 2813, PLSC 2813H, RESM 2853, SOCI 2013, SOCI 2013H, or SOCI 2033.

5 Engineering Science/Technical Elective: **Any Engineering/Science/ Math Technical Elective** or one of these 2000 level courses: MEEG 2013, MEEG 2303, MEEG 2403, CHEG 2313, or INEG 2413

6 ELEG TECHNICAL ELECTIVES are defined as ELEG 4000 or ELEG 5000 level courses. CSCE 4114, CSCE 4613, or CSCE 4233 are approved ELEG Technical Electives for students pursuing a dual ELEG/CSCE undergraduate degree. Not more than 6 hours may be ELEG 488V or ELEG 400VH courses.

[7] The Social Sciences Elective courses which satisfy General Education Outcome 3.3 include: AGEC 1103, AGEC 2103, ANTH 1023, COMM 1023, ECON 2013, ECON 2023, ECON 2143, EDST 2003, HDFS 1403, HDFS 2413, HDFS 2603, HIST 1113, HIST 1113H, HIST 1123, HIST 1123H, HIST 2003, HIST 2013, HIST 2093, HUMN 1114H, HUMN 2114H, INST 2013, INST 2813, INST 2813H, PLSC 2003, PLSC 2013, PLSC 2203, PLSC 2813, PLSC 2813H, PSYC 2003, RESM 2853, SOCI 2013, SOCI 2013H, SOCI 2033. Note, courses cannot be counted twice in degree requirements.

[8] The Fine Arts Elective courses which satisfy General Education Outcome 3.1 include: ARCH 1003, ARHS 1003, COMM 1003, DANC 1003, LARC 1003, MLIT 1003, MLIT 1003H, MLIT 1013, MLIT 1013H, MLIT 1333, THTR 1003, THTR 1013, or THTR 1013H.

[9] MATH SCIENCE/TECHNICAL ELECTIVES: **Any Engineering/ Science/Math Technical Elective,** suggested classes BIOL 1543/BIOL 1541L, CHEM 1123/CHEM 1121L, CHEM 3504, CHEM 3603, MATH 3083, MATH 4443, PHYS 3113, PHYS 3544, PHYS 3613, MEEG 2703 or STAT 3003.

[10] TECHNICAL ELECTIVES are 3000 or above level courses in Math, Engineering, or the sciences after the approval by ELEG advisor. CSCE 2014, Programming 2, and CSCE 2214, Computer Organization, are allowable non-ELEG technical electives. **Courses not eligible** for technical elective credit include ELEG 3903, ELEG 3933 and any history courses in math and the sciences (e.g., MATH 3133) .

Students should become very familiar with the Academic Regulations chapter for university requirements that apply to the electrical engineering program as well as the College of Engineering requirements (in particular the “D rule” and the “Transfer of Credit” for courses taken at another institution). Students are required to complete 40 hours of upper division courses (3000-4000 level). It is recommended that students consult with their adviser when making course selections. In addition to these graduation requirements, candidates for an electrical engineering degree must have earned a grade-point average of no less than 2.00 on all ELEG courses.

Electrical Engineering Honors Program

To graduate with Honors in electrical engineering, students must be a member of the Honors College, have a minimum cumulative GPA of 3.50, and complete a minimum of 12 hours of honors credit of which 6 hours must be Electrical Engineering Honors courses that include the following: ELEG 4063H Honors Electrical Engineering Design I, ELEG 4071H Honors Electrical Engineering Design II, and ELEG 400VH Honors Senior Thesis. Special problems credit hours (ELEG 488V) will not be counted in the requirement for graduation with Honors in Electrical Engineering.

Electrical Engineering Honors Courses:

ELEG 3124H, ELEG 3143H, ELEG 3214H, ELEG 3224H, ELEG 3304H, ELEG 3704H, ELEG 3924H: Required ELEG junior courses with Honors section (all junior required courses include honors sections).

ELEG 4061H Honors Electrical Engineering Design I (Sp, Fa)

ELEG 4073H Honors Electrical Engineering Design II

ELEG 400VH Honors Senior Thesis (Sp, Su, Fa)

ELEG 4203H**,** ELEG 4233H**,** ELEG 4403H**,** ELEG 4503H**,** ELEG 4703H**,** ELEG 4783H**,** ELEG 4914H**,** ELEG 4963H**:** ELEG technical elective courses that have an Honors section (Please check the offering of these Honors Sections for a particular semester).

ELEG 5000 or above**:** Any graduate level course.

Balda, Juan Carlos, Ph.D. (University of Natal), B.S. (Universidad Nacional del Sur), University Professor, 1989, 2013.
Chen, Zhong, Ph.D. (North Carolina State University), M.Eng. (National University of Singapore), B.S. (Zhejiang University), Assistant Professor, 2015.
Dix, Jeffrey, Ph.D., M.S., B.S.E.E., (University ot Tennessee, Knoxville), Assistant Professor, 2018.
El-Ghazaly, Samir M., Ph.D. (University of Texas at Austin), M.S., B.S. (Cairo University), Distinguished Professor, 2007.
El-Shenawee, Magda O., Ph.D. (University of Nebraska-Lincoln), M.S., B.S. (Assiut University, Egypt), Professor, 2001, 2010.
Farnell, Chris, Ph.D., M.S.E.E., B.S.E.E. (University of Arkansas), Research Assistant Professor, 2021.
Manasreh, Omar, Ph.D. (University of Arkansas), M.S. (University of Puerto Rico-Rio Piedras), B.S. (University of Jordan), Professor, 2003.
Mantooth, Alan, Ph.D. (Georgia Institute of Technology), M.S., B.S. (University of Arkansas), Distinguished Professor, Twenty-First Century Chair in Mixed-Signal IC Design and CAD, 1998, 2011.
Martin, Terry W., Ph.D., M.S.E.E., B.S.E.E. (University of Arkansas), Professor, 1990, 2002.
McCann, Roy A., Ph.D. (University of Dayton), M.S.E.E., B.S.E.E. (University of Illinois), Professor, 2003, 2009.
Naseem, Hameed A., Ph.D., M.S. (Virginia Polytechnic State University), M.Sc. (Panjab University), University Professor, 1985.
Saunders, Robert F., M.S.E.E., M.S. (University of Arkansas), Instructor, 2012.
Spiesshoefer, Silke, Ph.D., M.S.E.E., B.S.Ch.E. (University of Arkansas), Clinical Assistant Professor, 2014.
Ware, Morgan, Ph.D. (North Carolina State University), B.S. (Florida State University), Assistant Professor, 2005.
Wu, Jingxian, Ph.D. (University of Missouri-Columbia), M.S. (Tsinghua University), B.S. (Beijing University of Aeronautics and Astronautics), Associate Professor, 2008, 2013.
Yu, Fisher, Ph.D. (Arizona State University), M.S., B.S. (Peking University), Associate Professor, 2008, 2014.
Zhao, Yue, Ph.D. (University of Nebraska-Lincoln), B.S. (Beijing University), Assistant Professor, 2015.

Courses

ELEG 2101L. Electric Circuits I Laboratory. 1 Hour.
Experimental investigation of the steady-state behavior of resistive circuits excited by DC sources and transient behavior of simple R, L, and C circuits. Topics include fundamental laws of circuit theory applied to resistive networks and time response functions of R-L and R-C circuits. Corequisite: ELEG 2103. (Typically offered: Fall and Summer)

ELEG 2103. Electric Circuits I. 3 Hours.
Introduction to circuit variables, elements, and simple resistive circuits. Analysis techniques applied to resistive circuits. The concept of inductance, capacitance and mutual inductance. The natural and step responses of RL, RC, and RLC circuits. Corequisite: ELEG 2101L. Pre- or Corequisite: (MATH 2564 or MATH 2564C) and PHYS 2074. Prerequisite: PHYS 2054. (Typically offered: Fall and Summer)

ELEG 2111L. Electric Circuits II Laboratory. 1 Hour.
Experimental investigation of the steady-state behavior of circuits excited by sinusoidal sources. Topics include complex power, three-phase circuits, transformers, and resonance. Corequisite: ELEG 2113. (Typically offered: Spring and Summer)

ELEG 2113. Electric Circuits II. 3 Hours.
Introduction to complex numbers. Sinusoidal steady-state analysis of electric circuits, active, reactive, apparent and complex power; balanced and unbalanced three-phase circuits; mutual inductance; the use of the Laplace transform for electric circuit analysis and two-port networks. Corequisite: ELEG 2111L. Pre- or Corequisite: MATH 2584. Prerequisite: ELEG 2103, ELEG 2101L and PHYS 2074. (Typically offered: Spring and Summer)

ELEG 287V. Special Topics in Electrical Engineering. 1-4 Hour.
Consideration of current electrical engineering topics not covered in other courses. (Typically offered: Irregular) May be repeated for up to 4 hours of degree credit.

ELEG 2904. Digital Design. 4 Hours.
To introduce students to modern logic concepts, problem solving and design principles, and vocabulary and philosophy of the digital world. Corequisite: Lab component. Prerequisite: Engineering major. (Typically offered: Fall)
This course is cross-listed with CSCE 2114.

ELEG 3124. System & Signal Analysis. 4 Hours.
Definition and description of signals and systems; analog, digital, continuous- and discrete-time and frequency analysis of systems, Z- and Fourier Transforms, sampling and signal reconstruction, filter design and engineering applications. Pre- or Corequisite: MATH 2584. Corequisite: Lab component. Prerequisite: ELEG 2103 or ELEG 3903 or BMEG 2904. (Typically offered: Fall)

ELEG 3124H. Honors System & Signal Analysis. 4 Hours.
Definition and description of signals and systems; analog, digital, continuous- and discrete-time and frequency analysis of systems, Z- and Fourier Transforms, sampling and signal reconstruction, filter design and engineering applications. Pre- or Corequisite: MATH 2584. Corequisite: Lab component. Prerequisite: ELEG 2103 or ELEG 3903 or BMEG 2904. (Typically offered: Fall)
This course is equivalent to ELEG 3124.

ELEG 3143. Probability & Stochastic Processes. 3 Hours.
Review of system analysis, probability, random variables, stochastic processes, auto correlation, power spectral density, systems with random inputs in the time and frequency domain, and applications. Prerequisite: ELEG 3124. Pre- or Corequisite: MATH 2574. (Typically offered: Spring)

ELEG 3143H. Honors Probability & Stochastic Processes. 3 Hours.
Review of system analysis, probability, random variables, stochastic processes, auto correlation, power spectral density, systems with random inputs in the time and frequency domain, and applications. Pre- or Corequisite: ELEG 3124. (Typically offered: Spring)
This course is equivalent to ELEG 3143.

ELEG 3211L. Electronics I Laboratory. 1 Hour.
Experimental investigation into electronic circuit analysis concepts. Topics include: diode behavior and applications, zener diode regulator design, bipolar junction transistor biasing, BJT common-emitter amplifier design, and operational amplifier fundamentals. Corequisite: ELEG 3213. (Typically offered: Fall and Spring)

ELEG 3211M. Honors Electronics I Laboratory. 1 Hour.
Experimental investigation into electronic circuit analysis concepts. Topics include: diode behavior and applications, zener diode regulator design, bipolar junction transistor biasing, BJT common-emitter amplifier design, and operational amplifier fundamentals. Corequisite: ELEG 3213H. Prerequisite: Honors standing. (Typically offered: Fall and Spring)
This course is equivalent to ELEG 3211L.

ELEG 3213. Electronics I. 3 Hours.
Introduction to electronic systems and signal processing, operational amplifiers, diodes, non-linear circuit applications, MOSFETS, and BJTs. Course has a lab component. Pre- or Corequisite: MATH 2574 and ELEG 2113. Corequisite: ELEG 3211L. Prerequisite: MATH 2584. (Typically offered: Fall and Spring)

ELEG 3213H. Honors Electronics I. 3 Hours.
Introduction to electronic systems and signal processing, operational amplifiers, diodes, non-linear circuit applications, MOSFETS, and BJTs. Pre- or Corequisite: MATH 2574 and ELEG 2113. Corequisite: ELEG 3211M. Prerequisite: Honors standing and PHYS 2074. (Typically offered: Fall and Spring)
This course is equivalent to ELEG 3213.

ELEG 3221L. Electronics II Laboratory. 1 Hour.
Selected experiments to illustrate and complement topics covered in companion course ELEG 3223 - Electronics II Laboratory. Corequisite: ELEG 3223. (Typically offered: Spring)

ELEG 3221M. Honors Electronics II Laboratory. 1 Hour.
Selected experiments to illustrate and complement topics covered in companion course ELEG 3223 - Electronics II Laboratory. Corequisite: ELEG 3223H. Prerequisite: Honors standing. (Typically offered: Spring)
This course is equivalent to ELEG 3221L.

ELEG 3223. Electronics II. 3 Hours.
Differential pair amplifier, current mirrors, active loads, multistage amplifiers, amplifier frequency response, bode plots, Millers theorem, short circuit and open circuit time constant methods, feedback amplifiers, and stability of feedback amplifiers. Corequisite: ELEG 3221L. Prerequisite: ELEG 3213 and ELEG 2113. (Typically offered: Spring)

ELEG 3223H. Honors Electronics II. 3 Hours.
Differential pair amplifier, current mirrors, active loads, multistage amplifiers, amplifier frequency response, bode plots, Millers theorem, short circuit and open circuit time constant methods, feedback amplifiers, and stability of feedback amplifiers. Corequisite: ELEG 3221M. Prerequisite: Honors standing, ELEG 3213 and MATH 2584. (Typically offered: Spring)
This course is equivalent to ELEG 3223.

ELEG 3304. Energy Systems. 4 Hours.
Steady state analysis of DC machines, transformers, induction machines and synchronous machines. Introduction to speed control of electric machines using power electronics. Corequisite: Lab component. Prerequisite: ELEG 2113. (Typically offered: Spring)

ELEG 3304H. Honors Energy Systems. 4 Hours.
Steady state analysis of DC machines, transformers, induction machines and synchronous machines. Introduction to speed control of electric machines using power electronics. Corequisite: Lab component. Prerequisite: ELEG 2113. (Typically offered: Spring)
This course is equivalent to ELEG 3304.

ELEG 3704. Applied Electromagnetics. 4 Hours.
Analysis of transmission lines with sinusoidal and transient excitation. Development and use of the Smith Chart and methods of impedance matching. Vector analysis, static form of Maxwell's equations, electrostatics, and magnetostatics. Corequisite: Lab component. Pre- or Corequisite: PHYS 2074. Prerequisite: ELEG 2113 and MATH 2574. (Typically offered: Fall)

ELEG 3704H. Honors Applied Electromagnetics. 4 Hours.
Analysis of transmission lines with sinusoidal and transient excitation. Development and use of the Smith Chart and methods of impedance matching. Vector analysis, static form of Maxwell's equations, electrostatics, and magnetostatics. Corequisite: Lab component. Pre- or Corequisite: PHYS 2074 and MATH 2574. Prerequisite: ELEG 2113. (Typically offered: Fall)
This course is equivalent to ELEG 3704.

ELEG 387V. Special Topics in Electrical Engineering. 1-4 Hour.
Consideration of current electrical engineering topics not covered in other courses. (Typically offered: Irregular) May be repeated for up to 9 hours of degree credit.

ELEG 3903. Electric Circuits and Machines. 3 Hours.
Basic electrical principles and circuits; Introduction to sinusoidal steady-state analysis of electric circuits, active, reactive, and complex power; balanced three-phase circuits; Steady-state analysis of electric machines and transformers. Introduction to power electronics for machine speed control and alternative energy sources. For engineering students other than those in electrical engineering. Prerequisite: MATH 2564 and PHYS 2074. (Typically offered: Fall and Spring)

ELEG 3924. Microprocessor Systems Design. 4 Hours.
Introduction to 8-bit microprocessors and their application. Microprocessor architecture and assembly language; interface devices; system design using microprocessors. Corequisite: Lab component. Prerequisite: ELEG 2904. (Typically offered: Fall)

ELEG 3924H. Honors Microprocessor Systems Design. 4 Hours.
Introduction to 8-bit microprocessors and their application. Microprocessor architecture and assembly language; interface devices; system design using microprocessors. Corequisite: Lab component. Prerequisite: ELEG 2904. (Typically offered: Fall)
This course is equivalent to ELEG 3924.

ELEG 3933. Circuits & Electronics. 3 Hours.
Basic principles of electric and electronic circuits and devices. For engineering students who are not pursuing a degree in electrical engineering. Prerequisite: MATH 2584 and PHYS 2074. (Typically offered: Spring)

ELEG 400VH. Honors Senior Thesis. 1-3 Hour.
Honors senior thesis. Prerequisite: Senior standing. (Typically offered: Fall, Spring and Summer)

ELEG 4063. Electrical Engineering Design I. 3 Hours.
Capstone design and application in electrical engineering. Prerequisite: ELEG 3223 and ELEG 3924. (Typically offered: Fall and Spring)

ELEG 4063H. Honors Electrical Engineering Design I. 3 Hours.
Design and application in electrical engineering. Prerequisite: ELEG 3223 and ELEG 3924. (Typically offered: Fall and Spring)
This course is equivalent to ELEG 4063.

ELEG 4071. Electrical Engineering Design II. 1 Hour.
Design and application in electrical engineering. Prerequisite: ELEG 4063. (Typically offered: Fall and Spring)

ELEG 4071H. Honors Electrical Engineering Design II. 1 Hour.
Design and application in electrical engineering. Prerequisite: ELEG 4063. (Typically offered: Fall and Spring)
This course is equivalent to ELEG 4071.

ELEG 4203. Semiconductor Devices. 3 Hours.
Crystal properties and growth of semiconductors, energy bands and charge carriers in semiconductors, excess carriers in semiconductors, analysis and design of p/n junctions, analysis and design of bipolar junction transistors, and analysis and design of field-effect transistors. Students may not receive credit for both ELEG 4203 and ELEG 5203. Prerequisite: MATH 2584 and ELEG 3213, or graduate standing. (Typically offered: Irregular)

ELEG 4203H. Honors Semiconductor Devices. 3 Hours.
Crystal properties and growth of semiconductors, energy bands and charge carriers in semiconductors, excess carriers in semiconductors, analysis and design of p/n junctions, analysis and design of bipolar junction transistors, and analysis and design of field-effect transistors. Students may not receive credit for both ELEG 4203 and ELEG 5203. Prerequisite: MATH 2584 and ELEG 3213, or graduate standing. (Typically offered: Irregular)
This course is equivalent to ELEG 4203.

ELEG 4233. Introduction to Integrated Circuit Design. 3 Hours.
Design and layout of large scale digital integrated circuits using CMOS technology. Topics include MOS devices and basic circuits, integrated circuit layout and fabrication, dynamic logic, circuit design, and layout strategies for large scale CMOS circuits. Students may not receive credit for both ELEG 4233 and ELEG 5923. Prerequisite: ELEG 3213 or ELEG 3933 and ELEG 2904 or equivalent. (Typically offered: Fall)

ELEG 4243. Analog Integrated Circuits. 3 Hours.
Theory and design techniques for linear and analog integrated circuits. Current mirrors, voltage to base emitter matching, active loads, compensation, level shifting, amplifier design techniques, circuit simulation using computer-assisted design programs. Prerequisite: ELEG 3223. (Typically offered: Irregular)

ELEG 4253L. Integrated Circuit Design Lab I. 3 Hours.
This course will cover digital VLSI design and integrated circuit design tools. The course is structured with lectures. This course is offered to both senior undergraduate and graduate students. Students cannot get credit for both the undergraduate and graduate version of the course. Students cannot receive credit for both ELEG 4253L and ELEG 5253L. Prerequisite: ELEG 4233 or ELEG 5923. (Typically offered: Spring)

ELEG 4283. Mixed Signal Test Engineering I. 3 Hours.
Overview of mixed signal testing, the test specification process, DC and parametric measurements, measurement accuracy, tester hardware, sampling theory, DSP-based testing, analog channel testing, digital channel testing. Prerequisite: Senior or graduate standing. (Typically offered: Irregular)

ELEG 4303. Introduction to Nanomaterials and Devices. 3 Hours.
This course provides the students with an introduction to nanomaterials and devices. The students will be introduced to the quantization of energy levels in nanomaterials, growth of nanomaterials, electrical and optical properties, and devices based on these nanomaterials, such as tunneling resonant diodes, transistors, detector, and emitters. Graduate students will be given additional or different assignments. Graduate students will be expected to explore and demonstrate an understanding of the material with a greater level of depth and breadth than the undergraduates. Each group of students will have different expectations and grading systems. The instructor will prepare and distribute two distinct syllabi. Corequisite: ELEG 4203. Prerequisite: ELEG 3213 and PHYS 2074. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

ELEG 4343. Organic Electronics Technology. 3 Hours.
Students become familiar with recent developments in and process technology for organic material based devices and sensors in the classroom, but also gain hands on experience with fabrication processes using micro-fabrication tools in the lab. Students may not receive credit for both ELEG 4343 and ELEG 5343. (Typically offered: Irregular)

ELEG 4403. Control Systems. 3 Hours.
Mathematical modeling of dynamic systems, stability analysis, control system architectures and sensor technologies. Time-domain and frequency-domain design of feedback control systems: lead, lag, PID compensators. Special topics in microprocessor implementation. Students may not receive credit for both ELEG 4403 and ELEG 5403. Prerequisite: ELEG 3124. (Typically offered: Irregular)

ELEG 4403H. Honors Control Systems. 3 Hours.
Mathematical modeling of dynamic systems, stability analysis, control system architectures and sensor technologies. Time-domain and frequency-domain design of feedback control systems: lead, lag, PID compensators. Special topics in microprocessor implementation. Students may not receive credit for both ELEG 4403 and ELEG 5403. Prerequisite: ELEG 3124. (Typically offered: Irregular)

ELEG 4413. Advanced Control Systems. 3 Hours.
A second course in linear control systems. Emphasis on multiple-input and multiple-output systems: State-space analysis, similarity transformations, eigenvalue and eigenvector decomposition, stability in the sense of Lyapunov, controllability and observability, pole placement, quadratic optimization. Students may not receive credit for both ELEG 4413 and ELEG 5413. Prerequisite: ELEG 4403 or equivalent course. (Typically offered: Irregular)

ELEG 4423. Optimal Control. 3 Hours.
Introductory theory of optimizing dynamic systems: Formulation of performance objectives; calculus of variations; linear quadratic optimal control; discrete-time optimization; robustness and frequency domain techniques; reinforcement learning and optimal adaptive control. Prerequisite: ELEG 4403. (Typically offered: Irregular)

ELEG 4463L. Control Systems Laboratory. 3 Hours.
Experimental study of various control systems and components. The use of programmable logic controllers in the measurement of systems parameters, ladder-logic applications, process-control applications, and electromechanical systems. Prerequisite: ELEG 3924 and ELEG 3124. (Typically offered: Irregular)

ELEG 4473. Power System Operation and Control. 3 Hours.
Study of the control and operation of electric power systems: Modeling, dynamics, and stability of three-phase power systems. Design and implementation of control systems related to generation and transmission. Overview of the related industry and government regulations for power system protection and reliability. Students may not receive credit for both ELEG 4473 and ELEG 5473. Prerequisite: ELEG 3124 and ELEG 3304. (Typically offered: Irregular)

ELEG 4503. Design of Advanced Electric Power Distribution Systems. 3 Hours.
Design considerations of electric power distribution systems, including distribution transformer usage, distribution system protection implementation, primary and secondary networks design, applications of advanced equipment based on power electronics, and use of capacitors and voltage regulation. Students may not receive credit for both ELEG 4503 and ELEG 5503. Prerequisite: ELEG 3304. (Typically offered: Irregular)

ELEG 4513. Power and Energy Systems Analysis. 3 Hours.
Modeling and analysis of electric power systems: Energy sources and conversion; load flow analysis; reference frame transformations; symmetrical and unsymmetrical fault conditions; load forecasting and economic dispatch. Students may not receive credit for both ELEG 4513 and ELEG 5513. Prerequisite: ELEG 2113. (Typically offered: Irregular)

ELEG 4533. Power Electronics and Motor Drives. 3 Hours.
Characteristics of Insulated Gate Bipolar Transistors (IGBTs), Silicon Carbide (SiC) MOSFETs, Gallium Nitride (GaN) devices, Design of driver and snubber circuits for IGBTs and SiC MOSFETs, and an introduction to electric motor drives. Students may not receive credit for both ELEG 4533 and ELEG 5533. Prerequisite: ELEG 3304 and ELEG 3223. (Typically offered: Irregular)

ELEG 4543. Introduction to Power Electronics. 3 Hours.
Presents basics of emerging areas in power electronics and a broad range of topics such as power switching devices, electric power conversion techniques and analysis, as well as their applications. Students may not receive credit for both ELEG 5543 and ELEG 4543. Prerequisite: ELEG 2113 and ELEG 3213. (Typically offered: Irregular)

ELEG 4553. Switch Mode Power Conversion. 3 Hours.
Basic switching converter topologies: buck, boost, buck-boost, Cuk, flyback, resonant; pulse-width modulation; integrated circuit controllers; switching converter design case studies; SPICE analyses of switching converters; state-space averaging and linearization; and switching converter transfer functions. Prerequisite: ELEG 3223 and ELEG 3124. (Typically offered: Irregular)

ELEG 4563. EMI in Power Electronics Converters: Generation, Propagation and Mitigation. 3 Hours.
Concepts of electro-magnetic-interference issues in power electronics converters. Basic concepts of EMI measurement, modeling and mitigation, with a focus on conducted EMI in power electronics converters. The course is structured with lectures and a lab session. Students can not receive credit for both ELEG 4563 and ELEG 5563. Prerequisite: ELEG 2103 or equivalent and MATH 2574. (Typically offered: Irregular)

ELEG 4583. Programming for Power Electronics: DSPs. 3 Hours.
This course will focus on the development of both theoretical and practical skills needed to design and implement controls for power electronic systems using a Digital Signal Processors (DSPs). The course is structured with lectures and utilizes a project-based approach. Students cannot receive credit for both ELEG 5583 and ELEG 4583. Prerequisite: Senior standing, ELEG 2904, ELEG 3924, and CSCE 2004. (Typically offered: Spring)

ELEG 4593. Programming for Power Electronics: FPGA. 3 Hours.
This course will focus on the development of both theoretical and practical skills needed to design and implement controls for power electronic system using Field Programmable Gate Arrays (FPGAs). The course is structured with lectures and utilizes a project-based approach. Students cannot receive credit for both ELEG 5593 and ELEG 4593. Prerequisite: Senior standing, ELEG 2904, ELEG 3924 and CSCE 2004. (Typically offered: Spring)

ELEG 4603. Deterministic Digital Signal Processing System Design. 3 Hours.
Design of Digital Signal Processing systems with deterministic inputs. Sampling, quantisizing, oversampling, ADC trade-offs, distortion, equalizers, anti-aliasing, coherency, frequency domain design, audio and video compression. Prerequisite: ELEG 3124. (Typically offered: Irregular)

ELEG 4623. Communication Systems. 3 Hours.
Various modulation systems used in communications. AM and FM fundamentals, pulse modulation, signal to noise ratio, threshold in FM, the phase locked loop, matched filter detection, probability of error in PSK, FKS, and DPSK. The effects of quantization and thermal noise in digital systems. Information theory and coding. Students may not receive credit for both ELEG 4623 and ELEG 5663. Pre- or Corequisite: ELEG 3143. (Typically offered: Irregular)

ELEG 4703. Introduction to RF and Microwave Design. 3 Hours.
An introduction to microwave design principles. Transmission lines, passive devices, networks, impedance matching, filters, dividers, and hybrids will be discussed in detail. Active microwave devices will also be introduced. In addition, the applications of this technology as it relates to radar and communications systems will be reviewed. Prerequisite: ELEG 3704. (Typically offered: Irregular)

ELEG 4773. Electronic Response of Biological Tissues. 3 Hours.
Understand the electric and magnetic response of biological tissues with particular reference to neural and cardiovascular systems. Passive and active forms of electric signals in cell communication. We will develop the central electrical mechanisms from the membrane channel to the organ, building on those excitation, dielectric models for tissue behavior, Debye, Cole-Cole models. Role of bound and free water on tissue properties. Magnetic response of tissues. Experimental methods to measure tissue response. Applications to Electrocardiography & Electroencephalography, Microwave Medical Imaging, RF Ablation will be discussed that are common to many electrically active cells in the body. Analysis of Nernst equation, Goldman equation, linear cable theory, and Hodgkin-Huxley Model of action potential generation and propagation. High frequency response of tissues to microwave. Prerequisite: ELEG 3704 or equivalent; MATH 2584 or equivalent; basic Biology. (Typically offered: Irregular)

ELEG 4783. Introduction to Antennas. 3 Hours.
Basic antenna types: small dipoles, half wave dipoles, image theory, monopoles, small loop antennas. Antenna arrays: array factor, uniformly excited equally spaced arrays, pattern multiplication principles, nonuniformly excited arrays, phased arrays. Use of MATLAB programming and mathematical techniques for antenna analysis and design. Emphasis will be on using simulation to visualize variety of antenna radiation patterns. Corequisite: Drill component. Prerequisite: ELEG 3704. (Typically offered: Irregular)

ELEG 4783H. Honors Introduction to Antennas. 3 Hours.
Basic antenna types: small dipoles, half wave dipoles, image theory, monopoles, small loop antennas. Antenna arrays: array factor, uniformly excited equally spaced arrays, pattern multiplication principles, nonuniformly excited arrays, phased arrays. Use of MATLAB programming and mathematical techniques for antenna analysis and design. Emphasis will be on using simulation to visualize variety of antenna radiation patterns. Corequisite: Drill component. Prerequisite: ELEG 3704. (Typically offered: Irregular)
This course is equivalent to ELEG 4783.

ELEG 487V. Special Topics in Electrical Engineering. 1-3 Hour.
Consideration of current electrical engineering topics not covered in other courses. Prerequisite: Senior standing. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

ELEG 488V. Special Problems. 1-3 Hour.
Individual study and research on a topic mutually agreeable to the student and a faculty member. Prerequisite: Senior standing. (Typically offered: Fall, Spring and Summer) May be repeated for up to 6 hours of degree credit.

ELEG 4914. Advanced Digital Design. 4 Hours.
To master advanced logic design concepts, including the design and testing of synchronous and asynchronous combinational and sequential circuits using state of the art CAD tools. Students may not receive credit for both ELEG 4914 and ELEG 5914. Corequisite: Lab component. Prerequisite: ELEG 2904 or CSCE 2114. (Typically offered: Irregular)
This course is cross-listed with CSCE 4914.

ELEG 4963. CPLD/FPGA Based System Design. 3 Hours.
Field Programmable logic devices (FPGAs/CPLDs) have become extremely popular as basic building blocks for digital systems. They offer a general architecture that users can customize by inducing permanent or reversible physical changes. This course will deal with the implementation of logic options using these devices. Corequisite: Lab component. Prerequisite: ELEG 4914. (Typically offered: Irregular)
This course is cross-listed with CSCE 4353.

ELEG 4983. Computer Architecture. 3 Hours.
Design of a single board computer including basic computer organization, memory subsystem design, peripheral interfacing, DMA control, interrupt control, and bus organization. Prerequisite: ELEG 3924. (Typically offered: Irregular)
This course is cross-listed with CSCE 4213.