

## Bachelor of Science in Electrical Engineering

### Department of Electrical and Computer Engineering

Dr. John Peebles: 843.953.5057

john.peeples@citadel.edu

#### General Information:

In 1941 the Board of Visitors authorized the establishment of a Department of Electrical Engineering at The Citadel. Because World War II intervened, the first electrical engineering degrees were awarded to the class of 1948. The electrical engineering program is offered in two modes—day mode and the two-plus-two evening mode. The day mode is coeducational and open only to members of the South Carolina Corps of Cadets and enlisted active duty students assigned to one of The Citadel's ROTC Departments. The two-plus-two evening mode is coeducational, is open to transfer students and does not require ROTC or Health and Physical Education. Otherwise curricula, faculty, textbooks, laboratory equipment, course content, classrooms, and laboratories are the same for both modes.

The Electrical and Computer Engineering Department is located in Grimsley Hall, a first-tier engineering education facility that provides a great learning environment. Modern, fully equipped laboratories, classrooms, and faculty offices are logically arranged on the third floor. The related Departments of Mathematics and Computer Science, Physics, and Civil and Environmental Engineering are housed adjacent to the department, creating a "micro-campus" of science and technology.

The electrical engineering program is accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET), 111 Market Place, Suite 1050, Baltimore, MD 21202-4102 - Telephone: (410) 347-7700.

#### Mission:

The mission of the Department of Electrical and Computer Engineering is: To prepare the individual for professional work or for graduate study in the fields of electrical and computer engineering and to provide as many of the elements of a broad education as can be included in a program of professional study leading to the degree of Bachelor of Science in Electrical Engineering.

In addressing its mission, the department strives, through small classes, and hands-on experience in laboratories closely monitored by full-time faculty, to provide an environment highly conducive both to learning and to the development of close student-faculty relationships.

The electrical engineering curriculum places emphasis on a broad liberal education base, a strong background in mathematics and basic sciences, and a logical sequence of electrical and computer engineering courses that provide the breadth and depth necessary for continuous professional growth in today's technological society.

By the end of the junior year, the electrical engineering student normally selects an area of professional emphasis such as computer engineering, control systems, communication systems, electronics, or power systems. Integral to the program is the design component that develops the student's ability to address practical engineering problems. Engineering design problems and concepts are included throughout the curriculum and the experience is capped by a mandatory two-semester senior design course in which the students undertake significant design projects.

Convinced of the great value of practical experience, the department encourages its majors to obtain gainful employment in electrical engineering or a related field for at least one summer, preferably between the junior and senior years.

#### Admission Requirements:

1. Complete the designated courses with Trident Technical College or equivalent with a grade of C or higher.
2. Maintain a minimum 2.0 GPA.
3. Submit all official transcripts to the CGPS office.
4. Complete and return an undergraduate application to the College of Graduate & Professional Studies (CGPS), Bond Hall Room 101.

#### Program Requirements: Two-Plus-Two Evening Mode

The Citadel through the College of Graduate and Professional Studies offers an undergraduate Bachelor of Science degree in Electrical Engineering (BSEE). This program is offered in cooperation with Trident Technical College where the student completes the first two years of study. The junior and senior years of study are completed at The Citadel by attending evening classes. The program is designed and offered to enable the full-time student to complete the upper two years of the program and receive a BSEE within two academic years and two summers. Students are required to be advised for each semester of enrollment at The Citadel.

#### Program Objectives:

Graduates of The Citadel Department of Electrical and Computer Engineering's program of study will:

- be able to apply a foundation of scientific, mathematic and engineering knowledge to solve practical electrical and computer engineering problems.
- have strong oral and written communication skills and highly developed computer skills, and be able to apply both to solve engineering problems in a complex technological society.
- be familiar with the capabilities, application and operation of the equipment and tools in current use in engineering analysis, design and research environments.
- be aware of contemporary issues facing society and appreciate the need for, and harbor a desire to, engage in lifelong learning.
- have strong leadership and teaming skills.

These objectives are wholly consistent with the mission of the

Department and the Institution.

## Electrical Engineering Program:

The initial year of study includes engineering fundamental courses designed to develop the basic skills and good teaming habits through case studies requiring the communication of creative ideas. Electrical engineering topics studied in the sophomore year include 6 credit hours of electrical circuit analysis, 1 credit hour of electrical circuits laboratory, and 3 credit hours of computer applications pertinent to the field. Theory is combined with application, demonstration, and experimental verification. In addition, the first two years include 19 credit hours of mathematics, 8 credit hours of chemistry, 8 credit hours of physics, 18 credit hours of English and history and 3 credit hours of social science to provide the foundation necessary for an engineering education. Specific course requirements, using Trident Technical College course numbers, are outlined later under **Required Program for 2+2**.

The junior year requires a total 21 credit hours of electrical engineering course work. Breadth of coverage is provided by courses in linear system analysis, electronics, systems (automatic controls), digital systems, electromagnetics, and electromechanical energy conversion. Many of these courses include engineering design problems drawn from the experience of the faculty. First semester juniors complete their sixth mathematics course, MATH 335 (Applied Mathematics II), providing coverage of mathematical topics required in upper division electrical engineering courses. The junior year includes a single elective course that must be technical in nature but outside the mainstream of electrical engineering.

The senior year provides depth in electrical and computer engineering by requiring five out of a specified set of 400-level electrical engineering elective courses and at least one approved Computer Science elective. The elective courses are ELEC 401 (Electronics II), ELEC 403, (Electric Power Systems), ELEC 405 (Electrical Measurements) and ELEC 415 (Electrical Measurements Laboratory), ELEC 407 (Systems II), ELEC 413 (Advanced Topics in Electrical Engineering) ELEC 414 (System Simulation), ELEC 416 (Communications Engineering), ELEC 418 (Advanced Digital Systems), ELEC 419 (Computer Network Architecture), ELEC 423 (Digital Signal Processing), ELEC 424 (Solid-State Devices), ELEC 425, (Interference Control in Electronics), ELEC 426 (Antennas and Propagation) and CSCI 420 (Software Engineering). These electives provide the student the opportunity to pursue an area of interest. While narrow specialization is neither possible nor desirable at the undergraduate level, these three-credit electives provide depth in both design and theory in their specialized areas. Below are several examples of possible areas of concentration available to the student.

### Computer Engineering

- CSCI 223 Data Structures
- CSCI 420 Software Engineering
- ELEC 418 Advanced Digital Systems
- ELEC 419 Computer Network Architecture
- ELEC 423 Digital Signal Processing
- ELEC 416 Communications Engineering

### Power Engineering

- CIVL 310 Statics and Mechanics of Materials For Non-

### Civil Engineers

- ELEC 307 Nuclear Engineering
- ELEC 403 Electric Power Systems
- ELEC 407 Systems II
- ELEC 405 Electrical Measurements
- ELEC 415 Electrical Measurements Laboratory
- ELEC 426 Antennas and Propagation

### Communications

- PHYS 308 Optics
- ELEC 401 Electronics II
- ELEC 416 Communication Engineering
- ELEC 419 Computer Network Architecture
- ELEC 423 Digital Signal Processing
- ELEC 426 Antennas and Propagation

### Electronics

- PHYS 410 Thermodynamics
- ELEC 401 Electronics II
- ELEC 418 Advance Digital Systems
- ELEC 423 Digital Signal Processing
- ELEC 424 Solid State Devices
- ELEC 405 Electrical Measurements
- ELEC 415 Electrical Measurements Laboratory

## Electrical Engineering Design Experiences

Engineering design is distributed throughout the electrical engineering curriculum. Introduction to the design process and the initial design experience occur in the freshman courses. The engineering profession and the ethical responsibilities of professional engineers are discussed. Design problems are posed that require little or no in-depth engineering knowledge. For example, a first design problem might ask the student to design a dormitory room workplace. Functionality, aesthetics, and cost of implementation are a few of the issues to be considered. Case studies are assigned that provide an opportunity for the students to work in teams. The emphasis is on the synthesis of a product that meets broad requirements. The students are introduced to the concept of design in which there is no single right answer and where there are relatively few limits placed on the creative process.

Techniques of analysis, synthesis, iteration, and approximations are studied in the sophomore and junior electrical engineering courses. Specialized design exercises are used to illustrate the use of these techniques in the areas of circuits, systems, electronics, electric machines, and digital circuits and systems.

The senior year provides the opportunity for the student to begin to focus on design techniques in a particular area of interest through the choice of at least five senior electrical engineering elective courses. Examples range from the use of a load flow program to determine operational conditions of a small power system in a contingency situation (ELEC 403), to the design of a state estimator (ELEC 407), to the design and implementation of digital filters (ELEC 423).

The design experience culminates in the required senior design courses, ELEC 421 and ELEC 422. This two-semester design sequence provides students the opportunity to work on a project of interest and provides the faculty the opportunity to guide students in their first major design experiences and emphasize once more the various constraints that may come into play in

a design. The students are taught several different structured design approaches. Project definition and documentation are stressed. Design teams of three to four students are formed at the beginning of the first semester. Students are instructed on various practical aspects of design, such as layout considerations, safety, functionality, and documentation of design.

The student design teams select and propose a major design project to be completed by the end of second semester. They must enlist a faculty project advisor to guide their project. At the end of the first semester the design teams present their design proposals (written and oral) that include their preliminary design (block diagram level), a schedule for the following semester, and a cost estimate. In the second semester, the teams do the detailed design, and build, test, refine, demonstrate, and document their design projects. In addition to the technical aspects, project management and presentation techniques are taught and applied. A detailed project specification is developed and placed under tight change control. Financial and scheduling aspects of the project are tracked. A final presentation in both written and oral form is required at the end of the semester, along with a working demonstration.

### Required program for 2+2:

Lower two years of study offered at Trident Technical College.

#### TTC First Year

ENG 101/102  
MAT 140/141/240  
CHM 110/111  
HIS 101/102  
EGR 270/275  
PHY 221/ECE 201

#### TTC Second Year

MAT 241/132  
PHY 222  
ENG 205/2XX  
PSY 201  
ECE 221/222/205  
EGR 273

#### Citadel Third Year

ELEC 311/312  
MAT 206/ELEC 316  
MAT 335/ELEC 330  
ELEC 309/302  
CIVL 314/TECH ELEC  
ELEC 306/318  
CIVL 313/301

#### Citadel Fourth Year

ELEC 421/422  
HUM/SOC SCI ELEC \*\*  
ELEC 412/4XX \*  
ELEC 4XX/4XX \*  
ELEC 4XX/4XX \*

Credit hours required for graduation: 128 for evening students

XX Technical Electives: One of the following courses: Optics, PHYS 308; Thermodynamics, PHYS 410; Statics and Mechanics

of Materials For Non-Civil Engineers, CIVL 310; Data Structures, CSCI 223; Engineering Management, CIVL 411; Deterministic Methods of Operational Research, MATH 381; Mathematical Models and Applications, MATH 470

\*\*Advanced humanities or social science courses.

\*Approved Departmental Electives must be selected from among the following courses: Nuclear Engineering (ELEC 307), Electronics II (ELEC 401), Electric Power Systems (ELEC 403), Electrical Measurements (ELEC 405), Systems II (ELEC 407), Advanced Topics in Electrical Engineering (ELEC 413), System Simulation (ELEC 414), Electrical Measurements Laboratory (ELEC 415), Communication Engineering (ELEC 416), Advanced Digital Systems (ELEC 418), Computer Network Architecture (ELEC 419), Digital Signal Processing (ELEC 423), Solid-State Devices (ELEC 424), Interference Control in Electronics (ELEC 425), Antennas and Propagation (ELEC 426) and Software Engineering (CSCI 420) *Note: ELEC 405 and ELEC 415 must be taken together*

Note: Advanced Topics in Electrical Engineering (ELEC 413) is offered only occasionally. The Engineering science and engineering design credits are a function of the topics studied.

### List of Courses:

#### ELEC-104—Engineering Fundamentals I

One Credit Hour

Required of electrical engineering freshmen.

An introduction to the engineering profession, branches and functions of engineering, professional ethics, and the role of engineers in society. Fundamentals of engineering problem solving and the use of calculators and computers as tools to aid in problem solving.

Lecture: One hour; Laboratory: One hour.

#### ELEC-105—Engineering Fundamentals II

Two Credit Hours

Required of electrical engineering freshmen.

Continuation of Engineering Fundamentals I to include the introduction of subject areas common to most engineering disciplines, such as mechanics, energy, engineering economy, electrical theory, and material balance. Introduction to the design process to include preliminary design team exercises.

Lecture: Two hours.

#### ELEC-201—Electric Circuit Analysis I

Three Credit Hours

*Prerequisites:* Analytic Geometry & Calculus 1 (MATH 131) or permission of the department head to allow it as a co-requisite; prerequisite or co-requisites: Engineering Fundamentals 1 (ELEC 104), Physics with Calculus 1/Laboratory for Physics with Calculus 1 (PHYS 221/271.).

#### ELEC-202—Electric Circuit Analysis II

Required of electrical engineering sophomores.

Basic electrical elements and sources, Ohm's and Kirchhoff's Laws, techniques of DC circuit analysis, sinusoidal analysis and phasors, power, three-phase circuits; and transient response of simple circuits, uses of SPICE to aid circuit analysis.

Lecture: Three hours, two semesters.

*Prerequisites:* Analytic Geometry & Calculus II (MATH 132) or permission of the department head to allow it as a co-requisite, a grade of “C” or better in ELEC 201; prerequisite or co-requisites: Engineering Fundamentals (ELEC 105), Electrical Laboratory (ELEC 204), Computer Applications for Electrical Engineers (ELEC 206).

#### **ELEC-204—Electrical Laboratory**

One Credit Hour

Required of electrical engineering sophomores.

An introduction to the experimental method in electrical engineering. Laboratory exercises are designed to supplement the material presented in ELEC 201 and ELEC 202.

Laboratory: Two hours.

*Prerequisites or co-requisite:* Elecyric Circuit Analysis II (ELEC 202) or Elements of Electrical Engineering (ELEC 308), Computer Applications for Electrical Engineers (ELEC 206).

#### **ELEC-206—Computer Applications for Electrical Engineers**

Three Credit Hours

Required of electrical engineering sophomores.

The computer is presented as a tool for the solution of electrical engineering problems. High level language programming of computers; the use of application programs for the study of electrical circuits in the time and frequency domains; data manipulation, data plotting, and equation solving using application programs such as MATLAB.

Lecture: Three hours.

*Prerequisites or co-requisite:* Electric Circuit Analysis (ELEC 202) or Elements of Electrical Engineering (ELEC 308).

#### **ELEC-301—Linear Systems Laboratory**

One Credit Hour

Required of all electrical engineering juniors. A laboratory course to accompany ELEC 312.

Laboratory: Two hours.

*Prerequisite:* Electrical Laboratory (ELEC 204), Signals and Systems (ELEC 309). *Corequisite:* Systems I (ELEC 312).

#### **ELEC-302—Electrical Machinery Laboratory**

One Credit Hour

Required of electrical engineering juniors.

A laboratory course to accompany ELEC 316.

Laboratory: Two hours.

*Prerequisite or corequisite:* Electromechanical Energy Conversion (ELEC 316)

#### **ELEC-306—Electronics I**

Three Credit Hours

Required of all electrical engineering juniors.

Characteristics of solid-state devices, theory and design of low-frequency amplifiers, transistor biasing and stabilization, design of multistage and feedback amplifiers utilizing bipolar and MOS devices.

Lecture: Three hours.

*Prerequisites:* Electric Circuit Analysis II (ELEC 202), Electrical Analysis (ELEC 204), Computer Applications for Electrical Engineers (ELEC 206); prerequisite or corequisite: Electronics Laboratory (ELEC 313).

#### **ELEC 307—Nuclear Engineering**

Three Credit Hours

An introduction to the theory and application of nuclear energy. Topics include fission and the chain reaction; nuclear fuels; nuclear reactor principles, concepts, examples, construction, operation, and ecological impact; heat transfer and fluid flow; radiation hazards and shielding; nuclear propulsion; and controlled fusion. Lecture: Three hours.

*Prerequisites:* Physics with Calculus II/Laboratory for Physics with Calculus II (PHYS 222/272).

#### **ELEC-308—Elements of Electrical Engineering**

Three Credit Hours

Required of civil engineering juniors.

Fundamental electrical concepts and units; basic laws of electrical circuits; equivalent circuits; DC and steady-state AC circuit analysis; and effective current, average power, and three-phase power.

Lecture: Three hours.

*Prerequisite:* Analytic Geometry and Calculus II (MATH 132).

#### **ELEC-309—Signals and Systems**

Three Credit Hours

prerequisites or co-requisites: MATH 335 Required of electrical engineering juniors. The study of continuous and discrete systems utilizing Laplace, Fourier, and z-transform theory.

Lecture: Three hours.

*Prerequisites:* Electric Circuit Analysis (ELEC 202), Electrical Laboratory (ELEC 204), Computer Applications for Electrical Engineers (ELEC 206), Applied Engineering Mathematics (MATH 234).

#### **ELEC-311—Digital Logic and Circuits**

Three Credit Hours

Introduction to Boolean algebra; digital data coding; digital arithmetic; design of combinational and sequential circuits; design, construction and evaluation of digital circuits using industry-standard digital integrated circuits. Employs HDL and other S/W design tools.

Lecture: Three hours.

*Prerequisite or corequisite:* Introduction to Discrete Structures (MATH 206) or consent of department head.

#### **ELEC-312—Systems I**

Three Credit Hours

Required of electrical engineering juniors.

An introduction to feedback control systems, system representation, stability, root-locus and frequency response, and compensation.

Lecture: Three hours.

*Prerequisites:* Signals and Systems (ELEC 309)

*Co-requisites:* Linear Systems Laboratory (ELEC 301)

#### **ELEC-313—Electronics Laboratory**

One Credit Hour

Required of electrical engineering juniors.

Experimental studies coordinated with the subjects introduced in ELEC 306.

Laboratory: Two hours.

*Prerequisite:* Electric Circuit Analysis (ELEC 202), Electric

Laboratory (ELEC 204), Computer Applications for Electrical Engineers (ELEC 206).

*Corequisite:* Electronics I (ELEC 306).

### **ELEC-316—Electromechanical Energy Conversion**

Three Credit Hours

Required of electrical engineering juniors.

Analysis of transformers; fundamentals of electromechanical energy conversion; and study of DC, induction, and synchronous machines.

Lecture: Three hours.

*Prerequisite:* Signals and Systems (ELEC 309), or consent of the department head; prerequisite or co-requisite: Electrical Machinery Laboratory (ELEC 302).

### **ELEC-318—Electromagnetic Fields**

Three Credit Hours

Required of electrical engineering juniors.

Static and magnetic fields; experimental laws and their relation to Maxwell's equations; Laplace and Poisson's equations; boundary value problems; and time varying fields, plane waves, and transmission line phenomena.

Lecture: Three hours.

*Prerequisites:* Electric Circuit Analysis (ELEC 202), Electrical Laboratory (ELEC 204), Computer Applications for Electrical Engineers (ELEC 206), Physics with Calculus II/Laboratory for Physics with Calculus II (PHYS 222/272), Applied Engineering Mathematics I (MATH 234), Applied Engineering Mathematics II (MATH 335).

### **ELEC-330—Digital Systems Engineering**

Three Credit Hours

Required of electrical engineering juniors.

Characteristics, specifications, and design of digital systems; analysis and synthesis of sequential circuits; microprocessor interfacing. Design projects required.

Lecture: Three hours.

*Prerequisite:* Digital Logic and Circuits (ELEC 311).

### **ELEC-401—Electronics II**

Three Credit Hours

Characteristics and applications of modern linear and digital integrated circuits. CMOS digital logic, differential amplifiers, power amplifiers, oscillators and filter circuits.

Lecture: Three hours.

*Prerequisite:* Electronics I (ELEC 306), Electronics Laboratory (ELEC 313).

### **ELEC-403—Electric Power Systems**

Three Credit Hours

A study of electrical power generation, transmission, and distribution; load flow, faults, system stability, and system economics. Design project required.

Lecture: Three hours.

*Prerequisites:* Computer Applications for Electrical Engineers (ELEC 206), Electromechanical Energy Conversion (ELEC 316), and Electromagnetic Fields (ELEC 318).

### **ELEC-405—Electrical Measurements**

Two Credit Hours

An introduction to modern electrical instrumentation and

measurements. Topics include: measurement theory, analog and digital signal conditioning, noise, transducers, instrumentation system design, digital interfaces, and computer based instrumentation and measurements..

Lecture: Two hours.

*Prerequisite:* Any two 300-level electrical engineering laboratory courses; prerequisite or corequisite: Electrical Measurements Laboratory (ELEC 415).

### **ELEC-407—Systems II**

Three Credit Hours

A continuation of Systems I with primary emphasis on digital control systems. Topics include: state-variable analysis, simulation techniques, controllability, state-variable feedback, observability, and state estimator design.

Lecture: Three hours.

*Prerequisite:* Systems I (ELEC 312).

### **ELEC-412—Applied Probability and Statistics for Engineers**

Three Credit Hours

Required for electrical engineering majors. Application of the theory of probability and statistics in modeling random phenomena and signals; in the calculation of system responses; and in making estimates, inferences and decisions in the presence of chance and uncertainty. Applications will be studied in areas such as communications, power systems, device modeling, measurements, reliability, and quality control.

Lecture: Three hours.

*Prerequisites:* Analytic Geometry and Calculus III (MATH 231), Computer Applications for Electrical Engineers (ELEC 206).

### **ELEC 413—Advanced Topics in Electrical Engineering**

Three Credit Hours

Advanced topics in electrical engineering. Offered occasionally when the special interests of students and faculty coincide. The syllabus must be approved by the Electrical Engineering Faculty. This course may be taken only once for credit.

Lecture: Three hours.

### **ELEC-414—System Simulation**

Three Credit Hours

An introduction to system concepts, mathematical models of systems, and simulation methods applied to a broad range of systems. Design project required.

Lecture: Three hours.

*Prerequisite:* Systems (ELEC 312).

### **ELEC-415—Electrical Measurements Laboratory**

One Credit Hour

A laboratory course to complement ELEC 405.

Laboratory: Two hours.

*Prerequisite or corequisite:* Electrical Measurements (ELEC 405).

### **ELEC-416—Communications Engineering**

Three Credit Hours

Principles of amplitude, frequency, and pulse modulation; signal flow and processing in communications systems; and analog and digital communication systems.

Lecture: Three hours.

*Prerequisites:* Electronics I (ELEC 306), Systems I (ELEC 312), and Electromagnetic Fields (ELEC 318), Digital Systems Engineering

(ELEC 330)

### **ELEC418—Advanced Digital Systems**

Three Credit Hours

Experience in advanced digital design techniques and exposure to the development tools used in the design of advanced digital systems. Topics include the design of digital systems using VHDL, industry standard FPGA devices and software, and microprocessor hardware components.

Lecture: Three hours.

*Prerequisite:* Digital Systems Engineering (ELEC 330).

### **ELEC419—Computer Network Architecture**

Three Credit Hours

This course will cover network architecture and protocols. Included are transmission technologies, encoding/decoding schemes, packet switching, frame relay, ISDN, ATM and performance modeling techniques.

Lecture: Three hours.

*Prerequisite:* Digital Logic and Circuits (ELEC 311).

### **ELEC421—Design I**

Three Credit Hours

Required of electrical engineering seniors.

Initiation, design, scheduling, documentation and reporting on a major design project. Normally accomplished by students working in small groups. All students will make written and oral presentations on their contribution to the project. Financial, legal, ethical, societal, regulatory, environmental, manufacturability, and quality issues will be discussed and will constrain the designs as appropriate.

Lecture: One hour; Laboratory: Four hours.

*Prerequisites:* Electrical Machinery Laboratory (ELEC 302), Electronics I (ELEC 306), Systems I (ELEC 312), Electromechanical Energy Conversion (ELEC 316), Digital Systems Engineering (ELEC 330) and Electromagnetic Fields (ELEC 318) or consent of the department head.

### **ELEC422—Design II**

Three Credit Hours

Continuation of the major design project begun in ELEC 421. Project implementation, documentation, and reporting. Normally to be accomplished by students working in the small groups formed in ELEC 421. The impact of the practical, societal, and governmental issues raised in ELEC 421 will be assessed. Each student will make written and oral presentations on their contributions to the project. A prototype demonstration and presentation of final results in a symposium format is required.

Lecture: One hour; Laboratory: Four hours.

*Prerequisite:* Design I (ELEC 421) taken the preceding semester. Required of all electrical engineering seniors.

### **ELEC423—Digital Signal Processing**

Three Credit Hours

Introduction to the characteristics, design, and applications of discrete time systems using digital signal processors. Discrete time Fourier Transforms, FIR and IIR systems, and the design of FIR and IIR filters.

Lecture: Three hours.

*Prerequisite:* Systems I (ELEC 312), Digital Systems Engineering (ELEC 330).

### **ELEC424—Solid-State Devices**

Three Credit Hours

Basic principles governing the operation of solid-state devices are developed from fundamental concepts. P-N junction theory is developed and applied to the analysis of devices such as bipolar transistors, solar cells, detectors, and photo devices. The theory of field-effect devices is developed.

Lecture: Three hours.

*Prerequisites:* Electronics I (ELEC 306), and Electromagnetic Fields (ELEC 318).

### **ELEC425—Interference Control in Electronics**

Three Credit Hours

An introduction to the control and measurement of interference between electronic devices. Analysis methods and practical design techniques to minimize both radiated and conducted emissions and susceptibility. Enhancing signal integrity in high-speed circuits and reducing crosstalk. Laboratory exercises and demonstrations will be used to reinforce the material.

Lecture: Three hours.

*Prerequisites:* Signals and Systems (ELEC 309), Electromagnetic Fields (ELEC 318), Digital Systems Engineering (ELEC 330).

### **ELEC426—Antennas and Propagation**

Three Credit Hours

Transmission, radiation, and propagation of electromagnetic waves by means of transmission lines, waveguides, optical fibers, and antennas. Design project required.

Lecture: Three hours.

*Prerequisites:* Electromagnetic Fields (ELEC 318).