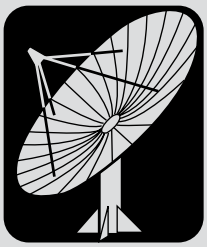
Engineering – Electrical and Electronic

College of Engineering and Computer Science

Bachelor of Science
Master of Science



PROGRAM DESCRIPTION

Electrical Engineering (power distribution, motors, generators) and Electronic Engineering (integrated circuits, digital and analog hardware, electromagnetic fields, communications, controls) requires the understanding and application of electrical, electronic, and magnetic phenomena.

The Department offers a comprehensive program leading to a Bachelor of Science degree in Electrical and Electronic Engineering. Students receive a thorough grounding in mathematics and the basic sciences during their first four semesters. Engineering design and applications are stressed in upper division courses. Prospective students are urged to discuss their plans as early as possible with their high school or community college counselor and with the Electrical and Electronic Engineering Department Chair who will advise students individually.

In cooperation with the Department of Computer Science, a separate major in Computer Engineering is offered. Students deciding between Electrical and Electronic Engineering and Computer Engineering as majors should also refer to the Computer Engineering section of this catalog.

The Department offers a Master of Science degree in Electrical and Electronic Engineering, with specialties in control systems, power systems, communications, digital systems, microwaves, and intelligent machines.

Career Possibilities

Controls Engineer • Design Engineer • Research Engineer • Test Engineer • Biomedical Engineer • Product Design Engineer • Applications Engineer • Systems Engineer • Project Engineer • Product Engineer • Communication Engineer • Power Engineer • Computer Engineer • Electronic Engineer

Faculty

John Balachandra, Jean-Pierre Bayard, Cynthia Colinge, Steve de Haas, Turan Gonen, Perry Heedley, Mahlon Heller, Preetham Kumar, Milica Markovic, Miroslav Markovic, Thomas W. Matthews, John Oldenburg, Jing Pang, S.K. Ramesh, Pradeep Setlur, Warren Smith, Suresh Vadhva, Salah Yousif

Contact Information

S.K. Ramesh, Department Chair
Suzanne Abshire, Administrative Support Coordinator
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(916) 278-6873
www.ecs.csus.edu/eee

Special Features

- The BS degree in Electrical and Electronic Engineering is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, 111 Market Place, Suite 1050, Baltimore, MD 21202.
- The major strengths of the Electrical and Electronic Engineering program lie in its faculty, whose basic philosophy built the curriculum, and in outstanding laboratory facilities.
- Faculty are active in curriculum development, scholarly and creative activities through funded research projects, and participation in professional technical societies.
- The curriculum provides a sound engineering background with small class sizes.
- The Electric Power Education Institute, housed within the Department and supported by local industry, provides scholarships for students interested in Power. It also provides short courses for local industry.
- The EEE Department Industry Liaison Council (ILC) consists of four members from industry representing the areas of interest to the department. The ILC provides feedback on program direction and our outcomes assessment efforts. The ILC is active in providing professional development opportunities for our faculty.

Program Educational Objectives

The objectives of this program are to prepare graduates to:

- enter professional employment and/or graduate study in several areas of Electrical and Electronic Engineering including, Electronics, Communications, Control, and Electric Power;
- identify, analyze, and solve practical problems, making use of appropriate engineering tools and techniques;
- work with contemporary laboratory instrumentation, design and perform experiments, and analyze and interpret the results;
- communicate effectively through speaking, writing, and using graphics, functioning collaboratively within multidisciplinary problem-solving teams;
- use their understanding of professional, ethical, and social responsibilities and the importance of life-long learning in the conduct of their careers; and
- adapt successfully to changing technologies, and apply their skills in new contexts to meet the demands of society.

UNDERGRADUATE PROGRAM

Development and Integration of Design

The field of Electrical Engineering continues to expand rapidly, requiring our graduates to apply their skills in new contexts and manage intelligently the consequences of their technical decisions. Thus, the number of critical topics to which the Electrical and Electronic Engineering graduate needs to be exposed is expanding. Our curriculum accommodates this expansion and emphasizes hands-on experience through numerous laboratory courses.

The Electrical and Electronic Engineering program provides breadth (core courses), depth (elective sequence) and a culminating experience to practice the design knowledge gained through the curriculum. The program motivates students to appreciate the connectedness among abstract ideas, applications, their classes and their careers. The electrical engineering core is emphasized, providing students with a broad undergraduate electrical engineering education. At the senior level, the curriculum allows flexibility by offering 13 units of elective course work. Seven of these units must be from within a selected elective area, providing our graduates depth in their area of interest. The four selected areas are: Analog/Digital Electronics, Control Systems, Communication Engineering and Power Engineering. The senior design project is a one-year (two semester) course sequence and serves as the capstone requirement. It allows students to integrate and apply their design knowledge from previous course work, making it consistent with their career goals.

Institute of Electrical and Electronic Engineers, Student Branch Activities

The Department has a strong IEEE Student Branch. It is among the most active chapters in the Sacramento Section of IEEE. The student branch has an elected core of officers, who plan and execute the programs of the chapter in consultation with the branch faculty advisor.

The primary purpose of the student branch is to develop professional awareness among the students and provide them with opportunities to expand their leadership and communication skills. The specific goals of the branch are to:

- increase student membership and encourage graduating seniors to maintain their membership as professionals;
- foster comradeship between the students by sponsoring technical and social events;
- increase the students' awareness of professional issues through the hosting of presentations by guest speakers from industry and by sponsoring tours.

The student branch plans a wide array of activities and assists with events such as the college's open house during National Engineers Week every year. Several Electrical and Electronic Engineering faculty members are active at the sectional and regional levels as IEEE officers. The Sacramento State student branch was the first in the Sacramento Section to organize a Student Professional Awareness Conference (SPAC). Also, students from Sacramento State regularly compete and win prizes in the Central Area Region 6 IEEE student contests. In 2003-04, the branch was recognized as the Outstanding Student Branch in IEEE Region 6 (Western USA).

The student branch is active in promoting student professional development and provides members with the opportunity to interact with engineers and scientists from industry. As evidenced by the active membership, the branch is a focal point in the career of the Electrical and Electronic Engineering students at Sacramento State. It provides them with invaluable leadership experience, communication skills, and professional awareness.

Requirements • Bachelor of Science Degree

Units required for Major: 57
Units required for Pre-major: 44
Minimum total units required for BS: 134

Note: Additional units may be required to meet the Sacramento State foreign language requirement.

A grade of "C-" or better is required in all courses applied to an Electrical Engineering major.

Courses in parentheses are prerequisites.

A. Required Lower Division Courses (Pre-major 44 units)

(5)	CHEM 1A*	General Chemistry I (High school algebra (two years) and high school chemistry; or equivalent)
(3)	CSC 25	Introduction to C Programming
(4)	EEE 64#	Introduction to Logic Design (CSC 15 or CSC 25)
(3)	ENGL 20	College Composition II (ENGL 1A with grade of "C-" or better, or equivalent)
(3)	ENGR 17#	Introductory Circuit Analysis (MATH 45, PHYS 11C, either concurrent, not both)
(3)	ENGR 70	Engineering Mechanics (PHYS 11A)
(4)	MATH 30*	Calculus I (MATH 29 or four years of high school mathematics which includes two years of algebra, one year of geometry, and one year of mathematical analysis; completion of ELM requirement and Pre-Calculus Diagnostic Test.)
(4)	MATH 31*	Calculus II (MATH 30 or appropriate high school based AP credit)
(4)	MATH 32	Calculus III (MATH 31)
(3)	MATH 45	Differential Equations for Science and Engineering (MATH 31)
(4)	PHYS 11A*	General Physics: Mechanics (MATH 30, MATH 31 or equivalent certificated high school courses. MATH 31 may be taken concurrently)
(4)	PHYS 11C*	General Physics: Electricity and Magnetism, Modern Physics (MATH 31, PHYS 11A)

B. Required Upper Division Courses (Major 36 units)

Students are not permitted to enroll in upper division courses until they have completed all lower division requirements in **Section A** and have filed a change of major form for Electrical and Electronic Engineering. It is imperative that students take the University's Writing Proficiency Examination (WPE) during the first semester of the junior year, as it is a prerequisite to all laboratory courses after EEE 117.

(3)	EEE 108	Electronics I (EEE 117, EEE 166; Corequisite: EEE 108L)
(1)	EEE 108L	Electronics I Laboratory (EEE 117, EEE 117L, EEE 166. Corequisite: EEE 108)

(3)	EEE 117#	Network Analysis (ENGR 17, EEE 64; EEE 64 may be taken concurrently. Corequisite: EEE 117L)
(1)	EEE 117L	Network Analysis Laboratory (Corequisite: EEE 117)
(3)	EEE 130	Electromechanical Conversion (EEE 117)
(4)	EEE 161	Applied Electromagnetics (MATH 32, MATH 45, PHYS 11C, ENGR 17 and CSC 25)
(3)	EEE 166	Physical Electronics (EEE 117, EEE 117L, either may be taken concurrently)
(4)	EEE 174	Introduction to Microprocessors (EEE 64; junior status)
(3)	EEE 180	Signals and Systems (EEE 117)
(3)	EEE 184	Introduction to Feedback Systems (EEE 180)
(3)	EEE 185	Modern Communication Systems (EEE 180, ENGR 120)
(3)	ENGR 120	Probability and Random Signals (EEE 180, may be taken concurrently)
(2)	ENGR 140	Engineering Economics (ENGR 17, ENGR 30 or MET 30, or instructor permission)

C. Required Design Project Series (8 units)

(3)	EEE 141	Power System Analysis (EEE 130, may be taken concurrently) **AND**
(1)	EEE 143	Power System Laboratory (EEE 130, EEE 141 passing score on WPE) **AND**
(2)	EEE 192A*	Electrical Power Design Project I (EEE 143, EEE 143 may be taken concurrently and any two of the following courses: EEE 141, EEE 142, EEE 144) **AND**
(2)	EEE 192B*	Electrical Power Design Project II (EEE 192A, EEE 142, EEE 144; EEE 142 or EEE 144 may be taken concurrently--but not both) **OR**
(4)	EEE 109	Electronics II (EEE 108, EEE 108L, EEE 117, EEE 117L, passing score on WPE) **AND**
(2)	EEE 193A*	Product Design Project I (EEE 108, EEE 109, EEE 130, EEE 161, EEE 174, EEE 180, passing score on WPE; EEE 109 may be taken concurrently) **AND**
(2)	EEE 193B*	Product Design Project II (EEE 193A)

D. Required Electives (13 units)

(7)	EEE	Depth Requirement: Select two lecture courses (6 units) and one lab course (1 unit) from one of the Depth Requirement Areas listed below.
(6)	EEE	Electives Requirement: Select two additional 3-unit lecture courses from any of the four areas listed below.

* Indicates course which can also be used to meet General Education (GE) requirements. The designation "General Education course" denotes a course which meets GE requirements other than those which also serve as prerequisites to courses in the major. Students are expected to satisfy the requirements of the Accreditation Board for Engineering and Technology (ABET) as well as the University's GE requirements. Consult the Department Chair for specific GE requirements. Students should take ENGL 1A as early as possible since it is required for admission to the upper division.

Workshops (EEE 64W, ENGR 17W, and ENGR 117W) are available to augment understanding of material, however, they cannot be used to satisfy graduation requirements.

Depth Requirement Areas and List of Electives

Analog/Digital Electronics

EEE 109*	Electronics II (EEE 108, EEE 108L, EEE 117, EEE 117L; passing score on WPE)
EEE 110	Advanced Analog Integrated Circuits (EEE 109 or instructor permission)
EEE 111	Advanced Analog Integrated Circuits Laboratory (EEE 109, either EEE 110 or EEE 230 may be taken concurrently)
CPE 138	Computer Networks and Internets (CSC 35, CSC 60, CSC 130)
CPE 151	CMOS and VLSI (CPE/EEE 64, CPE/EEE 102 or EEE 108)
CPE 153	VLSI Design (CPE 151)
CPE 166	Advanced Logic Design (CPE/EEE 64, ENGR 17)
CPE 186	Computer Hardware System Design (CPE 185 or EEE 174)
CPE 187	Embedded Processor System Design (CPE 166, CPE 185, EEE 102 passing score on WPE)

Control Systems

EEE 187	Robotics (EEE 180 or equivalent, or instructor permission)
EEE 188	Digital Control Systems (EEE 180, passing score on WPE)
EEE 189	Controls Laboratory (EEE 184; EEE 184 may be taken concurrently, passing score on WPE)

Communication Engineering

EEE 162	Applied Wave Propagation (EEE 117, EEE 161)
EEE 163	Traveling Waves Laboratory (EEE 117, EEE 162; EEE 162 may be taken concurrently; passing score on WPE)
EEE 165	Introduction to Optical Engineering (EEE 161, EEE 180, EEE 185; EEE 185 may be taken concurrently)
EEE 167	Electro-Optical Engineering Laboratory (EEE 161, EEE 165, EEE 180, passing score on WPE. EEE 165 may be taken concurrently)
EEE 181	Introduction to Digital Signal Processing (CPE/EEE 64 or equivalent, EEE 180)
EEE 182	Digital Signal Processing Lab (EEE 180, EEE 181; EEE 181 may be taken concurrently)
EEE 183	Digital and Wireless Communication System Design (EEE 161, EEE 180, EEE 185; EEE 185 may be taken concurrently)
EEE 186	Communication Systems Laboratory (EEE 117, EEE 185, passing score on WPE; EEE 185 may be taken concurrently)
PHYS 106	Introduction to Modern Physics (MATH 31; PHYS 11A, PHYS 11B, PHYS 11C or PHYS 5A, PHYS 5B)
PHYS 130	Acoustics (MATH 45, PHYS 11A, PHYS 11B, PHYS 11C)

Power Engineering

EEE 131	Electromechanics Laboratory (EEE 117, EEE 130, passing score on WPE; EEE 130 may be taken concurrently)
EEE 141**	Power System Analysis (EEE 130 may be taken concurrently)
EEE 142	Energy Systems Control and Optimization (EEE 130)
EEE 143**	Power Systems Laboratory (EEE 130, EEE 141, passing score on WPE)
EEE 144	Electric Power Distribution (EEE 130)
EEE 145	Power System Relay Protection (EEE 130, EEE 141)
EEE 146	Power Electronics Controlled Drives (EEE 108, EEE 130)
EEE 148	Power Electronics Laboratory (EEE 146, may be taken concurrently)

Note: Other upper division courses in Engineering and Computer Science may be selected as elective lectures with **prior** approval of the student's advisor.

*Students planning to complete EEE 193A / EEE 193B series may **not** use EEE 109 to meet depth/elective requirement.

Students planning to complete EEE 192A / EEE 192B series may **not use EEE 141 and EEE 143 to meet depth/elective requirement.

Sequencing Course Work for Undergraduate Major

The Engineering Electrical and Electronic Department strongly recommends that EEE majors sequence their courses as outlined in the EEE Curriculum Pattern Guide, available at the Department office, RVR 3018.

Cooperative Education Program (Work Experience)

The Electrical and Electronic Engineering Department encourages students to participate in the University's Cooperative Education Program (Co-op). They will complete one or two six-month periods of full-time, off-campus work in their field during their upper division years. Employment with private industry or government agencies is arranged by the University's Cooperative Education Program Office. Students are paid by the employer. Participating students must enroll in EEE 195A, B, C, or D, but units earned for Co-op work cannot be used to satisfy the requirements for a major. Students who satisfactorily complete two work periods are awarded a certificate. The Co-op experience will enhance the student's employment prospects after graduation. Students interested in the Cooperative Education Program should apply in the satellite office in Riverside Hall 2004 or the main office in Lassen Hall Room 2000 (*http://www.csus.edu/careercenter/*). For information, call (916) 278-7234.

GRADUATE PROGRAM

The Master of Science degree program in Electrical and Electronic Engineering is designed to provide students with advanced study in a variety of electrical and electronic engineering topics, and opportunities to conduct independent research to broaden their professional scope.

The scheduling of courses and the Culminating Experience options in the program are designed to provide flexibility for working professionals. All students complete a three-unit general core course and at least two of the designated elective area core courses. This requirement is designed to provide a strong academic foundation. In consultation with the Graduate Coordinator and faculty advisors, students then focus their studies in one or more of the following areas, adapting to the needs and interests of the practicing engineer or post-graduate candidate:

- Control Systems
- Communication Systems
- Power Systems
- Microelectronic Design
- Computer Architecture and Digital Design

Coordinated courses are offered in advanced microprocessors, electromagnetic theory and microwaves, lasers and fiber optics, semiconductor devices, robotics and intelligent machines, systems and control, networks, and communication systems. Other coordinated courses facilitate the study of estimation and stochastic control, advanced communications and signal processing, large interconnected power systems, power systems reliability and planning, advanced design and organization of digital computer systems, and advanced integrated circuit design. The program is also sufficiently flexible to allow special independent studies of problems of current interest.

The Department has a strong relationship with the local engineering community. Students of the program have access to Department laboratories and facilities and to University computer services.

Admission Requirements

Admission as a classified graduate student in Electrical and Electronic Engineering requires:

- a BS in Electrical and Electronic Engineering or equivalent;
- at least a 3.0 GPA in the last 60 units of the BS in Electrical and Electronic Engineering or equivalent; and
- at least a 3.25 GPA in the Electrical and Electronic Engineering major or equivalent major.

Under special circumstances, a student who does not satisfy the Admission Requirements may be admitted as a conditionally classified graduate student. Deficiencies will be specified in the acceptance letter to the student and must be removed by the student before the student can become a classified graduate student.

A student registered as an unclassified graduate student should carefully note that graduate courses taken as an unclassified graduate or as an open university student cannot be used to improve the student's grade point average for admittance to the Electrical and Electronic Engineering graduate program. Only undergraduate Electrical and Electronic Engineering courses can be taken or retaken to improve the GPA of the student for admittance to the graduate program.

Admission Procedures

Applications are accepted as long as room for new students exists. However, students are strongly urged to apply by April 1st for the following fall or October 1st for the following spring. All prospective graduate students, including Sacramento State

graduates, must file the following with the Office of Graduate Studies, River Front Center 206, (916) 278-6470:

- an online application for admission; and
- two sets of official transcripts from all colleges and universities attended, other than Sacramento State.

At the same time, students not meeting the above admission requirements should submit to the Electrical and Electronic Engineering Graduate Coordinator two letters of recommendation, Graduate Record Examination scores, and/or other evidence of their potential for successful graduate study in this program.

Approximately six weeks after receipt of all items listed above, a decision regarding admission will be mailed to the applicant.

Advancement to Candidacy

By the end of the first semester, after admission to the program, each student in the EEE Department is required to have a program of study approved by an elective area core faculty advisor and the Graduate Coordinator. Students will fill out a form (contract) outlining what courses they plan to take to complete the MS degree. This contract will be signed by the student and the faculty advisor, and filed in the EEE Department Office.

Each student must satisfy the university Writing Proficiency Exam (WPE) requirement, or register for an appropriate remedial English class, before registering for the seventh course in the program of study.

In addition, each student must file an application for Advancement to Candidacy with the Office of Graduate Studies indicating a proposed program of graduate study for the completion of the MSEE. This procedure should begin as soon as the *classified* graduate student has:

- removed any deficiencies in Admission Requirements;
- completed a minimum of 12 units in the graduate program with a minimum 3.0 GPA; at least nine units of the 12 units must be EEE 200 level courses; and
- passed the Writing Proficiency Examination (WPE) or secured approval for a WPE waiver.

Each student must be advanced to candidacy prior to registering for EEE 500.

Advancement to Candidacy forms are available in the Office of Graduate Studies and in the Electrical and Electronic Engineering Department Office.

Requirements • Master of Science Degree

Units required for MS: 30
Minimum required GPA: 3.0

A. Required Core Courses (9 units)

(3) EEE 244 Electrical Engineering Computational Methods and Applications (EEE 180)

(6) Select two of the following elective area core courses:

- EEE 211* Microwave Engineering (EEE 161; EEE 108 or instructor permission)
- EEE 230 Analog and Mixed Signal Integrated Circuit Design (EEE 109 and instructor permission)
- EEE 241 Linear Systems Analysis (EEE 180 or equivalent)
- EEE 250 Analysis of Faulted Power Systems (EEE 130 or equivalent)
- EEE 260* Statistical Theory of Communication (EEE 185)
- EEE 285 Micro-Computer System Design I (EEE 174 or CPE 185)

* Only one of these two courses will be counted as a core requirement. The other may be taken as an elective.

B. Electives (15-21 units)

Select 15-21 units from the following fields of study and other areas, in consultation with the elective area faculty advisor and Graduate Coordinator. A maximum of 6 units of undergraduate technical electives in electrical and electronic engineering or computer engineering may be applied to this requirement if approved by the Graduate Coordinator and if they have not been used to satisfy the BS program requirements or MSEE admission requirements.

Communication Systems

- EEE 211 Microwave Engineering (EEE 161; EEE 108 or instructor permission)
- EEE 215 Lasers (EEE 180, EEE 161; or instructor permission)
- EEE 233 Advanced Digital Signal Processing (EEE 174, EEE 181 or equivalent)
- EEE 260 Statistical Theory of Communication (EEE 185)
- EEE 261 Information Theory, Coding, Detection (EEE 185)
- EEE 262 Wireless Communications Systems (EEE 185)
- EEE 267 Fiber Optic Communications (EEE 185 or instructor permission)

Control Systems

- EEE 221 Machine Vision
- EEE 225 Advanced Robot Control (EEE 184 or equivalent)
- EEE 241 Linear Systems Analysis (EEE 180 or equivalent)
- EEE 242 Statistical Signal Processing
- EEE 246 Advanced Digital Control (EEE 241)
- EEE 249 Advanced Topics in Control and Systems

Power Systems

- EEE 250 Analysis of Faulted Power Systems (EEE 130 or equivalent)
- EEE 251 Power System Economics and Dispatch (EEE 141 or equivalent)
- EEE 252 Power System Reliability and Planning (EEE 142 or equivalent)
- EEE 254 Large Interconnected Power Systems (EEE 142)
- EEE 256 Advanced Power Systems Protection (EEE 141; EEE 145 or instructor permission)
- EEE 259 Advanced Topics in Power Systems (EEE 142)

Microelectronic Design

- EEE 230 Analog and Mixed Signal Integrated Circuit Design (EEE 109 and instructor permission)
- EEE 236 Advanced Semiconductor Devices
- EEE 238 Advanced VLSI Design-For-Test I (CPE 151, CPE 166)

Computer Architecture and Digital Design

EEE 272	High Speed Digital System Design (EEE 161)
EEE 273	Hierarchical Digital Design Methodology (EEE 64 or equivalent)
EEE 280	Advanced Computer Architecture (CSC 205 or instructor permission)
EEE 285	Micro-Computer System Design I (EEE 174 or CPE 185)
EEE 286	Micro-Computer System Design II (EEE 285 or CPE 186)

C. Culminating Requirement (0, 3 or 6 units)

EEE 201	Research Methodology
EEE 500	Culminating Experience (Advancement to Candidacy)

Notes:

- **The student cannot register for the Culminating Experience until the student passes the Writing Proficiency Exam (WPE), and advances to candidacy.** In subsequent semesters, students will enroll in EEE 599, Continuous Enrollment, after qualifications for enrollment are verified.
- **Before registering** for EEE 500, students choosing Plan A, Master Thesis (5 units), or Plan B, Master Project (2 units), must submit an approved Topic Form to the Graduate Coordinator. Note: Selection of Plan A or Plan B requires the completion of EEE 201, Research Methodology (1 unit), in the program of graduate study.
- **Students opting for Plan C, Comprehensive Exam**, must have that option approved by their elective area advisor. They will not receive degree credit for either EEE 201 or EEE 500. They must complete a total of 30 units of approved course work, including core, elective core, and elective courses. They must advance to candidacy for the degree, and take a written comprehensive exam that will cover all of the material in their MS Program of Study. Students who fail may be permitted to retake the exam at its next offering; however, those who fail the exam a second time will not be allowed to continue with the Plan C option. NB: It should be recognized that industry puts a high value on project and thesis problem-solving experience, and the demonstration of technical writing skill that these options require. Graduating under Plan C option will not provide that experience. Students taking this option should consider, with their elective area advisors, other ways of gaining that valuable experience, such as through an EEE 299 Special Problems course.
- **As soon as possible after the student has registered for** EEE 500, it is expected that the student will select a committee appropriate to the chosen plan of study. The Thesis Committee is to consist of the student's Thesis Advisor, who is the Chairperson of the student's Thesis Committee, and two other faculty members. The Project Committee is to consist of the student's Project Advisor, who is the Chairperson of the student's Project Committee, and one other faculty member. The committee members selected by the student must be approved by the Electrical and Electronic Engineering Department's Graduate Coordinator.
- **The Thesis (Plan A)** must be orally presented and defended, approved by the student's Thesis Committee, and approved by the Electrical and Electronic Engineering Graduate Coordinator prior to submittal of the Thesis to the Office of Graduate Studies.
- **The Project (Plan B)** is to culminate in a report and a device or simulation, which is to be demonstrated to the student's Project Committee. The Project Report must be approved by the student's Project Committee and approved by the Electrical and Electronic Engineering Graduate Coordinator prior to its submittal to the Office of Graduate Studies.

Lower Division Courses

EEE 64. Introduction to Logic Design. Covers the following topics: logic gates, binary number system, conversion between number systems, Boolean algebra, Karnaugh maps, combinational logic, digital logic design, flip-flops, programmable logic devices (PLDs), counters, registers, memories, state machines, designing combinational logic and state machines into PLDs, and basic computer architecture. Lab emphasizes the use of software equation entry design tools, the use of a schematic entry, and the use of a logic simulation design tool. Lab assignments are design-oriented. **Prerequisite:** CSC 15 or CSC 25 **Cross-listed:** CPE 64; only one may be counted for credit. **Units:** 4.0.

EEE 64W. Introduction to Logic Design Workshop. Assists students in developing a more thorough understanding of logic simulation and logic design. Focus is on problem solving and design. Activity two hours. Lecture three hours; laboratory three hours. **Corequisite:** EEE 64. **Cross-listed:** CPE 64W; only one may be counted for credit. **Graded:** Credit / No Credit. **Units:** 1.0.

EEE 96. Experimental Offerings in Electrical and Electronic Engineering. Proseminars devoted to subject matter not adequately covered elsewhere in the curriculum may be scheduled in response to proposals from faculty and students. **Note:** May be repeated for credit with permission of advisor. **Units:** 1.0-4.0.

Upper Division Courses

EEE 102. Analog/Digital Electronics. Introduction to analog/digital electronics, diodes, FET's, BJT's, DC biasing, VI characteristics, single-stage amplifiers, power supplies and voltage regulators, power electronic devices, OP-amps, active filters, A/D and D/A converters. PSPICE used extensively. **Note:** Cannot be taken for credit by EEE Majors. **Prerequisite:** ENGR 17. **Corequisite:** EEE 102L. **Units:** 3.0.

EEE 102L. Analog/Digital Electronics Laboratory. Introduction to analog/digital electronics, diodes, FET's, BJT's, DC biasing, VI characteristics, single stage amplifiers, power supplies and voltage regulators, power electronic devices, OP-amps, active filters, A/D and D/A converters. PSPICE used extensively. **Note:** Cannot be taken for credit by EEE Majors. **Prerequisite:** ENGR 17. **Corequisite:** EEE 102. **Units:** 1.0.

EEE 108. Electronics I. Introduction to electronics, ideal OP-AMPS, BJTs, FETs, DC biasing, VI characteristics, single stage amplifiers, low frequency small signal models, power supplies and voltage regulation. PSPICE required. **Prerequisite:** EEE 117, EEE 166. **Corequisite:** EEE 108L. **Units:** 3.0.

EEE 108L. Electronics I Laboratory. Characteristics and applications of OP-AMPS, rectifiers, BJTs and FETs. Introduction to GPIB, PSPICE and LabVIEW. Laboratory three hours. **Prerequisite:** EEE 117, EEE 117L, EEE 166. **Corequisite:** EEE 108. **Units:** 1.0.

EEE 109. Electronics II. Differential and multistage amplifiers, high frequency models (BJTs and FETs), feedback and sensitivity, power amplifiers, oscillators and waveform shaping circuits. Advanced use of PSPICE. Lecture three hours; laboratory three hours. **Prerequisite:** EEE 108, EEE 108L, EEE 117, EEE 117L; passing score on WPE. **Units:** 4.0.

EEE 110. Advanced Analog Integrated Circuits. The use of operational amplifiers in circuit designs for applications such as filtering, switched capacitor design, sample and hold design, instrumentation amplifiers, and voltage reference circuitry will be explored, as well as topics in Feedback Theory. **Prerequisite:** EEE 109 or consent of instructor. **Units:** 3.0.

EEE 111. Advanced Analog Integrated Circuits Laboratory. Circuit design, mask design, and simulation of integrated circuitry. Use of CAD software to prepare design for fabrication. Individual and group design projects. Laboratory three hours. **Prerequisite:** EEE 109; either EEE 110 or EEE 230. EEE 110 or EEE 230 may be taken concurrently. **Units:** 1.0.

EEE 117. Network Analysis. Review of Sinusoidal steady state, phasors, complex power, three phase power, mutual inductance, series and parallel resonance. Introduction to application of Laplace transforms in network analysis, transfer functions, Bode plots, Fourier series, two-port circuits. **Prerequisite:** ENGR 17, EEE 64; EEE 64 may be taken concurrently. **Corequisite:** EEE 117L. **Units:** 3.0.

EEE 117L. Networks Analysis Laboratory. Introduces fundamental laboratory techniques while demonstrating the concepts introduced in the EEE 117 lecture. The computer simulation language PSPICE is introduced and applied. Laboratory three hours. **Corequisite:** EEE 117. **Units:** 1.0.

EEE 130. Electromechanical Conversion. Magnetic circuits and principles of electromechanical energy conversion, DC machines, state equations, terminal characteristics, transformers, AC machines, terminal characteristics of synchronous machines, stability considerations. Induction machine theory. Introduction to energy sources including conventional and nuclear power plants. **Prerequisite:** EEE 117. **Units:** 3.0.

EEE 131. Electromechanics Laboratory. Direct current motor and generator characteristics, three phase synchronous motor and synchronous generator characteristics, single phase power transformer short circuit and no-load tests, frequency changer tests and tests on DC and AC machine models, potential and current transformers. **Prerequisite:** EEE 117, EEE 130; EEE 130 may be taken concurrently. **Units:** 1.0.

EEE 141. Power System Analysis. Characteristics of power system components; power system planning; transmission line parameters and the steady-state performance of transmission lines; disturbance of the normal operating conditions, symmetrical components and sequence impedances; analysis of balanced and imbalanced faults; and a brief review of protection systems. **Prerequisite:** EEE 130; may be taken concurrently. **Units:** 3.0.

EEE 142. Energy Systems Control and Optimization. Energy systems and ecology, load flow studies, sensitivity; optimum allocation and dispatching; optimal dynamic system control; modern stability studies. Students in the course will use MATLAB to solve problems. **Prerequisite:** EEE 130. **Units:** 3.0.

EEE 143. Power System Laboratory. Simulation of three phase operations and transmission line operation including voltage regulation, efficiency of long lines, power system stability, voltage control and load-frequency control, load flow and optimal dispatch for simplified interconnected systems. **Prerequisite:** EEE 130, EEE 141, passing score on WPE. **Units:** 1.0.

EEE 144. Electric Power Distribution. Operation and design of utility and industrial distribution systems including distribution system planning; load characteristics; application of distribution transformers; design of subtransmission lines, distribution substations, primary systems, secondary systems; application of capacitors; voltage regulation and reliability. **Prerequisite:** EEE 130. **Units:** 3.0.

EEE 145. Power System Relay Protection. Principles of relay techniques (classical and solid state), current and potential transformers and their application in relaying technique, overcurrent, differential, impedance, frequency, overvoltage and undervoltage relays, relay protection of overhead and underground power lines, generators, transformers, motors, buses and computer applications in relay protection. **Prerequisite:** EEE 130, EEE 141. **Units:** 3.0.

EEE 146. Power Electronics Controlled Drives. Review thyristors, controlled rectifiers, DC choppers and inverters and pulse width modulation methods including space vector method. Control of DC drives and methods of control of induction synchronious motors including flux-vector methods and computer simulations will be studied. **Prerequisite:** EEE 108, EEE 130. **Units:** 3.0.

EEE 147. Power System Operation and Control Laboratory. Computer simulation methods to describe power system behavior under steady state and dynamic conditions. Experiments conducted using MATLAB and Simulink for load flow in distribution lines, optimal power dispatch, synchronous machine transient behavior under short circuit conditions, transient stability, voltage and reactive power control, classical and modern load frequency control. Laboratory three hours. **Prerequisite:** EEE 141. **Units:** 1.0.

EEE 148. Power Electronics Laboratory. Solid state applications in power control. Diodes, rectifiers (single state and three phase), thrustors. Principle of phase controlled rectification, single phase and three phase converters. Power factor improvement. Three phase Pulse Width Modulation (PWM). AC voltage controllers. SPICE modeling. Strong design emphasis. EMTP modeling. LabView graphics simulation. Microprocessor control of power electronics systems. UPS systems, power supplies, power quality monitoring. **Prerequisite:** EEE 146; may be taken concurrently. **Units:** 1.0.

EEE 161. Applied Electromagnetics. Review of vector calculus. Electrostatic fields from lines, surface and volume charges by Coulomb's law, Gauss' law, Laplace's and Poisson's equations. Capacitance. Magnetostatic field calculations using Biot-Savart's law and Ampere's law. Inductance. Forces on moving charges. Magnetic materials. Electric and magnetic energy in fields. Faraday's law. Ideal transformer. Moving conductor in time-varying magnetic field. Displacement current. Charge-current continuity relation. Transmission line analysis, characteristic impedance, reflection coefficient and standing wave concepts. Introduction to Smith Chart solutions to matching problems. **Prerequisite:** MATH 32, MATH 45, PHYS 11C, ENGR 17, and CSC 25. **Units:** 4.0.

EEE 162. Applied Wave Propagation. Review of distributed circuit theory and the Smith chart. Impedance matching using series or shunt lumped and distributed circuits or near-quarterwave-matching sections. Noise temperature and noise figure. Scattering coefficient characterization of two-ports. Stability circles for high frequency transistors. Constant gain and noise figure circles. Basic antenna theory. Illustrated by their use for cell phones and other wireless systems. **Prerequisite:** EEE 117, EEE 161. **Units:** 3.0.

EEE 163. Traveling Waves Laboratory. Selected experiments in the transmission and reflection of waves in coaxial lines and waveguides. Antenna impedance and pattern measurements. Laboratory three hours. **Prerequisite:** EEE 117, passing score on WPE, EEE 162; EEE 162 may be taken concurrently **Units:** 1.0.

EEE 165. Introduction to Optical Engineering. Generation, propagation and detection of light. Fresnel equations, Snells law, diffraction, polarization and interference. Operating principles of LEDs, lasers, photodiodes and optical fibers. Introduction to optical communications systems, integrated optical devices, and optical instrumentation. **Prerequisite:** EEE 161, EEE 180, EEE 185; EEE 185 may be taken concurrently. **Units:** 3.0.

EEE 166. Physical Electronics. Semiconductor physics, atomic models and crystal structures. Quantum theory, energy bands, motion of charge carriers, minority/majority carrier profiles and pn junctions. Manufacturing processes for and operating characteristics of diodes, bipolar transistors and field effect devices. **Prerequisite:** EEE 117, EEE 117L, either may be taken concurrently. **Units:** 3.0.

EEE 167. Electro-Optical Engineering Lab. Provides senior level undergraduates with hands-on experience in optical engineering and design Experiments involving laser characteristics, spectral radiometry, diffraction, polarization, modulation of light, holography and spatial filtering will be performed. Laboratory three hours. **Prerequisite:** EEE 161, EEE 180, passing score on WPE, EEE 165; EEE 165 may be taken concurrently. **Units:** 1.0.

EEE 174. Introduction to Microprocessors. Topics include: microcomputer systems, microprocessor architecture, machine and assembly language programming, timing operations, bus arbitration and exception processing logic, addressing modes, parallel and serial ports, memory, assemblers and development systems. The lab uses development systems and target systems in the Computer Engineering laboratory to assemble, link, test and debug and run various assignments. Lecture three hours; laboratory three hours. **Prerequisite:** Junior status, EEE 64. **Units:** 4.0.

EEE 180. Signals and Systems. Rigorous development of the fundamental relationships governing time-domain and frequency-domain analysis of linear continuous-time and discrete-time systems. Topics include Fourier, Laplace and z-transforms, sampling theorem, modulation, system stability, and digital filters. **Prerequisite:** EEE 117. **Units:** 3.0.

EEE 181. Introduction to Digital Signal Processing. Focuses on the application of linear systems theory to design and analysis of digital signal processing systems. Discrete systems, the z transform, and discrete Fourier transform are reviewed. Design of infinite impulse response filters, finite impulse response filters, and digital spectral analysis systems is presented. Computer simulation is used to study the performance of filters and spectral analysis systems. Signal processing architectures are introduced. Lecture three hours. **Prerequisite:** EEE 64 or equivalent, EEE 180. **Units:** 3.0.

EEE 182. Digital Signal Processing Lab. Provides senior level undergraduate students with experience in the software/hardware design of discrete-time systems, and modern DSP techniques. Laboratory projects will include the following: spectral analysis of analog and digital signals, design of sampling and quantizer circuits, design and realization of IIR and FIR Digital Filters. Hardware projects will include acquisition, analysis, and filtering of speech, biomedical and video signals using Digital Signal Processors (DSPs). **Prerequisite:** EEE 180, EEE 181; EEE 181 may be taken concurrently. **Units:** 1.0.

EEE 183. Digital and Wireless Communication System Design. Review of fundamentals, probability, information, distortion by channel, sampling, pulse code modulation, companding, link power calculation, noise figure, pseudo noise. Matched filter detection of binary signals, bit error rate, inter-symbol interference, zero-forcing equalizers. Effects of additive white Gaussian noise in pulse code modulation, spread spectrum in multiple access, cellular radio and other wireless applications. Procedure for making design trade offs will be discussed. **Prerequisite:** EEE 161, EEE 180, EEE 185; EEE 185 may be taken concurrently. **Units:** 3.0.

EEE 184. Introduction to Feedback Systems. Dynamic system modeling by transfer function and state-space methods using differential equation, time-response and frequency-response methods. Determination of steady-state errors due to step, ramp and parabolic inputs and disturbances for closed-loop systems. Mapping of block diagrams and state-space representations to signal flow graphs (SFG) as well as finding the transfer function of the system represented by the SFG by Mason's Rule. Closed-loop system stability is examined via poles and eigenvalues and by using the Routh-Hurwitz criterion. Introduction to observability and controllability of systems. Design of compensators for feedback systems using root-locus, frequency response and state-space methods. Introduction to digital control. Computer simulation methods such as MATLAB and SIMULINK are used to support the above subjects. **Prerequisite:** EEE 180. **Units:** 3.0.

EEE 185. Modern Communication Systems. Review of signal and system analysis, sampling theorem and Nyquist's criteria for pulse shaping, signal distortion over a channel, study of digital and analog communication systems, line coding, signal to noise ratios, performance comparison of various communication systems. **Prerequisite:** EEE 180, ENGR 120. **Units:** 3.0.

EEE 186. Communication Systems Laboratory. Experimental study of modulation and demodulation in AM, FM, and digital communication systems, A/D and D/A conversion, measurement of power spectra, noise characterization in frequency domain. **Prerequisite:** EEE 117, passing score on WPE, EEE 185; EEE 185 may be taken concurrently. **Units:** 1.0.

EEE 187. Robotics. Lecture introduces principles of robotics and design of robot systems. Includes robot architectures, sensing position/velocity, digital circuit noise, actuator and path control, robot coordinate systems, kinematics, differential motion, computer vision/architectures, and artificial intelligence. Laboratory will apply lecture theory in design experiments utilizing five degree-of-freedom robots, an industrial robot, and vision systems. **Prerequisite:** EEE 180 or equivalent, or instructor permission. **Units:** 4.0.

EEE 188. Digital Control System. Intended to present treatment of the classical digital control with an introduction to modern digital control system in the state space. Z-transform as applied to discrete-time systems with transformation from the s-plane to the z-plane. Analyzes digital control systems using Nyquist and Bode plots and root-locus. Stability analysis of digital systems using Jury test, Routh Criterion, Nyquist and Bode plots. Design using root-locus and Bode plots introduced. Introduction to state-space and pole assignment. Finite-word length effects. MATLAB applications. **Prerequisite:** EEE 180, passing score on WPE **Units:** 3.0.

EEE 189. Controls Laboratory. Study, simulation and design of linear feedback control systems using digital control methods such as MATLAB and SIMULINK. Practical examples of analysis and compensation for closed loop systems. **Prerequisite:** EEE 184, passing score on WPE; EEE 184 may be taken concurrently. **Units:** 1.0.

EEE 192A. Electrical Power Design Project I. Concentrates on the planning, research and design aspects of electric power systems, including generation, transmission and distribution systems. Emphasis is placed on design philosophies, problem definition, research, project planning, written and oral communication skills, teamwork, development of specifications and effective utilization of available resources. Lecture one hour; laboratory three hours. **Prerequisite:** EEE 143 and any two of the following courses: EEE 141, EEE 142, EEE 144; EEE 143 make be taken concurrently. **Units:** 2.0.

EEE 192B. Electrical Power Design Project II. Continuation of EEE 192A. Students are expected to continue the power engineering design project begun the previous semester in EEE 192A. Final results of the project report will be presented orally to the class and invited faculty in a publicized seminar. Lecture one hour; laboratory three hours. **Prerequisite:** EEE 192A, EEE 142, EEE 144; EEE 142 or EEE 144, but not both may be taken concurrently. **Units:** 2.0.

EEE 193A. Product Design Project I. Concentrates on the planning and design of electronic engineering devices, systems and software. Emphasis is placed on design philosophies, problem definition, project planning and budgeting, written and oral communication skills, teamwork, development of specifications, utilization of computer aided design systems, and effective utilization of available resources. Lecture one hour; laboratory three hours. **Prerequisite:** EEE 108, EEE 109, EEE 130, EEE 161, EEE 174, EEE 180, passing score on WPE, GE Oral Communication requirement; EEE 109 may be taken concurrently. **Units:** 2.0.

EEE 193B. Product Design Project II. Concentrates on design projects begun by the previous semester design teams in EEE 193A. The hardware will be completed, tested for the meeting of specifications and other requirements, and redesigned if necessary. Required software will be written, debugged and incorporated in a written report. The final results of the team project will be presented orally to the class and invited faculty in a publicized seminar. Lecture one hour; laboratory three hours. **Prerequisite:** EEE 193A. **Units:** 2.0.

EEE 194. Career Development in Electrical and Electronic Engineering. Designed for Electrical and Electronic Engineering students making career decisions. Instruction will include effective career planning strategies and techniques including skill assessments, employment search strategy, goal setting, time management, interview techniques and resume writing. Lecture one hour. **Note:** Units earned cannot be used to satisfy major requirements. **Prerequisite:** EEE 192A or EEE 193A, may be taken concurrently. **Graded:** Credit / No Credit. **Units:** 1.0.

EEE 195. Fieldwork in Electrical and Electronic Engineering. Supervised work experience in Electrical and Electronic Engineering with public agencies or firms in the industry. Requires approval of a petition by the supervising faculty member and Department Chair. **Note:** May be repeated for credit. **Graded:** Credit / No Credit. **Units:** 1.0-3.0.

EEE 195A. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. **Note:** Units earned cannot be used to satisfy major requirements. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

EEE 195B. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. **Note:** Units earned cannot be used to satisfy major requirements. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

EEE 195C. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. **Note:** Units earned cannot be used to satisfy major requirements. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

EEE 195D. Professional Practice. Supervised employment in a professional engineering or computer science environment. Placement arranged through the College of Engineering and Computer Science. Requires satisfactory completion of the work assignment and a written report. **Note:** Units earned cannot be used to satisfy major requirements. **Prerequisite:** Instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-12.0.

EEE 196. Experimental Offerings in Electrical and Electronic Engineering. Proseminars devoted to subject matter not adequately covered elsewhere in the curriculum may be scheduled in response to proposals from faculty and students. **Note:** May be repeated for credit with permission of advisor. **Units:** 1.0-4.0.

EEE 199. Special Problems. Individual projects or directed reading. **Note:** Open only to students who appear qualified for independent work. Approval of the faculty sponsor and the academic advisor must be obtained before registering. May be repeated for credit. **Graded:** Graded (CR/NC Available). **Units:** 1.0-3.0.

Graduate Courses

EEE 201. Research Methodology. Research methodology, problem formulation and problem solving. Collective and individual study of selected issues and problems relating to fields of study in the Electrical and Electronic Engineering Graduate Program. Orientation to the requirements for Masters Thesis or Project in Electrical Engineering. **Prerequisite:** Fully classified graduate status. **Graded:** Credit / No Credit. **Units:** 1.0.

EEE 211. Microwave Engineering. High-frequency passive electronic circuit design, specifically S-parameters, impedance matching, microstrip lines, filters, couplers and antennas. **Prerequisite:** EEE 161; EEE 108 or instructor permission. **Units:** 3.0.

EEE 212. Microwave Engineering II. Passive microwave components; power dividers, couplers and hybrids. Microwave filter design, periodic structures, image parameter and insertion loss methods for designing filters. Design of ferromagnetic components, isolators, phase shifters and circulators. Noise in microwave circuits. **Units:** 3.0.

EEE 213. Microwave Devices and Circuits. Theory and application of electromagnetic radiation at microwave frequencies; study of microwave impedance and power measurement and characteristics of microwave circuit components, and electronic devices. **Prerequisite:** EEE 162. **Units:** 3.0.

EEE 215. Lasers. Review of electromagnetic theory. Ray tracing in an optical system, Gaussian beam propagation. Resonant optical cavities, study of excitation and lasing mechanisms in gas and semiconductor lasers. General characteristics and design of CW, Q switched and traveling wave lasers. **Prerequisite:** EEE 180 and EEE 161 or instructor permission. **Units:** 3.0.

EEE 221. Machine Vision. Introduces the student to fundamental digital imaging processing concepts and their application to the fields of robotics, automation, and signal processing. Topics include: digital image filters, two dimensional transforms, boundary descriptors, Hough transform, automated visual inspection techniques, vision for robot control, 3-D vision, and hardware architectures to support vision. **Units:** 3.0.

EEE 222. Electronic Neural Networks. Current neural network architectures and electronic implementation of neural networks are presented. Basics of fuzzy logic is covered. Application software will be used to simulate training. Testing of various neural net architectures. Learning strategies such as back-propagation, Kohonen, Hopfield and Hamming algorithms will be explored. A final project requires the student to design, train and test a neural network for electronic implementation that solves a specific practical problem. **Units:** 3.0.

EEE 225. Advanced Robot Control. Introduction to robot kinematics and dynamics followed by a comprehensive treatment of robot control. Topics include: independent joint control, multivariable control, force control, feedback linearization, real-time parameter estimation, and model-reference adaptive control. **Prerequisite:** EEE 184 or equivalent. **Units:** 3.0.

EEE 230. Analog and Mixed Signal Integrated Circuit Design. Covers core topics and circuits important for analog and mixed-signal integrated circuits. Topics include: device structures and models, single-stage and differential amplifiers, current mirrors and active loads, operational amplifier design, stability and compensation, fully-differential circuits and common-mode feedback, noise in integrated circuits and the impact of IC processes on analog performance. **Prerequisite:** EEE 109 or instructor permission. **Units:** 3.0.

EEE 231. Advanced Analog and Mixed Signal Integrated Circuit Design. A companion course to EEE 230, covers additional topics important in analog and mixed-signal integrated circuit design. Topics include traditional issues such as device matching and analog layout techniques, as well as important building blocks such as bandgap references and bias circuits. Also included are current-mode techniques such as high-speed current-mode logic (CML), and an introduction to noise in integrated circuits. Circuit and layout projects are assigned using CAD software. **Prerequisite:** EEE 230 or consent of the instructor. **Units:** 3.0.

EEE 232. Key Mixed-Signal Integrated Circuit Building Blocks. Covers key mixed-signal integrated circuit building blocks most often used in modern ICs. Topics covered include data converter fundamentals, comparators, and important circuit architectures for Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs), and Phase-Locked Loops (PLLs). **Prerequisite:** EEE 230 or consent of instructor. **Units:** 3.0.

EEE 233. Advanced Digital Signal Processing. Advanced signal processing topics include: multirate signal processing, adaptive filter design and analysis, spatial filtering and the application of FIR filter theory to beamforming. Applications of digital signal processing in communication systems, radar systems, and imaging systems are covered. Hardware and software topics, including current products and the incorporation of VLSI are included. Lecture. **Prerequisite:** EEE 174, EEE 181 or equivalent. **Units:** 3.0.

EEE 236. Advanced Semiconductor Devices. Semiconductor device modeling, including the application of the continuity equation and Poissons equation to abrupt and graded p/n junctions, semiconductor/metal contacts, junction field effect transistors (JFET), metal-oxide-semiconductor transistors (MOSFET), and bipolar junction transistors (BJT). Special topics include compound semiconductor devices and heterostructures. **Units:** 3.0.

EEE 238. Advanced VLSI Design-For-Test I. Focus on integrated circuit design-for-test-techniques; semiconductor reliablity factors and screening; semiconductor fabrication processes, device physics and related performance limitations; quantifying cost/quality tradeoffs; IC manufacturing flows and high-accuracy parametric test methods. **Prerequisite:** CPE 151 and CPE 166. **Units:** 3.0.

EEE 239. Advanced VLSI Design-For-Test II. Advanced topics in VLSI testing and Design-For-Test applications. Memory-specific test methodology and special features of memory designs employed in high volume manufacturing for improved testability, yield, and reliability. VLSI failure modes, their detection and prevention. Application of trim, redundancy, wear-leveling, and error correction. **Prerequisite:** EEE 238. **Units:** 3.0.

EEE 241. Linear Systems Analysis. Analyzes linear systems in the state-space. System realization and modeling, solutions of linear systems, stability including the method of Lyapunov, controllability and observability, state feedback and observers for both continuous and discrete-time systems. Familiarity with MATLAB is required. **Prerequisite:** EEE 180 or equivalent. **Units:** 3.0.

EEE 242. Statistical Signal Processing. Introduces the student to modern statistical approaches for solving electronic system noise problems. A few of the topics covered are: Stochastic processes, Wiener and Kalman filters, linear prediction, lattice predictors and singular-value decomposition. **Units:** 3.0.

EEE 243. Applied Stochastic Processes. Introduction to sequence of random variables and multivariable distributions; models of stochastic processes; stationary stochastic processes and their applications; Markov processes, Markov chains, continuous Markov chains; renewal processes; birth-death processes; time-series applications in stochastic processes in filtering, reliability and forecasting, prediction and control. **Prerequisite:** ENGR 120. **Units:** 3.0.

EEE 244. Electrical Engineering Computational Methods and Applications. Computational methods for solving problems in engineering analysis. Topics include variational methods, finite-difference analysis, optimization methods, and matrix methods. Focuses predominantly on applications of the methods, and students are required to solve real-world, engineering problems on the computer. **Prerequisite:** EEE 180. **Units:** 3.0.

EEE 246. Advanced Digital Control. Review of digital control methods using transform techniques. State-variable representation and design of digital control systems, state-space compensators and tracking systems, polynomial equations approach, LQR and LQG discrete-time control and identification, and introduction to adaptive self-turning regulators. **Prerequisite:** EEE 241. **Units:** 3.0.

EEE 249. Advanced Topics in Control and Systems. Topics from recent advances in control, systems and robotics control selected from IEEE Journals and related professional publications. May be taken twice for credit. **Units:** 3.0.

EEE 250. Analysis of Faulted Power Systems. Computation of phase and sequence impedances for transmission lines, machines, and transformers; sequence capacitance of transmission lines; applications of symmetrical components; changes in symmetry; analysis of simultaneous faults by two-port network theory and matrix transformations; analytical simplification for shunt and series faults; solution of the generalized fault diagrams; computer solution methods using the admittance and impedance matrices. **Prerequisite:** EEE 130 or equivalent. **Units:** 3.0.

EEE 251. Power System Economics and Dispatch. Study of a number of engineering and economic matters involved in planning, operating, and controlling power generation and transmission systems in electric utilities. Effects of hydro and nuclear plants on system economics. Economic and environmental constraints. Theoretical developments and computer methods in determining economic operation of interconnected power systems with emphasis on digital computers. **Prerequisite:** EEE 141 or equivalent. **Units:** 3.0.

EEE 252. Power System Reliability and Planning. Power system economics, generation, transmission and distribution reliability. Production costing and generation planning, transmission planning. **Prerequisite:** EEE 142 or equivalent. **Units:** 3.0.

EEE 254. Large Interconnected Power Systems. Computer control, optimization and organization of large power systems. Loan and frequency control, voltage control, large load flow and contingency studies. Introduction to state estimation and load forecasting. **Prerequisite:** EEE 142. **Units:** 3.0.

EEE 256. Advanced Power Systems Protection. Advanced concepts and schemes used in power system protection including the various protective schemes used for transmission lines, transformers, machines, and other elements of a large interconnected power system. Concepts in digital and microprocessor based relay design and analysis of typical protection subsystems, in conjunction with the protection of the power system as a whole. **Prerequisite:** EEE 141; EEE 145 or instructor permission. **Units:** 3.0.

EEE 259. Advanced Topics in Power Systems. Topics from recent advances in Electrical Power Engineering selected from IEEE Journal on "Power Systems" and "Power Systems Delivery." May be taken twice for credit. **Prerequisite:** EEE 142. **Units:** 3.0.

EEE 260. Statistical Theory of Communication. Review of Fourier analysis and theory of probability, random processes, optimum filtering, performance of analog and digital communication systems in the presence of noise, system optimization. **Prerequisite:** EEE 185. **Units:** 3.0.

EEE 261. Information Theory, Coding, and Detection. Signal space concepts, optimum M-ary communication systems, MAP estimation of continuous waveform parameters, information theory, coding. **Prerequisite:** EEE 185. **Units:** 3.0.

EEE 262. Wireless Communications Systems. Wireless communication techniques, systems and standards. Topics include cellular systems, RF transmission and analog/digital modulation techniques. Modern techniques such as multiple access and spread spectrum systems. Channel coding and diversity will also be included. **Prerequisite:** EEE 185 or instructor permission. **Units:** 3.0.

EEE 267. Fiber Optic Communications. Fundamentals of modern lightwave communication systems, sources detectors and optical fibers. Study of dispersion in Step Index, Graded Index and Single Mode Optical Fibers. Intensity Modulated Direct Detection systems (IMDD) and Coherent Fiber Optic Systems (COFOCS). Performance evaluation and design considerations. Wavelength division multiplexing, Local Area Networks, optical amplifiers and photonic switching. **Prerequisite:** EEE 185 or instructor permission. **Units:** 3.0.

EEE 272. High Speed Digital System Design. Theoretical topics and practical applications relating to high speed digital systems. Review of basic transmission line theory, crosstalk, impact of PCB traces, vias, and connectors on signal integrity, return current paths, simultaneous switching noise, high frequency power delivery, high speed timing budgets, high speed bus design methodologies, radiated emissions, and system noise. **Prerequisite:** EEE 161, fully classified graduate standing and instructor permission. **Units:** 3.0.

EEE 273. Hierarchical Digital Design Methodology. Hierarchical digital design course that includes: State machine design, Programmable Logic Devices, digital simulation techniques, digital interface, design with ASIC (Application Specific Integrated Circuits), programmable Gate Arrays, and designing with Gas high speed logic devices. Problems with EMI, RFI and EMC will be presented along with design guidelines. Lecture three hours. **Prerequisite:** EEE 64 or equivalent. **Cross-listed:** CSC 273; only one may be counted for credit. **Units:** 3.0.

EEE 274. Advanced Timing Analysis. Timing analysis of Application Specific Integrated Circuit (ASIC) designs: Topics include ASIC design methodology , static timing analysis, timing design constraints, design reports, clock timing issues, timing exceptions, operating conditions, hierarchical analysis, analyzing designs with asynchronous logic, performance measurement and power issues. **Prerequisite:** EEE 273, CSC 273, CPE 273 or instructor permission. **Cross-listed:** CPE 274; only one may be counted for credit. **Units:** 3.0.

EEE 280. Advanced Computer Architecture. Introduces computer classification schemes, structures of uni- and multi-processor systems, parallelism in uniprocessor systems, design and performance analysis of pipelined and array processors; survey and analysis of interconnection networks and parallel memory organizations; programming issues of multiprocessor systems; and fault tolerant computing and design for testability. **Prerequisite:** CSC 205 or instructor permission. **Cross-listed:** CSC 280; only one may be counted for credit. **Units:** 3.0.

EEE 285. Micro-Computer System Design I. Focuses on: design of the microprocessor based computer system, study of bus structures, interrupt schemes, memory interfacing, timing, bus arbitration, system architecture, data communications, introduction to multiprocessor systems, and software development. **Prerequisite:** EEE 174 or CPE 185. **Units:** 3.0.

EEE 286. Microcomputer System Design II. Includes PCI and PCI express bus specifications/architecture, PCI bridges transaction ordering, PCI express transactions and handshaking protocols, electromagnetic interference, methods of eliminating interference, shielding grounding, balancing, filtering, isolation, separation, orientation, cancellation techniques and cable design. Involves design projects and research presentations on PCI and PCI Express Bridge. **Prerequisite:** EEE 285 of CPE 186. **Units:** 3.0.

EEE 296. Experimental Offerings in Electrical and Electronic Engineering. Proseminars devoted to subject matter not adequately covered elsewhere in the curriculum may be scheduled in response to proposals from faculty or students. **Note:** may be repeated for credit with permission of advisor. **Units:** 1.0-4.0.

EEE 299. Special Problems. Open to qualified students who wish to pursue problems of their own choice. Projects must have approval and supervision of a faculty advisor. **Graded:** Graded (CR/NC Available). **Units:** 1.0-3.0.

EEE 500. Culminating Experience. Completion of a thesis, project or comprehensive examination. Credit given upon successful completion of one of the following plans: Plan A: Master's Thesis, 5 units; Plan B: Master's Project, 2 units; or Plan "C": Comprehensive Examination. **Prerequisite:** Advanced to candidacy and permission of the graduate coordinator. Passing score on WPE. **Graded:** Thesis in Progress. **Units:** 1.0-6.0.