DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

The Department of Electrical and Computer Engineering (ECE) offers two ABET-accredited bachelors degrees: a Bachelor of Science degree in Electrical Engineering (EE) and a Bachelor of Science degree in Computer Engineering (CPE). Individuals enrolled in these degree programs are given opportunities to develop a strong background in the engineering sciences and to learn the analysis, design, and synthesis tools necessary to function successfully as active participants in traditional, new, and emerging areas of electrical and computer engineering-related technologies. The ECE department continues to be recognized locally and nationally for the quality of its undergraduate programs. As a result, ECE graduates continue to find high-paying jobs or are accepted into graduate schools nationwide.

Direct Admission Criteria

Applicants entering UTSA as Freshmen or Freshmen Transfers (fewer than 12 transferable semester credit hours) will be directly admitted to the CPE or EE program if they:

- meet all UTSA undergraduate admission requirements,
- qualify for enrollment in MAT 1213 Calculus I, or a higher level mathematics course, and
- are ranked in the top 10 percent of their high school class (no minimum SAT or ACT scores required), *or*
- are ranked below the top 10 percent of their high school class and have a minimum 1200 SAT or 25 ACT score.

Applicants with SAT scores below 1200 or ACT scores below 25 may be considered for admission by committee review.

Transfer requirements for direct admission to the CPE or EE program for students who have earned 12 or more transferable semester credit hours:

- meet all UTSA undergraduate transfer admission requirements, and
- have completed MAT 1213 Calculus I and WRC 1013 Freshman Composition I , or the equivalents, with grades of “C-” or better, and
- meet grade point average requirements:
  - applicants with a transfer grade point average of 3.00 or higher may be granted direct admission to the major, or
  - applicants with a transfer grade point average below 3.00 may be granted admission to the College by committee review.

Applicants who do not meet CPE and EE admission requirements will be admitted to the Engineering, Math, and Sciences Studies major in the University College. Students have three semesters to complete Calculus I with a grade of "C-" or better and meet the major Transfer Requirements.

“C-” Grade Rule

A grade of “C-” or better in any science, engineering, or mathematics course required for an engineering degree or any other course that is a prerequisite to any required Computer Engineering (CPE), Electrical Engineering (EE), or Engineering (EGR) course indicates satisfactory preparation for further engineering education. Any course assigned a grade below a “C-” must be repeated before enrolling in any course for which it is a prerequisite. This requirement is subject to both the Gateway Course and Three-Attempt Limit rules.

Program Educational Objectives

The educational objectives of the Electrical Engineering program are that our graduates will:

1. Contribute their technical knowledge to better their lives and society
2. Assume positions of leadership and responsibility in their electrical engineering-related careers
3. Pursue graduate and professional studies
4. Conduct themselves in a professional manner that meets or exceeds the expectations of their employers

The educational objectives of the Computer Engineering program are that our graduates will:

1. Engage in life-long learning, remaining current and becoming leaders in their profession
2. Advance and expand in their computer engineering-related careers by applying their engineering knowledge and skills
3. Contribute productively to the workforce in state, regional, national, and international industries and government organizations
4. Communicate effectively, provide enabling solutions to societal challenges, and respond to technical, business, social, ethical, and human needs of the society through their professional endeavors.

Meeting Program Objectives

To meet the program objectives, the curriculum for the Bachelor of Science (B.S.) degree in Electrical Engineering and the curriculum for the B.S. degree in Computer Engineering are organized into a flexible 126-semester-credit-hour structure that provides high-quality education in the fundamentals of engineering, in addition to a thorough coverage of the major specialties within electrical engineering and computer engineering. For electrical engineering students, a selection of technical electives is provided to allow in-depth concentration in selected areas such as: communication, computers, digital signal processing (DSP), electronic materials and devices, systems and control, and electric power engineering. For students seeking the B.S. degree in Computer Engineering, the selection of technical electives are from areas of digital system design, computer architecture, VLSI design, engineering programming languages, and embedded systems.

Department faculty of outstanding quality work in concert to provide the two degree programs that are challenging to students, with depth in engineering sciences, design orientation, and modern laboratory experience. The program objectives are accomplished via a three-tiered curriculum structure comprised of the lower-division core (the first two years), the upper-division core (concentrated primarily in the third year), and the senior-level electives, each of which are briefly described below.

Lower-Division Core

The lower-division core provides students with a diverse range of courses over a broad base of basic technical and specialized courses in mathematics, physics, and chemistry; computer hardware and software fundamentals; electric circuit fundamentals and electrical engineering laboratory experience; statics and dynamics; and communication skills, humanities, and social sciences.

Upper-Division Core

The upper-division core for electrical engineering and computer engineering provides students with a basic education in the fundamentals of electrical and computer engineering.

The upper-division core in electrical engineering includes: fundamentals of circuits (3 semester credit hours), controls (3 semester credit hours), electromagnetics (3 semester credit hours), electronics (6 semester credit hours), electronic devices (3 semester credit hours), and probability and random processes (3 semester credit hours). Many of these fundamental courses include the use of modern software tools for design and analysis. These fundamentals are supplemented with one hands-on laboratory course (3 semester credit hours). Written and technical communication is further emphasized in the laboratory course.

The upper-division core in computer engineering includes: fundamentals of circuits (3 semester credit hours), C++ and data structures (3 semester credit hours), microcomputer systems (3 semester credit hours), electronics (6 semester credit hours), electronic devices (3 semester credit hours), and probability and random processes (3 semester credit hours). Many of these fundamental courses include the use of modern software tools for design and analysis. These fundamental courses are supplemented with one hands-on laboratory course (3 semester credit hours). Written and technical communication is further emphasized in the laboratory course.

Senior-Level Electives

In the senior year, electrical engineering students enroll in five technical electives (15 semester credit hours), a senior laboratory course (3 semester credit hours), and the capstone design sequence (5 semester credit hours). Students in the technical elective courses have ample opportunities to learn and use modern software tools. The capstone sequence not only provides a major design experience but also emphasizes teamwork, proposal development, communication skills, and professional and ethical responsibility. Electrical engineering students are required to choose one of the six technical areas and to select a minimum of two technical electives (6 semester credit hours) from the chosen area. The remaining three technical electives (9 semester credit hours) may be selected either from the same area or from the other five areas, including one course at the graduate level and/or 3 semester credit hours from an engineering cooperative program. Computer engineering students are required to choose five technical electives from a list of approved technical electives for Bachelor of Science in Computer Engineering. The engineering cooperative program provides an opportunity for students to obtain practical experience by enrolling in the co-op course for 3 credit hours and working in an approved industry. Students who want to pursue graduate studies are encouraged to enroll in a graduate class during their last year, which will be counted as one of the remaining technical electives.

Engineering Design Experience

Design process in electrical engineering and in computer engineering is emphasized throughout all four years. Engineering design is distributed throughout the programs starting from the second semester in EE 2513 Logic Design. During their junior and senior years, students take five technical elective courses which all have design components. During the seventh semester, students also take EE 4113 Electrical and Computer Engineering Laboratory II, in which they must design complex circuits. Modern software tools usage, design and analysis, and formal written report writing are integrated components of several of the electrical and computer engineering courses. EE 3113 Electrical and Computer Engineering Laboratory I and EE 4113 Electrical and Computer Engineering Laboratory II emphasize hands-on experiments using basic to advanced capability instruments and formal written, as well as oral, reports. In EE 4812 Electrical Engineering Design I, CPE 4812 Computer Engineering Design I, EE 4813 Electrical Engineering Design II, and CPE 4813 Computer Engineering Design II, students are required to design, implement, test, demonstrate, and make an oral presentation on an electronic or computer system.

Other courses with design emphasis that electrical engineering students take include: EE 3213 Electromagnetic Engineering, EE 3323 Electronic Devices, EE 3413 Analysis and Design of Control Systems, EE 2583 Microcomputer Systems I, EE 4313 Electronic Circuits II, and EE 4323 Dielectric and Optoelectronic Engineering Laboratory.

Other courses with design emphasis that computer engineering students take include: EE 3313 Electronic Circuits I, EE 3323 Electronic Devices, EE 3563 Digital Systems Design, EE 2583 Microcomputer Systems I, and EE 4513 Introduction to VLSI Design.

Laptop Program

The laptop program requires that students entering Klesse College programs have their own laptop (notebook) computers and required software. The computer should be upgradeable in order to be of productive use for the duration of the academic program. The laptop specifications may vary per academic program. For further and specific information concerning laptop requirements for each program, please see the Klesse College hardware recommendations website (https://klesse.utsa.edu/student/computer-requirements.html).

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- B.S. degree in Computer Engineering (p. 5)
- Integrated B.S./M.S. Program (p. 7)

Bachelor of Science Degree in Electrical Engineering

The Bachelor of Science (B.S.) degree in Electrical Engineering has concentrations in Communications, Computer Engineering, Digital Signal Processing (DSP), Electronic Materials and Devices, Systems and Control, and Electric Power Engineering. The program is currently accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org (http://www.abet.org/). The B.S. degree in Electrical Engineering offers students the opportunity to prepare for careers in areas associated with electronics and microelectronics, digital systems, communications, digital signal and image processing, controls and robotics, computer-aided design (CAD), instrumentation, bioengineering, electric power engineering, and other traditional and emerging technology areas. Through the proper selection of elective courses (at least three technical elective courses must be selected from a single technical area) to augment required courses, successful students will develop a specialization pertinent to many of these areas that may lead to productive employment in the public or private sector with electronics companies, high-technology industries, and government agencies. The program will also provide the opportunity for students to develop an understanding of fundamentals and current issues important for future years of learning through such activities as graduate school, distance education, professional training, and membership in professional societies.

The minimum number of semester credit hours required for this degree is 126, at least 39 of which must be at the upper-division level. At least 42 of the required electrical engineering credits must be taken at UTSA. All

candidates for this degree must fulfill the Core Curriculum requirements, the General Engineering requirements, and the Electrical Engineering requirements, which are listed below.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. degree in Electrical Engineering must fulfill University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both major requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for this degree.

MAT 1213 may be used to satisfy the core requirement in Mathematics, as well as one of the General Engineering requirements. PHY 1943 and PHY 1963 may be used to satisfy the core requirement in Life and Physical Sciences, as well as two of the General Engineering requirements.

Core Curriculum Component Area Requirements (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/)	
First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
Total Credit Hours	**42**

General Engineering Requirements

All degree-seeking candidates in engineering must complete the following 22 semester credit hours, as well as the Core Curriculum requirements and major requirements:

Code	Title	Credit Hours
CHE 1103	General Chemistry I	3
EGR 2302	Linear Algebra for Engineers	2
EGR 3423	Differential Equations for Engineers	3
MAT 1213	Calculus I	3
MAT 1223	Calculus II	3
or EGR 1333	Calculus II for Engineers	
PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	4
Total Credit Hours		**22**

Gateway Courses

Students pursuing the B.S. degree in Electrical Engineering must successfully complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change their major.

Code	Title	Credit Hours
EE 1322	Introduction to Electrical and Computer Engineering	
MAT 1213	Calculus I	
EGR 3423	Differential Equations for Engineers	

Electrical Engineering Degree Requirements

All degree-seeking candidates in Electrical Engineering must complete the following semester credit hours, as well as the Core Curriculum requirements and General Engineering requirements:

Code	Title	Credit Hours
A. Required Courses		
1. Electrical Engineering courses		
EE 1322	Introduction to Electrical and Computer Engineering	2
EE 2423	Electric Network Theory	3
EE 2511	Digital Circuit Laboratory	1
EE 2513	Logic Design	3
EE 2583	Microcomputer Systems I	3
EE 3113	Electrical and Computer Engineering Laboratory I	3
EE 3213	Electromagnetic Engineering	3
EE 3313	Electronic Circuits I	3
EE 3323	Electronic Devices	3
EE 3423	Mathematics in Signals and Systems	3
EE 3533	Probability and Random Signals	3
EE 4113	Electrical and Computer Engineering Laboratory II	3
EE 4313	Electronic Circuits II	3
EE 4812	Electrical Engineering Design I	2
EE 4813	Electrical Engineering Design II	3
2. Supporting courses		
CPE 2073	Introduction to Computer Programming for Engineers	3
EGR 2313	Multivariable Calculus and Series for Engineers	3
EGR 2413	Modern Physics for Engineers	3
3. Pathway courses: Select two from the following courses		6
EE 3223	C++ and Data Structures	
EE 3413	Analysis and Design of Control Systems	
EE 3513	Electromechanical Systems	
EE 3523	Discrete Signals and Systems	
EE 3563	Digital Systems Design	
B. Electrical engineering elective courses		

Select at least two courses from a single one of the following concentrations. The other three courses may be selected from any of the concentration areas. Topics offered under EE 4953 Special Studies in Electrical Engineering may be approved as technical electives in the relevant concentration. With prior approval, EGR 3303 and EGR 4993 may be counted as technical electives.		15
Communication Concentration		
EE 3413	Analysis and Design of Control Systems	
EE 3523	Discrete Signals and Systems	
EE 4613	Communication Systems	
EE 4653	Digital Communications	
EE 4673	Data Communication and Networks	
EE 4683	Wireless Communications	
EE 4693	Fiber Optic Communications	
Computer Engineering Concentration		
EE 3223	C++ and Data Structures	
EE 3233	Systems Programming for Engineers	
EE 3563	Digital Systems Design	
EE 4243	Computer Organization and Architecture	
EE 4513	Introduction to VLSI Design	
EE 4553	VLSI Testing	
EE 4583	Microcomputer Systems II	
Digital Signal Processing Concentration		
EE 3413	Analysis and Design of Control Systems	
EE 3523	Discrete Signals and Systems	
EE 4623	Digital Filtering	
EE 4643	Digital Signal Processing	
EE 4663	Digital Image Processing	
Electronic Materials and Devices Concentration		
EE 3513	Electromechanical Systems	
EE 4323	Dielectric and Optoelectronic Engineering Laboratory	
EE 4513	Introduction to VLSI Design	
EE 4523	Introduction to Nanoelectronics	
EE 4533	Principles of Microfabrication	
EE 4543	Advanced Topics in Micro and Nanotechnology	
EE 4763	Power Electronics	
Systems and Control Concentration		
EE 3413	Analysis and Design of Control Systems	
EE 3513	Electromechanical Systems	
EE 3523	Discrete Signals and Systems	
EE 4443	Discrete-Time and Computer-Controlled Systems	
EE 4723	Intelligent Robotics	
EE 4733	Intelligent Control	
EE 4743	Embedded Control Systems	
Electric Power Engineering Concentration		
EE 3413	Analysis and Design of Control Systems	
EE 3513	Electromechanical Systems	
EE 4123	Power Engineering Laboratory	
EE 4493	Electric Distribution System Modeling and Analysis	
EE 4753	Analysis of Power Systems	
EE 4763	Power Electronics	
EE 4773	Electric Drives	
EE 4783	Power System Operation and Planning	
EE 4793	Nuclear Energy and Engineering	
Total Credit Hours		**71**

B.S. in Electrical Engineering – Recommended Four-Year Academic Plan

First Year		
Fall		**Credit Hours**
AIS 1243	AIS: Engineering, Mathematics, and Sciences	3
CHE 1103	General Chemistry I	3
EE 1322	Introduction to Electrical and Computer Engineering	2
MAT 1213	Calculus I (core and major)	3
WRC 1013	Freshman Composition I (core)	3
Language, Philosophy & Culture (core)		3
	Credit Hours	**17**
Spring		
EE 2511	Digital Circuit Laboratory	1
EE 2513	Logic Design	3
MAT 1223 or EGR 1333	Calculus II or Calculus II for Engineers	3
PHY 1943	Physics for Scientists and Engineers I (core and major)	3
PHY 1951	Physics for Scientists and Engineers I Laboratory	1
WRC 1023	Freshman Composition II (core)	3
CPE 2073	Introduction to Computer Programming for Engineers	3
	Credit Hours	**17**
Second Year		
Fall		
EE 2583	Microcomputer Systems I	3
EGR 2302	Linear Algebra for Engineers	2
EGR 2313	Multivariable Calculus and Series for Engineers	3
PHY 1963	Physics for Scientists and Engineers II (core and major)	3
PHY 1971	Physics for Scientists and Engineers II Laboratory	1
American History (core)		3
	Credit Hours	**15**
Spring		
EGR 2413	Modern Physics for Engineers	3
EE 2423	Electric Network Theory	3
Pathway Course #1 [1]		3
EGR 3423	Differential Equations for Engineers	3
American History (core)		3
	Credit Hours	**15**

Third Year		
Fall		
EE 3113	Electrical and Computer Engineering Laboratory I	3
EE 3313	Electronic Circuits I	3
EE 3323	Electronic Devices	3
EE 3423	Mathematics in Signals and Systems	3
POL 1013	Introduction to American Politics ((core))	3
	Credit Hours	**15**
Spring		
EE 3213	Electromagnetic Engineering	3
Pathway Course #2 [1]		3
EE 3533	Probability and Random Signals	3
Elective/Co-Op		3
EE 4313	Electronic Circuits II	3
	Credit Hours	**15**
Fourth Year		
Fall		
EE 4113	Electrical and Computer Engineering Laboratory II	3
EE 4812	Electrical Engineering Design I	2
EE Technical elective		3
EE Technical elective		3
POL 1133 or POL 1213	Texas Politics and Society (core) or Civil Rights in Texas and America	3
Creative Arts (core)		3
	Credit Hours	**17**
Spring		
ECO 2023	Introductory Microeconomics (core)	3
EE 4813	Electrical Engineering Design II	3
EE Technical elective		3
EE Technical elective		3
Component Area Option (core)		3
	Credit Hours	**15**
	Total Credit Hours	**126**

[1] Select two Pathway courses from EE 3223 C++ and Data Structures, EE 3413 Analysis and Design of Control Systems, EE 3513 Electromechanical Systems, EE 3523 Discrete Signals and Systems, EE 3563 Digital Systems Design, which are prerequisites for technical electives. See Advisor for guidance in selection.

Bachelor of Science Degree in Computer Engineering

The Bachelor of Science (B.S.) degree in Computer Engineering gives students the opportunity to acquire broad engineering skills and knowledge to enable them to design and implement computer and digital systems. The discipline of computer engineering includes topics such as logic design; digital systems design; discrete mathematics; computer organization; embedded systems design requiring assembly programming of microprocessors, high-level programming and interfacing of processors to other circuits; high-level digital design languages (HDL) and Field Programmable Gate Arrays (FPGA's); Very Large Scale Integrated (VLSI) circuit design; and fundamental electrical engineering, mathematics, and science. The program is currently accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org (http://www.abet.org/).

The minimum number of semester credit hours required for this degree is 126, at least 39 of which must be at the upper-division level. At least 42 of the required computer engineering credits must be taken at UTSA. All candidates for this degree must fulfill the Core Curriculum requirements, the General Engineering requirements, and the Computer Engineering requirements, which are listed below.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. degree in Computer Engineering must fulfill University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both major requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for this degree.

MAT 1213 may be used to satisfy the core requirement in Mathematics, as well as one of the General Engineering requirements. PHY 1943 and PHY 1963 may be used to satisfy the core requirement in Life and Physical Sciences, as well as two of the General Engineering requirements.

Core Curriculum Component Area Requirements (http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/)	
First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
Total Credit Hours	**42**

General Engineering Requirements

All degree-seeking candidates in engineering must complete the following 22 semester credit hours, as well as the Core Curriculum requirements and major requirements:

Code	Title	Credit Hours
CHE 1103	General Chemistry I	3
EGR 2302	Linear Algebra for Engineers	2
EGR 3423	Differential Equations for Engineers	3
MAT 1213	Calculus I	3
MAT 1223	Calculus II	3
or EGR 1333	Calculus II for Engineers	

PHY 1943 & PHY 1951	Physics for Scientists and Engineers I and Physics for Scientists and Engineers I Laboratory	4
PHY 1963 & PHY 1971	Physics for Scientists and Engineers II and Physics for Scientists and Engineers II Laboratory	4
Total Credit Hours		**22**

Gateway Courses

Students pursuing the B.S. degree in Computer Engineering must successfully complete each of the following Gateway Courses with a grade of "C-" or better in no more than two attempts. A student who is unable to successfully complete these courses within two attempts, including dropping a course with a grade of "W" or taking an equivalent course at another institution, will be required to change their major.

Code	Title	Credit Hours
EE 1322	Introduction to Electrical and Computer Engineering	
EE 2513	Logic Design	
MAT 1213	Calculus I	

Computer Engineering Degree Requirements

All degree-seeking candidates in Computer Engineering must complete the following semester credit hours, as well as the Core Curriculum requirements and General Engineering requirements:

Code	Title	Credit Hours
A. Required courses		
1. Electrical and Computer engineering courses:		
EE 1322	Introduction to Electrical and Computer Engineering	2
EE 2423	Electric Network Theory	3
EE 2511	Digital Circuit Laboratory	1
EE 2513	Logic Design	3
EE 2583	Microcomputer Systems I	3
EE 3113	Electrical and Computer Engineering Laboratory I	3
EE 3223	C++ and Data Structures	3
EE 3233	Systems Programming for Engineers	3
EE 3313	Electronic Circuits I	3
EE 3323	Electronic Devices	3
EE 3423	Mathematics in Signals and Systems	3
EE 3533	Probability and Random Signals	3
EE 3563	Digital Systems Design	3
EE 4113	Electrical and Computer Engineering Laboratory II	3
EE 4243	Computer Organization and Architecture	3
CPE 4812	Computer Engineering Design I	2
CPE 4813	Computer Engineering Design II	3
2. Supporting courses		
CPE 2073	Introduction to Computer Programming for Engineers	3
or CS 2073	Computer Programming with Engineering Applications	
CS 2233	Discrete Mathematical Structures	3
EGR 2313	Multivariable Calculus and Series for Engineers	3
B. Computer engineering electives		
Take two required prescribed courses (marked with *) from one of the following concentrations. The other three courses may be selected from any of the concentration areas and graduate courses in Electrical and Computer Engineering. With prior approval, EGR 3303 (Co-Op class for internships) and EGR 4993 may be counted as technical electives.		15
AI and Autonomous Systems		
EE 4463	Introduction to Machine Learning (*)	
EE 4733	Intelligent Control (*)	
EE 4643	Digital Signal Processing	
EE 4663	Digital Image Processing	
EE 4953	Special Studies in Electrical and Computer Engineering (Introduction to Optimization)	
Computer Systems		
EE 4563	FPGA-Based System Design (*)	
EE 4583	Microcomputer Systems II (*)	
EE 4593	Embedded System Design	
CPE 4953	Special Studies in Computer Engineering (Superscalar Systems)	
Digital Hardware		
EE 4513	Introduction to VLSI Design (*)	
EE 4553	VLSI Testing (*)	
EE 4563	FPGA-Based System Design	
CPE 4953	Special Studies in Computer Engineering (AI Hardware and Programming)	
Network and IoT		
EE 4673	Data Communication and Networks (*)	
CPE 4953	Special Studies in Computer Engineering (Computer and Networking Security (*))	
CPE 4953	Special Studies in Computer Engineering (IoT Security)	
CPE 4953	Special Studies in Computer Engineering (AI in Networked Systems)	
Systems/Computer Programming		
CPE 4953	Special Studies in Computer Engineering (Engineering Programming I (*))	
CPE 4953	Special Studies in Computer Engineering (Engineering Programming II (*))	
CPE 4953	Special Studies in Computer Engineering (Engineering Algorithms)	
CPE 4953	Special Studies in Computer Engineering (Cloud Computing for Engineers)	
CPE 4953	Special Studies in Computer Engineering (AI Hardware and Programming)	
Total Credit Hours		**71**

B.S. in Computer Engineering – Recommended Four-Year Academic Plan

First Year		
Fall		**Credit Hours**
AIS 1243	AIS: Engineering, Mathematics, and Sciences	3
CHE 1103	General Chemistry I	3
EE 1322	Introduction to Electrical and Computer Engineering	2
MAT 1213	Calculus I (core and major)	3
WRC 1013	Freshman Composition I (core)	3
Language, Philosophy & Culture (core)		3
	Credit Hours	**17**
Spring		
CPE 2073 or CS 2073	Introduction to Computer Programming for Engineers or Computer Programming with Engineering Applications	3
EE 2511	Digital Circuit Laboratory	1
EE 2513	Logic Design	3
MAT 1223 or EGR 1333	Calculus II or Calculus II for Engineers	3
PHY 1943	Physics for Scientists and Engineers I (core and major)	3
PHY 1951	Physics for Scientists and Engineers I Laboratory	1
WRC 1023	Freshman Composition II (core)	3
	Credit Hours	**17**
Second Year		
Fall		
EE 2583	Microcomputer Systems I	3
EGR 2302	Linear Algebra for Engineers	2
EGR 2313	Multivariable Calculus and Series for Engineers	3
PHY 1963	Physics for Scientists and Engineers II (core and major)	3
PHY 1971	Physics for Scientists and Engineers II Laboratory	1
American History (core)		3
	Credit Hours	**15**
Spring		
EE 2423	Electric Network Theory	3
EE 3223	C++ and Data Structures	3
EGR 3423	Differential Equations for Engineers	3
CS 2233	Discrete Mathematical Structures	3
American History (core)		3
	Credit Hours	**15**
Third Year		
Fall		
EE 3113	Electrical and Computer Engineering Laboratory I	3
EE 3313	Electronic Circuits I	3
EE 3323	Electronic Devices	3
EE 3423	Mathematics in Signals and Systems	3
POL 1013	Introduction to American Politics (core)	3
	Credit Hours	**15**
Spring		
EE 3233	Systems Programming for Engineers	3
EE 3533	Probability and Random Signals	3
EE 3563	Digital Systems Design	3
Elective/Co-Op		3
EE 4243	Computer Organization and Architecture	3
	Credit Hours	**15**
Fourth Year		
Fall		
CPE 4812	Computer Engineering Design I	2
EE 4113	Electrical and Computer Engineering Laboratory II	3
Technical elective		3
Technical elective		3
POL 1133 or POL 1213	Texas Politics and Society (core) or Civil Rights in Texas and America	3
Creative Arts (core)		3
	Credit Hours	**17**
Spring		
CPE 4813	Computer Engineering Design II	3
ECO 2023	Introductory Microeconomics (core)	3
Technical elective		3
Technical elective		3
Component Area Option (core)		3
	Credit Hours	**15**
	Total Credit Hours	**126**

Integrated Bachelor of Science/Master of Science Program

The integrated B.S./M.S. (Bachelor of Science and Master of Science) program administered by the Department of Electrical and Computer Engineering is designed to make it possible for highly motivated and qualified B.S. students to obtain both an undergraduate degree and an advanced degree within an accelerated timeline. Through this program, motivated B.S. students can start working with their faculty advisors on research projects as early as in their senior year.

Program Admission Requirements

Applications to the B.S./M.S. program must be submitted after the completion of 75 semester credit hours of coursework.

The B.S./M.S. program applicants must have a minimum of 3.3 for both cumulative and major grade point averages. To apply for the program, students need to:

- Apply online under the category of Integrated B.S./M.S. (B.S. in Electrical Engineering or Computer Engineering, and M.S. in

Electrical Engineering, Computer Engineering, or Advanced Materials Engineering); and

- Submit an official UTSA transcript.

Submission of both recommendation letters and a personal statement is optional but highly recommended for consideration of scholarships.

Degree Requirements

B.S. Degree requirement: The current undergraduate degree programs in Electrical Engineering and Computer Engineering require 126 semester credit hours for completion, with fifteen of these hours (five 3-hour courses) as technical electives. Students accepted into the Integrated B.S./M.S. program will be required to complete 120 undergraduate credit hours and 6 graduate credit hours to replace two of the five undergraduate technical elective courses toward the B.S. degree. Undergraduate students wishing to voluntarily withdraw from the Integrated B.S./M.S. program must use a combination of five undergraduate technical electives and graduate organized courses to satisfy the original 126-hour regular degree program requirement in order to receive their B.S. degree. Students continuing on in the Integrated B.S./M.S. program will receive their B.S. degrees once they have earned 120 undergraduate credit hours and 6 credit hours of graduate organized courses. The 6 graduate credit hours taken as an undergraduate will be counted toward the M.S. degree requirement.

M.S. Degree requirement: A student enrolled in the Integrated B.S./M.S. program can graduate by completing requirements for a thesis or nonthesis (project) option.

(i) Thesis Option: Students must complete 30 credit hours, including 6 hours of thesis work.

(ii) Nonthesis Option: Students must complete 33 credit hours, including 3 hours of project work.

B.S./M.S. Classification

Once admitted to the Integrated B.S./M.S. program, students are allowed to take graduate courses as undergraduate students. Students admitted to the Integrated B.S./M.S. program will be reclassified from undergraduate to graduate student status when they have completed 126 semester credit hours of coursework (of any combination of graduate and undergraduate hours) toward their degrees. B.S./M.S. students can receive their B.S. degree upon completion of 126 semester credit hours, including two graduate courses, at which point the program will certify the student's eligibility to receive the B.S. degree and request the Graduate School to change the student status in the Student Information System.

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Certificate in Artificial Intelligence

Non-UTSA students who want to pursue the certificate in Artificial Intelligence (AI) but do not wish to also be admitted into the regular Electrical and Computer Engineering programs must apply via the University's special undergraduate admission process.

Code	Title	Credit Hours
A. Required course:		3
EE 3533	Probability and Random Signals	
B. Electives. Four courses (12 semester credit hours) selected from the following list. Graduate courses in Artificial Intelligence may be approved as electives for the certificate.		12
EE 3223	C++ and Data Structures (Only one of these courses can be counted towards the certificate)	
or EE 3233	Systems Programming for Engineers	
EE 4463	Introduction to Machine Learning	
EE 4723	Intelligent Robotics	
EE 4733	Intelligent Control	
EE 4953	Special Studies in Electrical and Computer Engineering (Internet of Things (IOT))	
EE 4953	Special Studies in Electrical and Computer Engineering (Robotics)	
EE 4953	Special Studies in Electrical and Computer Engineering (Cyber-Security)	
Total Credit Hours		**15**

Certificate in Computer Programming for Engineers

The undergraduate certificate program in Computer Programming for Engineers is designed so that students or professionals in electrical and computer engineering or related fields can take a focused set of courses pertinent to the broad field of computer programming. This certificate was developed in collaboration with the Department of Computer Science.

Eligibility and Admission Procedures

Current undergraduate electrical and computer engineering UTSA students are eligible for admission to the certificate program. Non-UTSA students who do not wish to also be admitted into the regular electrical and computer engineering programs must apply via the University's special undergraduate admission process. This is the recommended option for practicing engineers who already possess a Bachelor of Science in electrical or computer engineering or related field.

The 15-semester-credit-hour program consists of two 3-credit-hour required courses and three 3-credit-hour electives.

Code	Title	Credit Hours
A. Required courses:		
CPE 2073	Introduction to Computer Programming for Engineers	3
or CS 2073	Computer Programming with Engineering Applications	
or CS 2713	Computer Programming in C	
EE 3223	C++ and Data Structures	3
or CS 2123	Data Structures	
B. Electives. Three courses (9 semester credit hours) selected from the following list:		9
CS 3433	Computer and Information Security	
CS 3443	Application Programming	
CS 4643	Mobile and Wireless Network and Technologies	
CS 4833	Embedded Systems	
CS 4853	Advanced Systems Programming	

CS 4863	Distributed Computing and Systems
EE 3233	Systems Programming for Engineers
or CS 3423	Systems Programming
EE 4463	Introduction to Machine Learning
or CS 4253	Machine Learning
EE 4723	Intelligent Robotics
EE 4733	Intelligent Control
EE 4953	Special Studies in Electrical and Computer Engineering (Approved Topics: Engineering Programming, Intro to Computer and Network Security, Internet of Things (IOT), or Robotics)
Other Computer Programming electives must be approved by the committee.	
Total Credit Hours	**15**

Computer Engineering (CPE) Courses

CPE 2073. Introduction to Computer Programming for Engineers. (3-1) 3 Credit Hours.
Prerequisite: MAT 1213 (or MAT 1214 in previous catalogs), and completion of or concurrent enrollment in MAT 1223 (or MAT 1224 in previous catalogs) or EGR 1333. Algorithmic approach to problem solving, basic programming techniques such as conditional execution (e.g., if-else), repetition (loops), and functions, implicit and explicit memory management, and intro to object oriented programming. One hour of problem solving recitation per week. Generally offered: Fall, Spring. Course Fee: LRE1 $25; STSE $30.

CPE 4812. Computer Engineering Design I. (2-1) 2 Credit Hours.
Prerequisite: EE 3563 and concurrent enrollment in or completion of EE 3233 and EE 4113. Business planning and project management in engineering design; discussion of ethical and social issues in design; and selection of a design project, development of a detailed design proposal, and approval of a design project. (Formerly CPE 4811. Credit cannot be earned for both CPE 4812 and CPE 4811.) This course has Differential Tuition. Course Fee: DL01 $50.

CPE 4813. Computer Engineering Design II. (2-3) 3 Credit Hours.
Prerequisite: CPE 4812. Complex system design; advanced ATE; project management, detailed design package, status reporting, formal oral and written technical reports, design reviews, and test plan development and execution; open-ended design project considering safety, reliability, environmental, economic, and other constraints; and ethical and social impacts. Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: DL01 $75.

CPE 4911. Independent Study. (0-0) 1 Credit Hour.
Prerequisite: Permission in writing (form available) from the instructor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $10.

CPE 4912. Independent Study. (0-0) 2 Credit Hours.
Prerequisite: Permission in writing (form available) from the instructor, the student's advisor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $20.

CPE 4913. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Permission in writing (form available) from the instructor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

CPE 4953. Special Studies in Computer Engineering. (3-0) 3 Credit Hours.
Prerequisite: May vary with the topic (refer to the course syllabus on Bluebook or contact the instructor). An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Topics may include the following: Topic 1: Computer and Networking Security; Topic 2: IoT Security; Topic 3: AI in Networked Systems; Topic 4: Embedded System Design; Topic 5: Superscalar Systems; Topic 6: Engineering Programming I; Topic 7: Engineering Programming II; Topic 8: Engineering Algorithms; Topic 9: Cloud Computing for Engineers; Topic 10: AI Hardware and Programming. May be repeated for credit as topics vary. (Same as EE 4953. Credit cannot be earned for both EE 4953 and CPE 4953.) This course has Differential Tuition.

Electrical Engineering (EE) Courses

EE 1322. Introduction to Electrical and Computer Engineering. (2-1) 2 Credit Hours. (TCCN = ENGR 1201)
Prerequisite: MAT 1073. An introduction to the electrical and computer engineering profession with emphasis on technical communication, team-based engineering design, professional and ethical responsibilities, contemporary issues, and software tools. One hour of recitation session per week. (Formerly EE 1323. Credit cannot be earned for both EE 1323 and EE 1322.) Course Fees: LRE1 $25; STSE $20; DL01 $50.

EE 2213. Electric Circuits and Electronics. (3-0) 3 Credit Hours. (TCCN = ENGR 2305)
Prerequisite: PHY 1963 and completion of or concurrent enrollment in EGR 3423. Principles of electrical circuits and systems. Basic circuit elements (resistance, inductance, mutual inductance, capacitance, independent and dependent controlled voltage, and current sources). Topology of electrical networks; Kirchhoff's laws; node and mesh analysis; DC circuit analysis; operational amplifiers; transient and sinusoidal steady-state analysis; AC circuit analysis; first- and second-order circuits; application of Laplace transforms to the analysis of RLC circuits. (Formerly EE 2214. Credit cannot be earned for both EE 2213 and EE 2214.) Generally offered: Fall, Spring. Course Fee: LRE1 $25; STSE $30; DL01 $75.

EE 2423. Electric Network Theory. (3-1) 3 Credit Hours.
Prerequisite: EE 1322 and completion of or concurrent enrollment in EGR 3423 and PHY 1963. Basic network principles; simple resistive circuits; steady state responses to DC and AC signals; node-voltage and mesh-current analysis; source transformations and superposition; Thevenin and Norton equivalents; natural and step transient responses of first- and second-order circuits; Laplace transform in circuit analysis; and use of circuit simulation software to solve network problems. One hour of problem solving recitation per week. Generally offered: Fall, Spring, Summer. Course Fee: LRE1 $25; STSE $30; DL01 $75.

EE 2511. Digital Circuit Laboratory. (1-2) 1 Credit Hour.
Prerequisite: Completion of or concurrent enrollment in EE 2513. Introduction to digital design techniques. Implementation of basic digital logic and hardware; combinational circuits, flip-flops, registers, sequential circuits and state machines. Generally offered: Fall, Spring, Summer. Course Fee: LRE1 $20; STSE $10.

EE 2513. Logic Design. (3-1) 3 Credit Hours.
Prerequisite: EE 1322 and completion of or concurrent enrollment in CS 2073 or CPE 2073. Number systems, Boolean algebra, combinational and sequential circuit design, and minimization and implementation. One hour of problem solving recitation per week. Generally offered: Fall, Spring. Course Fee: LRE1 $25; STSE $30; DL01 $75.

EE 2583. Microcomputer Systems I. (3-1) 3 Credit Hours.
Prerequisite: EE 2513, and CS 2073 or CPE 2073. Introduction to assembly and C language programming; architecture, peripherals, operating system interfacing principles, and development tools; and software documentation techniques. One hour of recitation per week. (Formerly EE 3463. Credit can be earned for only one of the following: EE 3463 or EE 2583.) Generally offered: Fall, Spring, Summer. Differential Tuition: $165. Course Fee: L001 $30.

EE 3113. Electrical and Computer Engineering Laboratory I. (1-6) 3 Credit Hours.
Prerequisites: EE 2423, EE 2513, and completion of or concurrent enrollment in EE 3313. Introduction to basic measurement equipment and techniques; use of circuit simulation tools; comparison to empirical performance of simple circuits using discrete devices and circuits; simple subsystem circuit design; introduction to automated data acquisition; and laboratory technical communication. Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: L001 $30; DL01 $75.

EE 3213. Electromagnetic Engineering. (3-1) 3 Credit Hours.
Prerequisite: EGR 2313 and PHY 1963. Review of vector calculus, electrostatics, magnetostatics, electrodynamics, electromagnetic waves, dielectrics, boundary conditions, and RLC circuits. Selected other topics include wave guides, anisotropic crystal optics, transmission lines, fiber optics, reflection and refraction, and special relativity. One hour of problem solving recitation per week. Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 3223. C++ and Data Structures. (3-1) 3 Credit Hours.
Prerequisite: EE 2583 (or EE 3463 in previous catalogs). Review of C++ non-OOP concepts, object-oriented programming, inheritance, virtual functions and polymorphism, and operator overloading. In-depth study of data structures including stacks, queues, linked lists, trees, binary trees, and their application to binary search trees and sorting. One hour of problem solving recitation per week. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 $75.

EE 3233. Systems Programming for Engineers. (2-3) 3 Credit Hours.
Prerequisite: EE 3223. Programming low-level interfaces of Linux using Python; learning basics of Linux utilities and Python; interfacing to services in the underlying Linux kernel using Python's system programming tools; support for running programs covering threads, process forks, processing files and directories, and networking with pipes, socket, and queues in Python. Two hours of lecture, one hour of recitation, and one hour of programming lab per week. This course has Differential Tuition. Course Fee: DL01 $75.

EE 3313. Electronic Circuits I. (3-1) 3 Credit Hours.
Prerequisite: EE 2423. P-N junctions, diode circuits, BJTs and FETs, application to digital and analog circuits, and use of circuit simulation software to solve simple circuits. One hour of problem solving recitation per week. Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

EE 3323. Electronic Devices. (3-0) 3 Credit Hours.
Prerequisites: CHE 1103 and EE 2423. Introduction to semiconductor materials, fundamentals of quantum mechanics and carrier phenomena, operating principles of P-N junction diodes, metal-semiconductor contacts (Schottky diodes), bipolar-junction transistors, field-effect transistors, photodetectors and optoelectronic devices. Generally offered: Fall, Spring. This course has Differential Tuition.

EE 3413. Analysis and Design of Control Systems. (3-1) 3 Credit Hours.
Prerequisite: EE 3423 for electrical engineering majors; EGR 2513 and EE 2213 for mechanical engineering majors. Modeling, analysis, and design of linear automatic control systems; time and frequency domain techniques; stability analysis, state variable techniques, and other topics. Control systems analysis and design software will be used. One hour of problem solving recitation per week. Generally offered: Fall, Spring, Summer. This course has Differential Tuition. Course Fee: DL01 $75.

EE 3423. Mathematics in Signals and Systems. (3-1) 3 Credit Hours.
Prerequisite: EE 2423. Topics include: introduction and basic concepts, mathematical representation of signals and systems, graphs of functions, elements of complex numbers, partial fraction expansion, properties of basic functions (including sinusoidal and complex exponential signals), phasors, time and amplitude transformations of signals, properties of signals and classification of systems, Dirac delta function, step function, convolution integral, impulse response, frequency response function for linear time invariant systems, differential-equation models, response to real sinusoidal signals, ideal filters, periodic functions and Fourier series, continuous-time Fourier transform, energy and power spectral density functions, Laplace transforms in linear system analysis, differential equations with constant coefficients, transfer functions. (Formerly EE 3424. Credit cannot be earned for both EE 3424 and EE 3423.) This course has Differential Tuition. Course Fee: DL01 $75.

EE 3513. Electromechanical Systems. (3-0) 3 Credit Hours.
Prerequisite: PHY 1963. Principles of electromechanical energy conversion, polyphase circuits, dynamic analysis and simulation of energy-transfer devices, and power devices. Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 3523. Discrete Signals and Systems. (3-0) 3 Credit Hours.
Prerequisite: EE 3423. Topics include: time and frequency characteristics of signals and systems, sampling, discrete-time convolution, applications of discrete-time Fourier and Z-transforms to systems, MATLAB exercises. (Formerly titled "Signals and Systems II.") Generally offered: Fall, Spring. This course has Differential Tuition.

EE 3533. Probability and Random Signals. (3-0) 3 Credit Hours.
Prerequisite: EE 3423. Probability axioms, conditional probability, Bayes' theorem, and independence. Probability models for a single discrete or continuous random variable: cumulative distribution function (CDF), probability mass function (PMF), probability density function (PDF), expected value, variance, and standard deviation. Specific families of random variables, such as Bernoulli, geometric, binomial, uniform, exponential, and Gaussian random variables. Models for multiple random variables: joint CDF, joint PMF, and joint PDF; marginal PMF and marginal PDF; random variable independence, covariance, and correlation. Theorems pertaining to sequences of random variables, such as the Central Limit Theorem and the Law of Large Numbers. Conditional probability models. Introduction to random signals. Applications in Electrical and Computer Engineering provided throughout the semester. (Formerly titled: "Probability and Stochastic Processes.") Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 3563. Digital Systems Design. (2-3) 3 Credit Hours.
Prerequisite: EE 2513. Introduction to switching theory; design of complex combinational and sequential circuits; analysis of hazards and fault detection, location, and tolerance; and design and verification of complex circuitry using schematic entry, functional modeling, and mixed-mode simulation. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 $75; L001 $30.

EE 4113. Electrical and Computer Engineering Laboratory II. (1-6) 3 Credit Hours.
Prerequisite: EE 3113, and completion of or concurrent enrollment in either EE 3563 for computer engineering majors or EE 4313 for electrical engineering majors. Complex electronic circuit subsystem design, improving measurement system performance, impact of circuit parasitics, signal integrity, electromagnetic interference, thermal analysis, printed circuit board layout, and technical communication. Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: L001 $30; DL01 $75.

EE 4123. Power Engineering Laboratory. (1-6) 3 Credit Hours.
Prerequisite: EE 3113 and completion of or concurrent enrollment in EE 4753 and EE 4763. Power Electronics Laboratory to analyze and test DC-DC converters, voltage mode and current mode control. Power Systems Simulation Laboratory to analyze and design power systems that include power flow, transmission line, transient and fault analysis. This course has Differential Tuition. Course Fee: L001 $30.

EE 4243. Computer Organization and Architecture. (2-3) 3 Credit Hours.
Prerequisite: EE 2583 (or EE 3463 in previous catalogs). Design of advanced state machines and computer systems, and processor design using computer-assisted design and analysis tools. Generally offered: Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4313. Electronic Circuits II. (3-0) 3 Credit Hours.
Prerequisite: EE 3313 and concurrent enrollment in or completion of EE 3323. Multiple transistor circuits, feedback and frequency response analysis, operational amplifier analysis and design, and introduction to integrated circuit design and analysis. Design of analog and digital circuits, and use of circuit simulation software to analyze complex circuits. Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

EE 4323. Dielectric and Optoelectronic Engineering Laboratory. (2-4) 3 Credit Hours.
Prerequisite: EE 3213 and EE 3323. Principles of dielectric devices and optical components and systems. May be repeated for credit when topics vary. Topic 1 (generally offered in Spring): Capacitance, resistance, and inductance device evaluations, impedance frequency and temperature spectrum analysis, characterization microwave materials, electromechanical coupling and piezoelectric devices, diffraction optics, optical spectrometry and ellipsometry. Topic 2 (generally offered in Fall): Lasers, photodetectors, laser interferometer and high speed vibrometer, evaluation of electrooptic and nonlinear optical devices, characterization of sensors, actuators, and energy conversion materials, X-ray diffraction, atomic force microscopy, additive manufacturing of micro- and nano-electronics. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4443. Discrete-Time and Computer-Controlled Systems. (3-0) 3 Credit Hours.
Prerequisite: EE 3413 and completion of or concurrent enrollment in EE 3523. Sampled-data techniques applied to the analysis and design of digital control systems, stability criteria, compensation, and other topics. Generally offered: Fall. This course has Differential Tuition.

EE 4463. Introduction to Machine Learning. (3-0) 3 Credit Hours.
Prerequisite: EE 3533. Introduction to concepts of inference and learning. Introduction to concepts of regression and classification: linear and nonlinear regression; linear discriminant analysis, logistic regression, and support vector machines. Introduction to dimensionality reduction and clustering. Introduction to artificial neural networks. This course has Differential Tuition.

EE 4493. Electric Distribution System Modeling and Analysis. (3-0) 3 Credit Hours.
Prerequisite: EE 2423. Introduction to distribution systems. Nature of loads, series impedance and shunt admittance of overhead and underground lines, voltage regulation, three-phase transformer models, load models, power flow analysis, center-tapped transformers and secondaries, and short-circuit studies. This course has Differential Tuition.

EE 4513. Introduction to VLSI Design. (2-3) 3 Credit Hours.
Prerequisite: EE 3323 and EE 3563. Design of integrated digital systems; logic simulation, standard cell libraries, circuit simulation, and other computer-aided design tools; and integrated circuit processing and device modeling. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4523. Introduction to Nanoelectronics. (2-3) 3 Credit Hours.
Prerequisite: Completion of or concurrent enrollment in EE 3323. Fundamentals of semiconductor device physics. State-of-the-art CMOS and beyond-CMOS device technologies. Quantum transport theories of electron, phonon, and spin in nanoscale solids. Nanofabrication techniques. Low-dimensional nanomaterials for future electronics. Practical application of nanotechnology in mechanical, optical, and biological heterogeneous systems. Students will study a quantum phenomenon using a device simulation software. (Formerly titled "Introduction to Micro and Nanotechnology.") (Same as EE 5503. Credit cannot be earned for both EE 4523 and EE 5503.) Generally offered: Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4533. Principles of Microfabrication. (2-3) 3 Credit Hours.
Prerequisite: Completion of or concurrent enrollment in EE 3323. Fundamentals of microfabrication techniques, including photolithography, thin film deposition (physical vapor deposition and chemical vapor deposition), etching, thermal oxidation, diffusion, ion implantation, chemical and mechanical polishing, and epitaxy. Nanofabrication techniques that enable sub-micron feature sizes will also be discussed (electron beam or x-ray lithography, focused ion beam, and other bottom-up approaches). Students will visit nearby research institutes and foundry companies as part of this course. (Credit cannot be earned for both EE 4533 and EE 5413.) Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4543. Advanced Topics in Micro and Nanotechnology. (3-0) 3 Credit Hours.
Prerequisite: Completion of or concurrent enrollment in EE 3323. Topics to be selected from advanced sensors, actuators, engineered materials, device physics, microwave applications of MEMS structures, photonics, microelectronic devices, analog IC design, mixed-signal circuits and systems. May be repeated for credit when topics vary. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

EE 4553. VLSI Testing. (2-3) 3 Credit Hours.
Prerequisite: EE 2583 (or EE 3463 in previous catalogs). Faults modeling and simulation; stuck at faults, bridging faults, and functional testing; self-testing concepts; standard and test patterns; device and system testing; and design for testability. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

EE 4563. FPGA-Based System Design. (3-0) 3 Credit Hours.
Prerequisite: EE 2583 (or EE 3463 in previous catalogs) and EE 3563. FPGAs replace digital circuits in most applications. This course addresses underlying theory and applications: Introduction to Field Programmable Gate Arrays; General-Purpose FPGA Architecture; Reconfigurable Computing Devices and Systems; Hardware Description Language for FPGAs; synthesizing FPGA interconnections; Global Timing Constraints; evaluating and optimizing problems for FPGA implementations; Arithmetic, Precision Analysis & Floating Point; FPGA vs. CPU partitioning. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

EE 4583. Microcomputer Systems II. (2-3) 3 Credit Hours.
Prerequisite: EE 2583 (or EE 3463 in previous catalogs). Advanced microprocessor-based system design; high-speed bus interfacing, coprocessors, and other specialized input/output devices; and high-level languages and software performance analysis. Generally offered: Spring. This course has Differential Tuition. Course Fee: L001 $20.

EE 4593. Embedded System Design. (3-0) 3 Credit Hours.
Prerequisite: EE 2583 (or EE 3463 in previous catalogs) and EE 3563. The goal of this course is to develop a comprehensive understanding of the technologies behind embedded systems, particularly, those using computing elements: Embedded processor selection, hardware/firmware partitioning, circuit layout, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging. C programming of embedded microcontrollers, the function and use of common peripherals, and the programming and simulation (using VHDL/Verilog) of custom single-purpose processors. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

EE 4613. Communication Systems. (3-0) 3 Credit Hours.
Prerequisite: EE 3533. Basic theory and principles of modern analog and digital communication systems; signal, noise, and interference analysis, signal-to-noise and signal-to-noise-plus-interference ratio, and circuit implementations. This course has Differential Tuition.

EE 4623. Digital Filtering. (3-0) 3 Credit Hours.
Prerequisite: EE 3423 and completion of or concurrent enrollment in EE 2583 (or EE 3463 in previous catalogs). Design and implementation of FIR and IIR filters, hardware, and software; and topics from adaptive filtering, neural networks. MATLAB exercises. This course has Differential Tuition. Course Fee: LRE1 $25; STSE $30.

EE 4643. Digital Signal Processing. (3-0) 3 Credit Hours.
Prerequisite: Completion of or concurrent enrollment in EE 3523 and EE 3533. Topics include: transform techniques for discrete signal processing; discrete representation and analysis of digital filters and other topics; A/D and D/A conversion and associated filtering techniques. Generally offered: Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4653. Digital Communications. (3-0) 3 Credit Hours.
Prerequisite: EE 3533. Basic digital modulation schemes: ASK, BPSK, QPSK, FSK, QAM, OFDM, binary signal detection, matched filtering, bit error rate, intersymbol interference, equalization, signal-space methods, optimum receiver, fundamentals of information theory and block coding, convolutional coding and spread spectrum. This course has Differential Tuition.

EE 4663. Digital Image Processing. (3-0) 3 Credit Hours.
Prerequisite: EE 3523. Topics include: fundamentals and some practical applications of digital image processing; image formation; sampling; quantization; image motion and detector noise; future extraction; image enhancement and restoration by spatial filtering and maximum entropy; image coding for bandwidth compression by DPCM; transform coding, sub-band coding; use of MATLAB for image processing. Generally offered: Fall. This course has Differential Tuition.

EE 4673. Data Communication and Networks. (2-3) 3 Credit Hours.
Prerequisite: EE 3223. Introduction to computer networks and their underlying concepts and principles. Learn layered organization of the internet in a top-down fashion: Application, Transport, Network, Data Link, and Physical layers. The course will also cover advance topics including wireless networking, wireless communication, and network cybersecurity. This course has Differential Tuition.

EE 4683. Wireless Communications. (3-0) 3 Credit Hours.
Prerequisite: EE 3533. Common wireless systems and standards. Cellular radio concepts: frequency reuse and handoff strategies. Large-scale path loss models. Small-scale fading and multipath. Modulation techniques for mobile radio: performances in fading and multipath channels. Introduction to in multi-input multi-output (MIMO) systems. Multiple access techniques. RF hardware realization issues. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4693. Fiber Optic Communications. (3-0) 3 Credit Hours.
Prerequisites: EE 3313, EE 3423, and completion of or concurrent enrollment in EE 3213. Light propagation using ray and electromagnetic mode theories, dielectric slab waveguides, optical fibers, attenuation and dispersion in optical fibers, optical fiber transmitters and receivers, electro-optical devices, and optical fiber measurement techniques. This course has Differential Tuition.

EE 4723. Intelligent Robotics. (3-1) 3 Credit Hours.
Prerequisite: EE 3413 or ME 3543. Coordinate transformations, forward and inverse kinematics, Jacobian and static forces, path planning techniques, dynamics, design, analysis and control of robots, sensing and intelligence. (Formerly EGR 4723 and ME 4713. Credit cannot be earned for both EE 4723 and either EGR 4723 or ME 4713.) Generally offered: Spring. This course has Differential Tuition.

EE 4733. Intelligent Control. (3-0) 3 Credit Hours.
Prerequisite: EE 3423. Neural networks and fuzzy logic basics, approximation properties, conventional adaptive controller design and analysis, intelligent controller design and analysis techniques for nonlinear systems, and closed-loop stability. Generally offered: Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4743. Embedded Control Systems. (2-3) 3 Credit Hours.
Prerequisite: EE 3413 and EE 2583 (or EE 3463 in previous catalogs). Embedded system principles and control system concepts, programming, tools and their applications, embedded controls design, and analysis of industrial processes. This course has Differential Tuition. Course Fee: LRE1 $25; L001 $20; STSE $30.

EE 4753. Analysis of Power Systems. (3-0) 3 Credit Hours.
Prerequisite: EE 3413. Electric energy and principles of power generation. Power transformers and transmission lines. Power flow and fault analysis. Introduction to transient stability analysis and power systems controls. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4763. Power Electronics. (3-0) 3 Credit Hours.
Prerequisites: EE 3113 and EE 3413. Switch-mode power conversion, analysis and control of DC-DC converters, DC-AC inverters for motor drives and to interface renewable energy sources with utility, AC-DC rectifiers, applications in sustainable energy systems, introduction to power semiconductor devices and magnetic components. Generally offered: Spring. This course has Differential Tuition.

EE 4773. Electric Drives. (3-0) 3 Credit Hours.
Prerequisite: Completion of or concurrent enrollment in EE 3513. Analysis of electric machines in combination with power electronics; torque, speed and position control; space vectors, motor drive inverter; vector control; wind energy conversion. Generally offered: Fall. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4783. Power System Operation and Planning. (3-0) 3 Credit Hours.
Prerequisite: EE 3413. Unit commitment, spinning reserve, contingency, economic dispatch, production cost model, optimization, state estimation, measurement and monitoring, reactive power-voltage control, active power-frequency control, automatic generation control, generation planning, transmission planning, stability, reliability, and distribution planning. This course has Differential Tuition.

EE 4793. Nuclear Energy and Engineering. (3-0) 3 Credit Hours.
Prerequisite: EGR 2413 and EGR 2313. This is an introductory course for undergraduate and graduate students in electrical engineering desiring a nuclear energy sequence and elective course of students in science and other engineering disciplines. The course aspires to cover the basic knowledge and principles in nuclear energy and engineering and is structured in six parts. (i) Nuclear physics and radiation interactions, (ii) Basics of radiation detection, (iii) Nuclear reactors and nuclear power, (iv) Electric Utility and Nuclear Power Economics, (v) Nuclear Energy, Renewables and Environment, and (vi) nuclear instruments and sensors with artificial intelligence applied to nuclear safety, industry, and medicine. This course has Differential Tuition.

EE 4812. Electrical Engineering Design I. (2-1) 2 Credit Hours.
Prerequisites: Completion of EE 4313, and concurrent enrollment in, or completion of, EE 4113. Business planning and project management in engineering design; discussion of ethical and social issues in design; and selection of a design project, development of a detailed design proposal, and approval of a design project. One hour of problem solving recitation per week. (Formerly EE 4811. Credit cannot be earned for both EE 4812 and EE 4811.) Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: DL01 $50.

EE 4813. Electrical Engineering Design II. (2-3) 3 Credit Hours.
Prerequisite: EE 4812. Complex system design; advanced ATE; project management, detailed design package, status reporting, formal oral and written technical reports, design reviews, and test plan development and execution; open-ended design project considering safety, reliability, environmental, economic, and other constraints; and ethical and social impacts. Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: DL01 $75.

EE 4911. Independent Study. (0-0) 1 Credit Hour.
Prerequisites: Permission in writing (form available) from the instructor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

EE 4912. Independent Study. (0-0) 2 Credit Hours.
Prerequisite: Permission in writing (form available) from the instructor, the student's advisor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

EE 4913. Independent Study. (0-0) 3 Credit Hours.
Prerequisites: Permission in writing (form available) from the instructor, the Department Chair, and Dean of the College. Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but not more than 6 semester credit hours of independent study, regardless of discipline, will apply to a bachelor's degree. This course has Differential Tuition.

EE 4953. Special Studies in Electrical and Computer Engineering. (3-0) 3 Credit Hours.
Prerequisite: May vary with the topic (refer to the course syllabus on Bluebook or contact the instructor). An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when topics vary. Generally offered: Fall, Spring. (Same as CPE 4953. Credit cannot be earned for both EE 4953 and CPE 4953.) This course has Differential Tuition. Course Fee: DL01 $75.