CONST 166. Mechanical Systems II (3)
Prerequisite: CONST 162. Construction application of water systems, plumbing and storm drainage, and sewage disposal systems.

CONST 190. Independent Study (1-3; max total 6)
See *Academic Placement — Independent Study*. Approved for ***RP*** grading.

CONST 191T. Technical Topics in Construction (1-3; max total 6)
Prerequisite: permission of instructor. Investigation and analysis of selected subjects in construction. (2-6 lab hours)

CONST 193. Internship/Work Experience (3)
Open only to construction majors. Prerequisites: junior standing and permission of instructor. Supervised work experience in construction related industries. Periodic consultations with instructor.

Department of Electrical and Computer Engineering
Ramakrishna Nunna, *Chair*
Engineering East Building, Room 274
559.278.2726

Program Description

Electrical Engineering. The Electrical Engineering Program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET).

Electrical engineers design and develop electronic circuits, equipment and systems in the areas of electromagnetics (antennas; radar, radio, and television systems), communications and control (telephone systems, satellite communications; laser and optical fiber communications; aircraft and missile guidance systems), computers and digital systems (computers, microprocessors, and microcomputers; artificial intelligence), physical electronics and optics (transistors; integrated circuits; optical display devices; lasers; optical fibers), power systems and energy conversion (hydro, thermal, nuclear, solar electric power generation; analysis and synthesis of power transmission and distribution systems; on-line power control and dispatch centers), and control systems (computer control, robotics, automated manufacturing, intelligent sensors).

Computer Engineering. The Computer Engineering Program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). Computer engineering is a discipline which allows the student to obtain expertise in the design, programming, and applications of computers. It prepares the graduate for professional practice or graduate studies. The program combines the following:

a. A strong emphasis on electrical engineering (primarily electronic circuits and systems)
b. A broad basis in mathematics, physical science, and general engineering
c. Fundamentals of computer science including programming methodology, software engineering, and operating systems
d. Introductory and advanced concepts in the design of computers and computer systems

A rich set of technical area courses is available to allow students to broaden their knowledge within any of several computer engineering areas.

Career Opportunities

According to a report by the American Electronics Association, a shortage of electrical and computer engineers is projected for the next several years; it is anticipated that computer engineering positions will increase more than any other major profession. New developments are evolving in optical communications, microelectronics, intelligent controls, computers, radar, microwave communications, and innovative alternative energy sources at an explosive pace which should assure a solid growth pattern for electrical and computer engineers into the foreseeable future.

Mission and Educational Objectives

The mission of the Department of Electrical and Computer Engineering is to fulfill the needs of the region and state by providing an undergraduate technical education in electrical engineering and computer engineering to a diverse group of students. Additionally, the department strives to continually update its rigorous program of study in order to qualify its graduates for positions in industry located in the region and beyond while providing sufficient programmatic breadth and depth to assure its graduates a successful practice in the profession. Furthermore, students are grounded in the rigorous scientific and theoretical foundations of the discipline, in order not only to enable graduates to enter and be successful in any advanced level educational program of their choosing, but also to be able to build upon this strong foundation and extend it to new depths.

The mission of the department complements and is enhanced by a graduate program leading to the M.S. in Engineering. For more information, see the Master of Science in Engineering Program, pages 316-317.

The faculty members possess depth and breadth in their specialty areas and are active in bringing these experiences and skills to the classroom. The identifiable strengths of the academic program are the laboratory and hands-on experience for students, the proper attention given to the scientific and mathematical foundation of electrical engineering and computer engineering, and the rigor of upper-division courses coupled with design and culminating senior projects. The technical and liberal arts components of the curriculum provide the students with the opportunity for gaining self-development, technical competence, and awareness of economic and ethical responsibilities. The technical curriculum includes (l) basic engineering science, (2) core electrical and computer engineering subjects, and (3) a junior-/senior-level choice for more depth in communications and analog systems, power systems and controls, or digital systems and computers.

The department has a mandatory advising program to help students make sound academic decisions.

Organizations

Student chapters of the Institute of Electrical and Electronic Engineers and Eta Kappa Nu (the national honor society for electrical engineers) are active in the department. The College of Engineering, in addition, has chapters of Tau Beta Pi, the Society of Women Engineers, the Society of Hispanic Engineers, and the National Society of Black Engineers.

Co-op Program

The department participates in the Valley Industry Partnership Program which allows students to integrate planned industrial experiences into their academic programs. Students interested in this program should contact the chair of the Department of Electrical and Computer Engineering and the college's co-op coordinator.

Bachelor of Science Degree Requirements[1]

Electrical Engineering Major — *Units*

Major requirements 63-64

ECE 1, 71, 85, 85L, 90, 90L, 102, 118, 121, 124, 125, 126, 128, 128L, 134, 138, 138L, 155, 186A ..... (49)

Select two from ECE 119LA, 119LB, 120L, 121L, 136L ..... (2)

CE 29 or ME 29 or ME 136 ..... (3)

Technical Area Courses ..... (9-10)

Select three courses from the following: ECE 106, 107, 114, 115, 132,135, 136, 140, 146, 148, 151, 152, 162, 166, 168, 171, 172, 173, 174, 176

Other requirements 65

General Education

Select one course from each of the G.E. areas: Area A1, A2, C1, D1, D2. (See pages 89-92 for G.E. listings.)

The following courses are required to satisfy both G.E. and additional requirements: MATH 75 [B4], CHEM 3A [B1], PHIL 1 or 10 [C2], ECE 186B [IB], PHIL 120 [IC], PLSI 120 or BA 104 [M/I], ECON 40 or 50 [D3], BIOL 10 [B2]

Additional requirements

MATH 76, 77, 81

PHYS 4A; PHYS 4B, 4BL; PHYS 4C; choose one from ECE 191T, MATH 121, 123, 128, 152, 171, 181, 182 (see *Advising Notes*)

Total 128-129

Note: Engineering majors are exempt from G.E. Area A3, third course Area C, Area E, and Area ID.

Advising Notes

1. Courses in mathematics, the physical sciences, or engineering taken ***CR/NC*** are not counted toward fulfillment of degree requirements in electrical engineering.
2. Electrical engineering majors might consider a math minor (see faculty adviser for details).
3. All electrical engineering students must consult with their academic adviser at least once each year.
4. The Upper-Division Writing Skills requirements can be met by passing the university examination or completing an upper-division writing course with a letter grade of ***C*** or better no sooner than the term in which 60 units of coursework are completed. The writing course units are not counted toward the required 128 program units.
5. If ECE 191T is chosen, it must be the mathematical analysis in electrical engineering section of the course.
6. With adviser approval, ENGR 101 may be taken instead of MATH 81.
7. The prerequisites for ECE 186A are ECE 85, 85L, 90, 90L, 102, 118, 124, 128, 128L; one lab from ECE 119LA, 119LB, 120L, 121L, 138L; and two courses from ECE 121, 134, 138, 155.

See the catalog Web site for recommended program at *www.csufresno.edu/catoffice/current/engelrec.html*.

Prerequisites: Students violating any course prerequisites may be required to take an additional course (if they earned a ***C***) or repeat a course (if they earned a ***D*** or less.) Repeated violations of prerequisites may trigger disciplinary action.

Bachelor of Science Degree Requirements[1]

Computer Engineering Major — *Units*

Major requirements 58

ECE 1, 85, 85L, 90, 90L, 106, 107, 115, 118, 120L, 124, 125, 128, 128L, 174, 176, and 186A ..... (43)

CSCI 150 ..... (3)

Technical Area ..... (12)

Select 3 courses from the following:

ECE 114, 132, 134, 135, 138, 138L, 140, 146, 148, 155, 172, 173; CSCI 144, 156

Other requirements 70

General Education

Select one course from each of the G.E. areas: Area A1, A2, C1, D1, D2. (See pages 89-92 for G.E. listings.)

The following courses are required to satisfy both G.E. and major requirements: MATH 75 [B4], CHEM 3A [B1], PHIL 1 or 10 [C2], ECE 186B [IB], PHIL 120 [IC], PLSI 120 or BA 104[M/I], ECON 40 or 50 [D3], BIOL 10 [B2]

Additional requirements

MATH 76, 77, 81; PHYS 4A-C, 4BL; CSCI 40, 41 (see Advising Notes)

Total 128

Note: Engineering majors are exempt from G.E. Area A3, third course Area C, Area E, and Area ID.

Advising Notes

1. Courses in mathematics, the physical sciences, or engineering taken ***CR/NC*** are not counted toward fulfillment of degree requirements in computer engineering.
2. Computer engineering majors might consider a math minor. (See faculty adviser for details.)
3. All computer engineering students must consult with their academic adviser at least once each year.
4. The Upper-Division Writing Skills requirements can be met by passing the university examination or completing an upper-division writing course with a letter grade of ***C*** or better no sooner than the term in which 60 units of coursework are completed. The writing course units are not counted toward the required 128 program units.
5. With adviser approval, ENGR 101 may be taken instead of MATH 81.
6. The prerequisites for ECE 186A are ECE 85, 85L, 90, 106, 118, 120L, 124, 128, 128L; CSCI 41; and one course from ECE 107, 174, 176, or CSCI 150.

See the catalog Web site for recommended program at *www.csufresno.edu/catoffice/current/engelrec.html*.

Prerequisites: Students violating any course prerequisites may be required to take an additional course (if they earned a ***C***) or repeat a course (if they earned a ***D*** or less.) Repeated violations of prerequisites may trigger disciplinary action.

COURSES

Electrical and Computer Engineering (ECE)

Note: Students may be expected to purchase supplementary materials for senior projects and special topic laboratory and activity classes.

ECE 1. Introduction to Electrical and Computer Engineering (3)
Orientation to the electrical and computer engineering fields. Introduction to circuits, components, and instrumentation; electronic prototyping, engineering design process, computer productivity tools, laboratory safety, and hands-on hardware and software projects; teamwork; written and oral communications. (2 lecture, 3 lab hours)

ECE 70. Engineering Computations Using C (3)
Prerequisite: students must pass the ELM exam or be exempt from it; students who do not pass the exam must record a grade of *C* or better in a college-taught intermediate algebra course; trigonometry. Use of C computer language in engineering analysis and design. A systematic development in program structure, specification, testing, and debugging.

ECE 71. Engineering Computations (3)
Prerequisite: students must pass the ELM exam or be exempt from it; students who do not pass the exam must record a grade of *C* or better in a college-taught intermediate algebra course; trigonometry. Use of the C programming language in engineering analysis and design. A systematic development in program structure, specification, documentation, testing, and debugging.

ECE 85. Digital Logic Design (3)
Discrete mathematics, logic, and Boolean algebra. Number systems and binary arithmetic, logic gates, combinatorial logic, minimization techniques. Analysis and design of combinatorial circuits. Flipflops, multivibrators, registers, and counters. Introduction to sequential circuits and state machines. Synchronous state machine design.

ECE 85L. Digital Logic Design Laboratory (1)
Prerequisite: ECE 85 or concurrently. Usage, design, and implementation techniques for combinatorial and sequential circuits. Experiments utilizing logic gates, Karnaugh maps, multiplexers, decoders, programmable logic devices, latches, flipflops, counters and shift registers. Combinatorial and state machine design projects. Computer Assisted Engineering (CAE). (3 lab hours)

ECE 90. Principles of Electrical Circuits (3)
Prerequisites: PHYS 4B; MATH 77 or concurrently. Direct-current circuit analysis; circuit theorems; transient phenomena in RL and RC circuits, introduction to operational amplifiers, phasor concept; AC steady-state circuit analysis, sinusoidal steady-state response; power and RMS calculations in single-phase alternating-current circuits; principles of electrical instruments; computer solutions circuit simulation using Spice or other contemporary software tools. (CAN ENGR 12)

ECE 90L. Principles of Electrical Circuits Laboratory (1)
Prerequisite: ECE 90 or concurrently. Experiments on direct- and alternating-current circuits, including single-phase and polyphase systems. Use of electrical instruments, development of laboratory techniques, and verification of basic principles. (3 lab hours)

ECE 91. Introduction to Electrical Engineering (3)
Prerequisites: PHYS 4B; MATH 76. (No credit given for ECE 91 if taken after ECE 90). Direct current circuit analysis, transient and AC steady state circuit analysis, basic electronics, diodes, transistors, digital systems, digital logic circuit, simple microprocessors, DC and AC machines.

ECE 91L. Introduction to Electrical Engineering Laboratory (1)
Prerequisites: ECE 91 or concurrently. Experiments on direct and alternating current, basic electronics, digital logic circuits, and electric machines.

ECE 102. Advanced Circuit Analysis (4)
Prerequisites: MATH 81, ECE 90. Power, RMS calculations in single and polyphase AC circuits, transfer functions, RLC transient circuit analysis, mutual inductance, transformers, two-port circuits, pole-zero analysis, Bode plots, stability concepts, circuit response to periodic inputs, Lapace solution techniques, frequency response, passive and active circuits, design and circuit simulation using Spice.

ECE 106. Switching Theory and Logical Design (4)
Prerequisite: ECE 85 or equivalent. Synchronous machines; finite and non-finite state machine design and analysis; Mealy-Moore state models; modulo and shift-register counters; state minimization and assignment techniques; incompletely specified sequential machines; one-hot design; algorithmic state machine design; design description and simulations using contemporary software.

ECE 107. Digital Signal Processing (3)
Prerequisites: ECE 71 or CSCI 40; ECE 115 or 118, 124. Time and frequency domain analysis of discrete time signals and systems, digital processing of continuous time signals, FIR, IIR, lattice filter structures, design to specification, implementation issues, computer-based modeling and design.

ECE 114. Physical Electronics (3)
Prerequisites: PHYS 4C, ECE 128 or concurrently. Semiconductor fundamentals: the valence bond and energy band models of solids, carrier densities and current components. Discrete devices: the pn junction diode, BJT, MOS FET, and JFET; the Schottky barrier diode and GaAs MESFET. Integrated circuits and VLSI Systems. Modern fabrication techniques for discrete and integrated devices.

ECE 115. Computer Organization (3)
Prerequisites: ECE 85 and either CSCI 40 or ECE 71. Structural organization, hardware architecture and design of digital computer systems; binary representation of data; CPU, memory and I/O organization; register transfer and micro-operations; hardware/software design trade-offs. Introduction to RISC architecture and memory organization.

ECE 118. Microprocessor Architecture and Programming (3)
Prerequisite: ECE 85 and either CSCI 40 or ECE 71. Binary representation of data. Hardware architecture and programming models of a microprocessor. Assembly Language program specifications, development, testing, and documentation. Modular programming, parameter passing, macros.

ECE 119LA. Senior Laboratory A (1)
Prerequisite: senior standing and permission of instructor. Hands-on experience in topics in electrical and computer engineering. (3 lab hours) (Formerly ECE 119L)

ECE 119LB. Senior Laboratory B (1)
Prerequisite: ECE 71 or CSCI 40, ECE 118, senior standing, and permission of instructor. Hands-on experience in topics in micro-controllers and automation processes. (3 lab hours)

ECE 120L. Computer Systems Laboratory (1)
Prerequisite: ECE 118. Experiments on microprocessors and embedded systems; schematic capture, simulation and design, implementation of digital systems using programmable logic devices, assembly language

programming; hardware and software development. Design projects. (3 lab hours)

ECE 121. Electromechanical Systems and Energy Conversion (3)
Prerequisites: ECE 90 or ECE 91. Principles of direct- and alternating-current machinery and other energy-conversion devices and associated apparatus.

ECE 121L. Electromechanical Systems and Energy Conversion Laboratory (1)
Prerequisite: ECE 121 or concurrently. Experiments and computations on direct- and alternating-current machinery and on other energy-conversion devices and associated apparatus. (3 lab hours)

ECE 124. Signal and Systems (4)
Prerequisites: ECE 90, MATH 81, ECE 71 or CSCI 40. Analysis of discrete and continuous linear circuits, systems, and signals. Fourier transforms, Fourier series. Difference and differential equations, frequency response, system analysis via Laplace- and Z-transforms. Idealized sampling and aliasing. Stability analysis. Engineering applications, modeling, and simulation using Matlab.

ECE 125. Random Signals and Stochastic System Analysis (3)
Prerequisites: ECE 124. Probability theory and statistical principles, random variables and their characterization, transformations of random variables, random processes, correlations and power spectral densities, noise characterization and noise figure, systems' response to stochastic inputs, matched filters, applications to communication and control systems.

ECE 126. Electromagnetic Theory and Applications I (3)
Prerequisite: MATH 81 or concurrently, ECE 90. Electrostatics; boundary value problems; magnetostatics; time-varying fields; Maxwell's equations. Transmission of electromagnetic energy.

ECE 128. Electronics I (3)
Prerequisite: ECE 90. Characteristics and properties of solid state devices; theory and analysis of electronic circuits; power supply design; device and circuit models; single- and multi-stage amplifier analysis and design; analysis of digital circuits; circuit simulation using Spice or other contemporary software tools.

ECE 128L. Electronics I Laboratory (1)
Prerequisite: ECE 90L and 128 or concurrently. Experiments on static and dynamic characteristics of solid state devices in analog and digital electronic circuits; computer solutions as appropriate. (3 lab hours)

ECE 132. Design of Digital Systems (3)
Prerequisites: ECE 115, 118. Design of Digital Systems utilizing microprocessors; application of assembly programming language to input/output programming, interrupts and traps, DMA and memory management.

ECE 134. Analog and Digital Communication Engineering (3)
Prerequisite: ECE 124. Mathematical modeling of signals and systems, linear and nonlinear modulation theory, demodulators, link analysis and design, phase-lock loops, sampling theory and signal reconstruction, digitization techniques, basic digital transmission methodologies, computer simulations.

ECE 135. Wireless Communications Systems (3)
Prerequisite: ECE 125, 134. Principles of digital signal transmission and reception; binary, M-ary, and hybrid digital modulation techniques; channel and receiver front-end noise effects; statistical performance receiver analysis; source coding; block and convolutional channel coding; block decoding; VDA, channel fading, and multipath; equalization; cellular systems; Spread Spectrum and CDMA; computer simulations.

ECE 136. Electromagnetic Theory and Applications II (3)
Prerequisite: ECE 126. Plane wave propagation and reflection; waveguides; strip-lines and microstrip impedance matching, microwave circuits and S-parameters; amplifier power gain and stability, amplifier design, antenna analysis and design; methods for computer solution.

ECE 136L. Electromagnetic Theory and Applications Laboratory (1)
Prerequisite or corequisite: ECE 136. Experiments on the transmission of electromagnetic energy through wires, waveguides, and space; filters and antennas; impedance matching; cross-over networks; location of faults on lines. (3 lab hours)

ECE 138. Electronics II (3)
Prerequisites: ECE 102, 124, 128. Analysis and design of high frequency amplifiers; high frequency models of transistors; operational amplifiers and applications; feedback amplifiers; oscillators, modulators, bandpass amplifiers, and demodulators for communications. Emphasis on modern design methods.

ECE 138L. Electronics II Laboratory (1)
Prerequisite: ECE 128L and 138 or concurrently. Design oriented experiments to study the characteristics, limitations, and design trade-offs of circuits from ECE 138. Emphasis on circuit and system design to meet preestablished specifications. Design project included; computer solutions as appropriate. (3 lab hours)

ECE 140. VLSI System Design (3)
Prerequisites: ECE 118, 128. Emphasis on the design of a substantial, full custom VLSI system. Digital circuit design, fabrication principles, physical and electrical design rules, control and data path design techniques, system timing, design verification, simulation and testing. Project design requires utilization of engineering workstations running an industry standard CAD framework and incorporating a complete suite of IC design tools. Fabrication is available for potentially successful student design projects.

ECE 146. Computer Networking and Distributed Processing (3)
Prerequisites: ECE 118 or CSCI 113; ECE 125 or CSCI 60 or concurrently. Analysis and design of modern computer networks: layered protocols, routing; flow and congestion control; packet, message, and circuit switching; error control and recovery; performance analysis. Local area networks, asynchronous transfer mode and ISDN.

ECE 148. Analysis and Design of Digital Circuits (3)
Prerequisites: ECE 85, 128. Analysis and design of solid state digital circuits utilizing various logic families suitable for integration: TTL, ECL, NMOS, CMOS; logic gates; multivibrators; ROM, PROM, EPROM, and EEPROM; SRAM and DRAM.

ECE 151. Electrical Power Systems (3)
Prerequisites: ECE 90. Power system networks and equipment, power flow, symmetrical components, short circuits analysis, protection systems, and use of software in power system analysis.

ECE 152. Power Systems Analysis and Control (3)
Prerequisites: ECE 151, 155. Transmission and distribution systems, protection and coordination, stability analysis, voltage and

frequency control, system modeling, and computer simulation.

ECE 155. Control Systems (3)
Prerequisites: ECE 124. Analysis, design, and synthesis of linear control systems; modeling, performance evaluation, frequency response, and stability.

ECE 162. Analog Integrated Circuits and Applications (3)
Prerequisite: ECE 138. Analysis of monolithic operational amplifiers; case studies; Widlar and Wilson current sources; linear and nonlinear applications; multipliers, phase-lock loops, phase detectors; higher order active filters; all-pass equalizers; D/A and A/D converters; oscillators, function generators; mixers, modulators, regulators; system design.

ECE 166. Microwave Devices and Circuits Design (3)
Prerequisite: ECE 136. Microwave theory and techniques: slow-wave structures, S parameters, and microwave devices, including solid-state devices such as Gunn, IMPATT, TRAPATT, and BARITT diodes, and vacuum tubes such as klystrons, reflex klystrons, traveling-wave tubes, magnetrons and gyrotrons.

ECE 168. Microwave Amplifier and Oscillator Design (3)
Prerequisite: ECE 136. Small-signal and large-signal amplifier designs such as high-gain, high-power, low-noise, narrow-band and broadband amplifiers; microwave oscillator designs such as high-power, broadband, Gunndiode and IMPATT oscillator designs; power combining and dividing techniques; reflection amplifier design and microwave measurements.

ECE 171. Quantum Electronics (3)
Prerequisite: ECE 126. Review of wave properties; cavity mode theory; radiation laws; theory and morphology of lasers; laser and fiber-optic communications; designs of optical communication systems and components.

ECE 172. Sequential Machine and Automata Theory (3)
Prerequisite: ECE 106. Structure of sequential machines; covers; partitions; decompositions and synthesis of multiple machines. State identification and fault detection experiments; memory characteristics of finite automata.

ECE 173. Robotics Fundamentals (3)
Prerequisites: ECE 70/71, ECE 90/90L, and ECE 85/85L or 90/91L; MATH 81; ECE 118 and ECE 128 (may be taken concurrently). Introduction to industrial and mobile robots, forward and inverse kinematics, trajectory planning, sensors, micro controllers, and laboratory experiments.

ECE 174. Advanced Computer Architecture (3)
Prerequisites: ECE 115 or 118. Advanced computing architecture concepts: discrete math; pipelining; multiprocessing and multiprogramming; cache and virtual memory; direct memory access, local and system bus architectures; instruction set design and coding; CPU and system performance analysis.

ECE 176. Computer-Aided Engineering in Digital Design (3)
Prerequisites: ECE 120L or concurrently. Use of Computer-Aided Engineering tools in the design and implementation of digital systems utilizing Applications Specific Integrated Circuits. Design projects from specification through implementation using Field Programmable Gate Arrays (FPGAs) and Complex Programmable Logic Devices (CPLDs); simulation, timing analysis, Hardware Definition Languages. Hands-on exposure to current tools.

ECE 186A. Senior Design I (1)
Prerequisites: 30 units of ECE (*see advising notes*) or permission of instructor; university writing requirement or concurrently. Design projects in electrical and computer engineering.

ECE 186B. Senior Design II (3)
Prerequisite: ECE 186A and university writing requirement or concurrently. Design projects in electrical and computer engineering. Involves problem solving, critical thinking, and oral and written communication.

ECE 190. Independent Study (1-3; max total 6)
See *Academic Placement — Independent Study.* Approved for ***RP*** grading.

ECE 191T. Topics in Electrical and Computer Engineering (1-3; max total 6)
Prerequisite: permission of instructor. Investigation of selected electrical engineering subjects not in current courses.

ECE 193. Electrical and Computer Engineering Cooperative Internship (1-6; max 12)
Prerequisite: permission of adviser. Engineering practice in an industrial or governmental installation over a period of about seven months' duration. Each period must span a summer-fall or spring-summer interval. This course cannot be used to meet graduation requirements. ***CR/NC*** grading only.

GRADUATE COURSES

(See *Catalog Numbering System.*)

Electrical Engineering (EE)

EE 230. Nonlinear Control Systems (3)
Prerequisite: ECE 155 or permission of instructor. Dynamic systems modeling and analysis, stability, sliding mode control, fuzzy logic control, and introduction to relevant topics. (Formerly EE 291T)

EE 231. Digital Control Systems (3)
Prerequisite: ECE 155 or permission of instructor. Discrete Time Feedback systems modeling and analysis, stability, digital controller design, digital transformation of analog controllers, implementation techniques, and case studies. (Formerly EE 291T)

EE 241. Applied Electromagnetics (3)
Prerequisite: ECE 136 or permission of coordinator. Electrostatic field boundary conditions, energy relations, and forces; multidimensional potential problems; magnetic field boundary conditions, scalar and vector potentials, and magnetization; Maxwell's equations for stationary and moving media; energy, force, and momentum in an electromagnetic field; plane waves; waves near metallic boundaries; inhomogeneous wave equation.

EE 243. Modern Methods in Synchronous Sequential Design (3)
Prerequisite: ECE 172 or permission of coordinator. Synchronous machine design with PLDs and FPGAs; algorithmic state machines; incompletely specified machines; maximum compatibility classes; partitioning of sequential machines; state merging and state splitting.

EE 245. Communications Engineering (3)
Prerequisite: ECE 134 or permission of coordinator. Basic modulation concepts; statistical properties of signals; transmission systems optimization against noise; digital

transmission and modulation methods; attenuation and phase distortion in analog and digital systems; intermodulation distortion; random multipath channels; intersystem interference.

EE 247. Modern Semiconductor Devices (3)
Prerequisite: ECE 114 or permission of coordinator. Crystal structures and elastic constants; lattice energy and vibrations; thermal and dielectric properties of solids; ferroelectric and magnetic properties of crystals; free electron model of metals; quantum statistics distributions; band theory; semiconductor crystals; superconductivity; photoconductivity and luminescence; dislocations.

EE 249. Advanced Communication Engineering (3)
Prerequisite: ECE 245 or permission of coordinator. The measure of information; noiseless coding; models of communication channels; channel capacity; discrete memoryless channels; error correcting codes; information sources; discrete channels with memory; continuous channels.

EE 251. Antennas and Propagation (3)
Wave equation, plane waves, metallic boundary conditions; wave equation for the potentials Lorentz transformation; covariant formulation of electrodynamics; radiation from a moving charge; scattering and dispersion; Hamiltonian formulation of Maxwell's equations.

EE 255. Digital Signal Processing (3)
Prerequisite: ECE 107 or permission of coordinator. Discrete-time signals; Fourier transforms; random discrete-time signals; filtered random signals; correlation functions; power-spectral-density estimation; cross-spectral estimates; detection of signals in noise; estimation of signals in noise; recursive estimation of time-varying signals.

EE 257. Optical Communications and Lasers (3)
Quantum measure of light, linear, elliptical, and circular polarization; optical waveguide equations, ray and mode theory; source and detector characteristics; attenuation, dispersion, and noise effects; correlation, spectral density, noise equivalent bandwidth, coding, modulation, multiplexing techniques; systems and link design.

EE 259. Radar System Design (3)
The nature and history of radar, the radar equation, PRF and range considerations, CW and FM radars. MTI and pulse-Doppler radars, tracking radars. Radar power generation, antenna types and design considerations, receivers, detection of signals in noise, extraction of information from radar signals, propagation of radar wave, the effects of clutter, weather and interference. Examples of radar system engineering and design.

EE 290. Independent Study (1-3; max total 6)
Prerequisite: graduate status in engineering. See *Academic Placement — Independent Study*. Approved for ***RP*** grading.

EE 291T. Topics in Electrical Engineering (1-3; max total 6)
Prerequisite: graduate status in engineering or permission of instructor. Selected electrical engineering subjects not in current courses.

EE 298. Project (3; max total 3)
Prerequisite: graduate status in engineering. See *Criteria for Thesis and Project.* Independent investigation of advanced character such as analysis and/or design of special engineering systems or projects; critical review of state-of-the-art special topics, as the culminating requirement of the master's degree. Abstract required. Approved for ***RP*** grading.

EE 299. Thesis (3-6; max total 6)
Prerequisite: see *Criteria for Thesis and Project.* Preparation, completion, and submission of an acceptable thesis for master's degree. Approved for ***RP*** grading.

Geomatics Engineering
James K. Crossfield, *Coordinator*
Engineering East Building, Room 178
559.278.4827

Program Description

Geomatics engineers manage the global spatial infrastructure. This effort includes real property boundary determination, digital mapping, Geographic Information Systems (GIS), Global Positioning Systems (GPS), remote sensing, photogrammetric mapping, applications programming, project management, and construction layout activities. Students use a wide selection of specialized equipment while acquiring a solid theoretical background. Integration of geomatics engineering design concepts spans a sequence of courses throughout the curriculum. Intensive design coursework during the senior year provides a culminating focus. Coursework containing design components includes the following: Computer-Aided Mapping (GME 66) first year; Route and Construction Surveying (GME 40) second year; Stereophotogrammetry (GME 123) and Digital Mapping (GME 126) third year; Subdivision Design (GME 159) and two upper-level technical design courses — Senior Project (GME 180) and Project Design (GME 181) — senior year.

Career Opportunities

The need for specialists in geomatics engineering continue to grow with rapid advancements in analytical photogrammetry, geographic information systems, and inertial and satellite positioning technologies. Most graduates of this program have been employed by federal and state government agencies, the petroleum industry, and private consulting firms.

Mission of Geomatics Engineering

The mission of the Geomatics Engineering Program is to provide an educational experience that enriches the lives of students. The program teaches necessary discipline related knowledge and skills to prepare students for their profession. Students learn how to protect the health and welfare of the public while expanding their base of knowledge through research and scholarship.

Educational Objectives of the Instructional Program

- Provide a broad based curriculum in geomatics engineering that generates graduates having competency in boundary surveying, geographic information systems (GIS), photogrammetry, digital mapping, and geodesy (GPS).
- Provide graduates with the knowledge and skills necessary to pursue professional careers in the geomatics engineering arena.
- Provide graduates with the educational rigor necessary to prepare them for graduate educational experiences in geomatics education or related fields if desired.
- Provide students with leadership opportunities associated with geomatics engineering related student clubs (SAGE, ACSM, CLSA, ASPRS, etc.), the Annual Geomatics Engineering Conference, *The*