Electrical and Computer Engineering

In the College of Engineering

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The Radio Frequency Communication Systems Industry Chair

The Radio Frequency (RF) Communication Systems Industry Chair was established in recognition of the pervasiveness and vital role of radio frequency and wireless communications in modern society, and the emergence of San Diego as the world's leading center of research and development in the field of telecommunications and wireless engineering. The chair is sustained through generous contributions of Cubic Corporation and other corporations engaged in wireless communication technology, in appreciation of contributions of students trained in the field at SDSU. The RF Communication Systems Industry Chair is intended to promote excellence in education of RF and microwave engineers, and encourage significant professional activities in the field. Dr. Madhu S. Gupta, the first occupant of the chair, maintains a major involvement in professional work in the discipline and has received international recognition from his professional peers as a distinguished educator and scholar in the field of RF and microwave engineering.

Courses Acceptable for Master's Degree Program in Electrical and Computer Engineering (E E) (COMPE)

Refer to Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

Electrical Engineering (E E)

UPPER DIVISION COURSES

NOTE: Prerequisites will be enforced in all 500-level courses. A copy of an official transcript will be accepted as proof. For corequisites, an enrollment confirmation form will be accepted.

All courses at the 300 level or below must be passed with a grade of C– or better in order to be used as a prerequisite for any subsequent course with the exception of Electrical Engineering 210, Computer Engineering 160, Mathematics 150, 151, Physics 195, 196, which requires a grade of C or better.

E E 502. Electronic Devices for Rehabilitation (3)
Two lectures and three hours of laboratory.
Prerequisite: Electrical Engineering 330 with a grade of C- (1.7) or better.
Recent developments in electronic assistive devices and microcomputers for persons with various disabilities; assessment of disabled persons for suitable technological assistive devices.

E E 503. Biomedical Instrumentation (3)
Prerequisites: Aerospace Engineering 280 with a grade of C- (1.7) or better; Electrical Engineering 410 and 430 (or for Mechanical Engineering majors, Electrical Engineering 204 and Mechanical Engineering 330).
Instrumentation systems to monitor, image, control, and record physiological functions.

E E 522. Digital Control Systems (3)
Prerequisite: Electrical Engineering 420.
Digital controls systems; design algorithms including analoginvariance methods, direct digital techniques, and non-parametric approaches such as fuzzy control, neural networks, and evolutionary systems; implementation considerations.

E E 530. Analog Integrated Circuit Design (3)
Prerequisite: Electrical Engineering 430 with minimum grade of C-.
Advanced treatment of transistor pairs, device mismatches, differential amplifiers, current mirrors, active loads, level shifting, and output stages. Parasitic and distributed device parameters. Economics of IC fabrication and impact on design.

E E 540. Microwave Devices and Systems (3)
Prerequisite: Electrical Engineering 440. Recommended: Aerospace Engineering 515.
Applications of Maxwell's equations to wave propagation. Microwave network parameters; guided wave transmission and reflection. Design of filters, couplers, power dividers and amplifiers. Applications in radar and telecommunications systems.

E E 540L. Microwave Design and Measurements Laboratory (1)
Three hours of laboratory.
Prerequisites: Credit or concurrent registration in Electrical Engineering 430L and 540.
Microwave measurement equipment, simulation tools for designing microwave components, vector network analyzer calibration, design and measurement of planar microwave components, and a design project.

E E 558. Digital Communications (3)
Prerequisite: Electrical Engineering 458.
Design of baseband digital communication systems; noise characterization, sampling, quantization, matched filter receivers, bit-error performance, inter-symbol interference, link budget analysis.

E E 581. Power System Dynamics (3)
Prerequisite: Electrical Engineering 480.
Three-phase faults, symmetrical components, unsymmetrical faults, protective relay operating principles, economic dispatch of thermal power generation units, power system controls, voltage and power stability.

E E 584. Power Electronics (3)
Prerequisites: Electrical Engineering 380 and 430 with a grade of C- (1.7) or better in each course.
Design and analysis of power electronic devices. Permanent-magnet and pulse-width modulation ac-to-ac converters, dc-to-ac inverters, power electronics applications, power semiconductor switches, and switch-mode power supplies. (Formerly numbered Electrical Engineering 484.)

E E 584L. Power Electronics Laboratory (3)
Prerequisite: Credit or concurrent registration in Electrical Engineering 584.
Experimental design of dc-dc converters (boost, buck, buck-boost), flyback and forward converters, voltage and current mode control design and implementation. Basic photovoltaics and maximum-power-point-tracking (MPPT) design and battery charge control using switched-mode dc-dc converters.

E E 596. Advanced Electrical Engineering Topics (1-3)
Prerequisite: Consent of instructor.
Modern developments in electrical engineering. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit of nine units for any combination of Electrical Engineering 496 and 596 applicable to a bachelor's degree. Maximum combined credit of six units of Electrical Engineering 596 and 696 applicable to a 30-unit master's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

Computer Engineering (COMPE)
UPPER DIVISION COURSES

NOTE: Prerequisites will be enforced in all 500-level courses. A copy of an official transcript will be accepted as proof. For corequisites, an enrollment confirmation form will be accepted.

All courses at the 300 level or below must be passed with a grade of C– or better in order to be used as a prerequisite for any subsequent course with the exception of Computer Engineering 160, Electrical Engineering 210, Mathematics 150, 151, Physics 195, 196, which requires a grade of C or better.

COMPE 560. Computer and Data Networks (3)
Prerequisites: Computer Engineering 271 and Electrical Engineering 410 with a grade of C- (1.7) or better in each course.
Wide area and local area networks, multi-layered protocols, telephone systems, modems, and network applications.

COMPE 561. Windows Database and Web Programming (3)
Prerequisite: Computer Engineering 361 with a grade of C- (1.7) or better.
Programming applications involving file systems, relational databases, Structured Query Language (SQL), ADO.NET, client-server architecture, multithreading sockets, web servers, web browsers, web services, ASP.NET, Hypertext Markup Language (HTML), and Extensible Markup Language (XML).

COMPE 565. Multimedia Communication Systems (3)
Prerequisite: Credit or concurrent registration in Computer Engineering 560.
Design and implementation of multimedia communication systems. Image compression, JPEG, VQ, cell-B standards. Video and audio compression standards, MPEG, MPEG-2, H.26X, G.72X. Data storage systems and multimedia requirements. Networking requirements and networks as multimedia carriers. Transport and network protocols for carrying multimedia over data networks. Multimedia system design, scheduling, congestion control, traffic shaping, buffer management.

COMPE 570. VLSI System Design (3)
Prerequisite: Computer Engineering 470.
VLSI systems at the architectural level for digital signal processing applications: feedforward and feedback systems, fixed-point and floating-point representations, folding, iteration bound, parallel architectures, pipelining, retiming, unfolding, wave and asynchronous pipelining. (Formerly numbered Electrical Engineering 672.)

COMPE 571. Embedded Operating Systems (3)
Prerequisites: Computer Engineering 260 with a grade of C- (1.7) or better. Computer Engineering 475.
Real-time kernel, basic kernel services, threading and synchronization, preemptive multithreading, mutexes, spin locks, critical sections, priority scheduling, interrupts, RTOS implementation, memory management, task management, intertask communications.

COMPE 572. VLSI Circuit Design (3)
Prerequisites: Computer Engineering 271 with a grade of C- (1.7) or better. Electrical Engineering 330.
Design of digital integrated circuits based on CMOS technology; characterization of field effect transistors, transistor level design and simulation of logic gates and subsystems; chip layout, design rules, introduction to processing; ALU architecture.

COMPE 596. Advanced Computer Engineering Topics (1-3)
Prerequisite: Consent of instructor.
Modern developments in computer engineering. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit of nine units for any combination of Computer Engineering 496 and 596 applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

Electrical Engineering (E E)
GRADUATE COURSES

NOTE: All listed prerequisite courses or their equivalent for computer engineering and electrical engineering courses must be satisfied with a grade of C– or better.

E E 600. Seminar (1-3)
Prerequisite: Consent of instructor.
An intensive study in advance electrical engineering. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit six units applicable to a master's degree.

E E 601. Linear System Theory and Design (3)
Prerequisite: Electrical Engineering 420.
State models and solutions of the state equations, stability, controllability and observability, realizability and minimal realizations, linear state and output feedback control, introduction to linear optimal control.

E E 602. Stochastic Signals and Systems (3)
Prerequisite: Electrical Engineering 410.
Random signals, correlation functions, power spectral densities, the Gaussian process, narrow band processes. Applications to communication systems.

E E 634. RF Circuit Design (3)
Prerequisite: Electrical Engineering 540.
RF component and circuit design in frequency domain and scattering parameter terms. Linear amplifiers, stability considerations, unilateralization, matching techniques, low-noise amplifiers, wideband designs, power amplifiers, linearity considerations, oscillators, and mixers.

E E 641. RF Wireless Systems (3)
Prerequisites: Electrical Engineering 440, 558, 602.
Characteristics and performance measures of RF subsystem in wireless communication systems: wireless channel, antenna, modulators and demodulators, low-noise and power amplifiers, oscillators, ADC and DAC; receiver architectures, system-level design of RF front-end.

E E 645. Antennas and Propagation (3)
Prerequisite: Electrical Engineering 440.
Antenna radiation mechanism, antenna types, fundamental antenna parameters, microstrip patch antennas, theory and design of various array and wire antennas, antenna measurement techniques and radio wave propagation in different propagation environments to include mobile communications, multiple input multiple output (MIMO) communications, and satellite communications.

E E 650. Modern Communication Theory (3)
Prerequisites: Electrical Engineering 558 and 602.
Wireless digital communication; bandpass modulation and demodulation, multiple access techniques, broadband signaling techniques, spread spectrum techniques; applications include CDMA and OFDM.

E E 652. Principles and Applications of Information Theory (3)
Prerequisites: Electrical Engineering 558 and 602.
Information measure of data sources; Shannon's theorem and capacity of communication links; rate-distortion theory and performance of source codes.

E E 653. Coding Theory (3)
Prerequisite: Electrical Engineering 558.
Error control for digital information; arithmetic of Galois fields; block, cyclic, convolutional and turbo encoding and decoding; applications in digital communication and computer systems.

E E 654. Adaptive Filter Design (3)
Prerequisites: Electrical Engineering 450 and 602.
Constrained and unconstrained Wiener filters. Performance surfaces and gradient-based search methods. LMS and RLS algorithms. Lattice filters. Applications of adaptive filters in beamforming, channel equalization, echo cancellation, and system modeling.

E E 655. Modem Design (3)
Prerequisites: Electrical Engineering 450 and 558.
System level and DSP design of modems for wireless and wireline communications. Study modems for QAM, OFDM, CDMA, and T-1 modulation.

E E 656. Multirate Signal Processing (3)
Prerequisite: Electrical Engineering 450.
DSP techniques for sample rate changes in digital filters. Decimation and interpolation, aliasing as a processing option in resampling filters. Applications in communication and entertainment media systems.

E E 657. Digital Image Processing (3)
Prerequisite: Electrical Engineering 450.
Theory of two-dimensional signals and systems, image transforms, image enhancement, restoration and compression, image analysis and computer vision.

E E 658. Advanced Digital Signal Processing (3)
Prerequisites: Electrical Engineering 450 and 602.
Advanced topics in FIR and IIR filter design. Quantization effects in digital filters. Sigma-delta modulation. Signal modeling. Parametric and non-parametric spectral estimation. Frequency estimation.

E E 660. High Speed Networks: Design Principles and Recent Advances (3)
Prerequisite: Computer Engineering 560.
Provides students with knowledge of recent developments in area of computer networks. Current research in high speed computer networks.

E E 662. Wireless Sensor Networks (3)
Prerequisite: Computer Engineering 560.
Sensor platforms, wireless channel characteristics, time synchronization, medium access control, topology control, routing protocols, localization, coverage and placement, detection and tracking, query processing.

E E 665. Multimedia Wireless Networks (3)
Prerequisite: Computer Engineering 560.
Cross-layer protocol design, multimedia QoS-aware 4G, 5G, CRN, WLAN networks; multimedia source and bitstream characteristics, quality of service, and roles of processing capacity and power consumption.

E E 670. Digital ASIC Design (3)
Prerequisite: Computer Engineering 572.
High-performance and low-power digital application-specific integrated circuit (ASIC) chips.

E E 674. Signal and Power Integrity (3)
Prerequisites: Electrical Engineering 440 and Computer Engineering 572.
Interconnect and power distribution network design in very-large-scale integration systems packaging. High-speed transmission lines and crosstalk, macromodeling of interconnects. Switching noise, decoupling, numerical methodologies in power integrity design.

E E 684. Advanced Power Electronics (3)
Prerequisites: Electrical Engineering 584 and 601.
Advanced modeling strategies for bidirectional converters, DC/DC converters, design and integration of power electronics interfaces into smart girds, multi-level inverters, Pulse-Width-Modulation (PWM) switching techniques, resonant/quasi-resonant converters, SiC and GaN switches, single/three phase inverters, and soft switching.

E E 685. Micro-Electro-Mechanical Systems (MEMS) Design and Applications (3)
(Same course as Mechanical Engineering 685)
Prerequisite: Mechanical Engineering 585.
Design and manufacturing technology for micro- and nano-scale devices. Topics include solid state transducers, microscale physics, biomedical microelectronics, microfluidics, biosensors, and hybrid integration of microfabrication technology. Emphasis on biomedical applications.

E E 696. Advanced Topics in Electrical Engineering (1-3)
Intensive study in specific areas of electrical engineering. May be repeated with new content. See *Class Schedule* for specific content. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

E E 740. Advanced Topics in Physical Electronics (1-3)
Prerequisites: Graduate level coursework in the area and consent of instructor.
Selected topics in electromagnetic fields and waves, optoelectronics, and semiconductor devices. May be repeated with new content and consent of graduate adviser. See *Class Schedule* for specific content. Maximum credit six units applicable to a master's degree.

E E 795. Internship/Practicum (1) Cr/NC
Prerequisites: Eighteen units of graduate level coursework in electrical engineering and consent of adviser.
Supervised internship or practicum experience with approval of graduate adviser. Not applicable to an advanced degree. Maximum credit three units.

E E 797. Research (1-6) Cr/NC/RP
Prerequisites: Consent of department chair. Open only to students in Plan A Thesis.
Research in engineering. Maximum credit six units applicable to a master's degree for students in Plan A only.

E E 798. Special Study (1-3) Cr/NC/RP
Prerequisite: Consent of department chair.
Individual study. Maximum credit three units applicable to a master's degree for students in Plan B study.

E E 799A. Thesis or Project (3) Cr/NC/RP
Prerequisites: An officially appointed thesis committee and advancement to candidacy.
Preparation of a project or thesis for the master's degree.

E E 799B. Thesis or Project Extension (0) Cr/NC
Prerequisite: Prior registration in Thesis or Project 799A with an assigned grade symbol of RP.
Registration required in any semester or term following assignment of RP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis or project is granted final approval.

E E 799C. Comprehensive Examination Extension (0) Cr/NC
Prerequisite: Completion or concurrent enrollment in degree program courses.
Registration required for all students taking the comprehensive examination for the master's degree. Registration in 799C limited to two semesters.