SJSU Electrical Engineering Department

MSEE Program

Fall 2017

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The MSEE Program

San Jose State University is situated in the heart of the world-renowned Silicon Valley and supplies more engineers to Silicon Valley companies like Lockheed Martin and Space Systems, Hewlett Packard, IBM, Intel, National Semiconductor, Advanced Micro Devices, etc., than any other university in the country. The graduate program in Electrical Engineering is the fourth largest graduate program in the University with about 600 graduate students and 16 full time faculty members.

Approximately 300 students receive their MSEE degrees every year. The program is known for its high academic standards and its partnership with the local electronics industry. Many of our graduate students are working engineers in the valley. All graduate courses and many undergraduate courses are taught in the late afternoon or in the evening to accommodate working professionals. Our Full time professors are among the best in academics. Our part time instructors are also very prominent researchers and practicing engineers in private industry. They bring valuable practical experience to classrooms and relate course subjects to industry applications and practices. They are an integral part of our outstanding faculty.

The curriculum is continually updated to keep abreast of advances in the engineering profession and industry. Along with the traditional emphasis on fundamental scientific knowledge, the current engineering practice using computer design tools is integrated into the curriculum. The rapid pace with which high technology industry has developed in recent years has meant changes and modifications to our program almost on a yearly basis. We offer over 30 different graduate courses every year.

Applying for the MSEE Program

Anyone with a BS degree in Electrical Engineering or a related field who wishes to study for an MS degree in Electrical Engineering at San Jose State University may apply for admission. A graduate student currently enrolled in another department related to Electrical Engineering may not need to reapply for admission to the MSEE program. See section on "Applicants from other Graduate Program within the University." However, a student who was previously admitted to the Master's degree program at San Jose State University but was not enrolled in any course at San Jose State University for one or more semesters (not counting summer), must file a withdrawal form during the semester of absence and file an application for admissions and be readmitted to the program.

Application Procedure

To apply for the admissions application use this link https://www2.calstate.edu/apply. Deadlines for application for admission for the fall and spring semesters are announced every year. There are special instructions and requirements for foreign students, students with GPA less than 3.0, and students with degree other than BSEE. These requirements are described in the following sections. For more detailed information and to apply for admission via the Internet, use the link www.sjsu.edu/gradstudies/.

Classified Admitted Students

A student with a Bachelor of Science degree in electrical engineering from an ABET accredited university, who's GPA (Grade Point Average) in the last 60 units is higher than 3.0 may be admitted as a Classified Graduate Student. This status allows the student full participation in the program. A student with a Bachelor of Science degree in electrical engineering from a foreign university may be admitted as classified based on a high GPA and GRE scores.

Conditionally Classified Admitted Students

Applicants who do not qualify for classified standing, but fall into the categories discussed below, may be admitted as Conditionally Classified Graduate Students. They must petition for Classified Status after completing 2 core courses from 3 core graduate courses EE 210, EE 221, or EE 250 with **"B" or better grade** in both courses. A maximum of 15 units earned before the student attains the Classified Status may be counted towards the MSEE degree requirements.

Applicants with Undergraduate Degrees from Foreign Universities

To be considered for admission to the MSEE program, a foreign graduate applicant must have **all** of the following:

- A minimum score of 550 (or 213 if computer based, or 80 if Internet-based) in the TOEFL (Test of English as a Foreign Language) or 6.5 in the IELTS (International English Language Testing System).
- General GRE score. There are no hard cut-offs on the GRE scores but the scores will be used with applicants' degree and GPA to rank the candidates for admission.
- A baccalaureate degree in Electrical Engineering with a minimum computed GPA (Grade Point Average) of 3.0 on a 0 to 4.0 scale in the last 60 semester units. The university from which the transcripts were submitted computes the GPA.

Applicants satisfying these requirements may be admitted as Conditionally Classified Graduate Students with the condition that they must complete 2 core courses from 3 core graduate courses EE 210, EE 221, or EE 250 with **"B" or better grade** in both courses. However, a student with a high GPA and GRE score may be admitted as Classified.

Applicants from Other Graduate Programs within the University

A graduate student who has been admitted to another department in San Jose State University has to complete at least one semester of work in that department before asking for transfer to the Electrical Engineering Department. Transfer applications are considered using the same admission criterion, such as GPA and GRE, as for new applicants (See above). A "Change of Major Form" at http://www.sjsu.edu/gape/forms/ has to be first completed and submitted (instructions shown on the form) to GAPE. The files will be transferred to the Electrical Engineering Department for evaluation and decision. Submission of the "Change of Major Form" by itself does not indicate approval. Approval is dependent on the graduate advisor, who will subsequently inform GAPE of the decision. This process can take several weeks to complete.

Credit for Courses Completed as an Undergraduate Student

An undergraduate student in **senior** standing in Electrical Engineering may request award of **Graduate Credit** for courses taken as an undergraduate if **all** of the following apply:

- Fewer than 14 units are still needed to complete the BSEE degree at San Jose State University.
- None of the courses to be taken for graduate credit is required for the BSEE degree.
- The student has a GPA of at least 2.5 on all work completed in upper-division standing at San Jose State University.
- The student does not enroll in more than 15 units for the term in which this work is taken.
- The student has completed the graduation check (Registrar's Office).
- The student agrees not to take letter-graded courses as CR/NC.
- The student agrees that not more than 6 units of graduate credit earned by this process be applied towards the Master's degree program.
- The student submits a "Request for Award of Graduate Credit for Units Completed as an Undergraduate" form and the University Graduate Studies Office approves it before the student completes the baccalaureate degree.
- The Electrical Engineering department must approve the courses in order to be counted towards the MSEE degree.

Requirements for the MSEE Degree

To meet the requirements for the Master of Science Degree in Electrical Engineering, a student must complete 30 semester units with a major cumulative GPA and overall GPA of 3.0 or better. The program provides the following two options: 1). Project/Thesis Option or 2). Course-Only Option followed by a comprehensive exam.

Project/Thesis Option	**Semester Units**
Core: EE210, EE221 or EE250	6
Area of Specialization	9
Approved Electives	9
EE297 (MS Project) or EE299 (Thesis)	6
Total Units Required	30

Course-Only Option	**Semester Units**
Core: EE210, EE221 or EE250	6
Area of Specialization	9
Approved Electives	15
Comprehensive Exam	0
Total Units Required	30

Electives must have prior approval from the Area/Concentration Advisor and the Graduate Advisor, and must form a coherent plan of study as evidenced in the signed Plan of Study. Normally, they should be graduate courses in Electrical Engineering or related fields. **In exceptional cases, up to 3 units of undergraduate upper division elective courses taken in the EE Department may be approved as electives**. A maximum of 6 units (including those taken as an Open University student) taken outside the Electrical Engineering Graduate Program at SJSU (or transferred from another university) may count towards the MSEE degree.

EE 297 (MSEE Project) or EE 299 (Master's Thesis) or the Comprehensive Exam is the culminating experience of the MSEE program. Project or Thesis may be taken after completing 12 units and the Comprehensive Exam may be taken after completing at least 18 units. Before a student is eligible to enroll in EE 297 or EE 299, he or she must be classified, have satisfied the CSU competency in written English requirement, and have overall GPA and major GPA of 3.0 or above. To register for EE297 or EE299, student must complete the appropriate form and submit to the EE department for approval.

Competency in Written English for Graduate Students

In May 1986, the Board of Trustees adopted a resolution endorsing "the principle that all students entering CSU after implementation of the proficiency/diagnostic examination be required to demonstrate their competency with regard to writing skills as a requirement for graduation." Therefore, the establishment of English competency shall be a requirement of Classified Graduate students as a condition necessary for advancement to the candidacy for the award of the Master's Degree.

Writing Skills Competency shall be established by one of the following: Satisfactory completion of EE 295; **Or-** Satisfactory completion of the CSU baccalaureate graduation requirement of competency in written English; **Or-** Satisfactory completion of an upper-division technical writing course at another university judged by the SJSU Office of Graduate Studies and Research to be equivalent to Engr 100W.

In addition to the above requirements, each student must satisfy all University requirements and procedures as stated in the San Jose State University Catalog.

Areas of Specialization

The Department offers an opportunity to specialize in one of the areas of specialization; Digital / Logic / Embedded System Design, ASIC/VLSI Circuits, Analog/Mixed-Signal Integrated Circuits, Communications/ Digital Signal Processing, Networking and Control and Power Electronics. A student can specialize in an area by taking at least 3 courses in that area. The electives can be taken from the area of specialization or from other areas. A student must consult his/her area/concentration advisor to design his/her program of study during the first semester in the department.

Graduate Courses in Electrical Engineering

General and Core Courses

EE210 Linear System Theory. Continuous and discrete convolution and correlation. Review of transform theory. Two-side transforms including continuous and discrete Fourier transforms. Continuous and discrete state variable theory. Applications and computer simulations. Prerequisite: Graduate Standing. 3 units.

EE221 Semiconductor Devices I. Study of semiconductors in equilibrium and non-equilibrium conditions; principles of semiconductor device fabrication, p-n junctions; and junction transistors; device modeling for circuit analysis. Prerequisites: Graduate Standing. 3 units.

EE250 Probability, Random Variables and Stochastic Processes. Random variables, random processes, power spectral density, optimum linear systems, queuing theory. Prerequisites: Graduate Standing. 3 units.

EE295 Technical Writing- Engineering Ethics: Students learn to analyze and write about issues in engineering ethics. Three types of ethics are explored: ethics of the person, the process, and the product. Prerequisites: Graduate Standing. 3 units.

EE297A MSEE Project Proposal: Written project proposal development for research/design project, subsequently culminating the MSEE work in EE297B. An approved application for EE297A registration including project title and abstract, graduate seminar participation, oral proposal presentation and defense required. Prerequisite: Classified, overall GPA of 3.3 or above, EE295 (may be taken concurrently) (or competency in written English certification). CR/NC grading. 3 units.

EE297B MSEE Project: Implementation of the research/design project, culminating the MSEE work proposed in EE 297A. Formal Master's project report and its formal defense required. Prerequisite: EE297A or EE299A, EE295 with grade C or above (or competency in written English certification). Letter grading. 3 units.

EE298i Electrical Engineering Internship Experience. For this course a student is employed in industry as an electrical engineering intern or in an equivalent position. Prerequisite: Classified and good standing. Repeatable for credit. CR/NC grading.

EE298 Special Problems. Advanced individual work in Electrical Engineering. Prerequisite: Classified and good standing. CR/NC grading. 1 to 3 units.

EE299A MSEE Thesis Proposal. Written Thesis proposal development for research/design, subsequently culminating the MSEE work in EE299B. An approved application for EE299A registration, including project title and abstract, graduate seminar participation, oral proposal presentation and defense required. Prerequisite: Classified, overall GPA of 3.3 or above, EE295 (may be taken concurrently) (or competency in written English certification). CR/NC grading. 3 units.

EE299B MSEE Thesis: Implementation of the research/design, culminating the MSEE work proposed in EE 297A. Formal Master's Thesis report and its formal defense required. Prerequisite: EE299A or EE297A, EE295 with grade C or above (or competency in written English certification). CR/NC grading. 3 units.

Communications and Digital Signal Processing Courses

EE211 Network Analysis and Synthesis. Basic methods for synthesizing passive one-port and two-port networks. Review of analysis methods and mathematical tools; LC, RC input impedance synthesis; two-port synthesis; properties of second-order systems; sensitivities; operational-amplifier considerations. Prerequisites: EE210 (may be taken concurrently). 3 units.

EE212 Active Network Synthesis. Active network synthesis. Advanced and specialized techniques of analysis, synthesis and approximation; consideration of recent developments in the field. Prerequisite: EE211. 3 units.

EE251 Digital Data Transmission I. Review of random processes. Gaussian noise. Sampling, quantization and pulse transmission. Band limited channels and equalization. Signal space analysis. Digital modulation techniques. Tradeoffs between power and transmission rate. Prerequisites: EE250 (may be taken concurrently). 3 units.

EE252 Digital Data Transmission II. Digital modulation techniques for power and bandwidth limited communication systems. Offset QPSK, GMSK, non-coherent modulation and detection. Multipath fading channels, diversity and combining methods. Prerequisite: EE250 (may be taken concurrently). 3 units.

EE253 Digital Signal Processing I. Time/frequency analysis of discrete-time signals and systems. Fast implementations of the DFT and its relatives. IIR and FIR digital filter design, implementation and quantization error analysis. Decimation, interpolation and multirate processing. Prerequisites: EE210 (may be taken concurrently). 3 units.

EE254 Digital Signal Processing II. Optimal filtering of discrete-time noisy signals. LMS and RLS adaptive processing. Interference canceling. Linear prediction. Adaptive FIR and lattice implementation. Classical, model based, and eigen analysis spectral estimation. Dynamic power spectra and wavelets. Prerequisites: EE210 and EE250 (may be taken concurrently). 3 units.

EE255 Mobile/Wireless Communications: Cellular mobile radio systems, propagation models, multipath propagation effects, diversity and combining noise, and interference are discussed. Analog and digital modulation techniques and their performance measures, multiple access techniques such as FDMA, TDMA and CDMA are discussed. Prerequisites: EE210 and EE250 (may be taken concurrently). 3 units.

EE256 Programmable DSP Architecture and Applications. Implementations of DSP algorithms using programmable DSP architectures. Internal architectural requirements for a DSP device, system level hardware/software design and applications of programmable DSP architectures. Prerequisites: EE210. 3 units.

EE257. Digital Communications Processing. Application of signal processing techniques to analysis and simulation of basic digital communication functions. Optimal filtering, digital modulation, optimal receivers in the presence of noise, carrier and symbol synchronization, ISI and channel equalization, adaptive implementation, digital beamforming. Prerequisite: EE210 and EE250 (may be taken concurrently). 3 units.

EE258 Neural Networks. Principles of neural networks. Basic neurophysiology, neural nets as finite-state machines, synaptic learning, perceptrons, the LMS and back propagation algorithms, capacity theorems, feedforward nets as statistical classifiers, stability of feedback nets, self-organizing feature maps, adaptive resonance theory, retinal and cochlear models. Prerequisite: EE210. 3 units.

EE259 Selected Topics in Signal Processing. Advanced topics in signal processing. Content varies from semester to semester. Prerequisite: Consent of Instructor. 3 units.

EE265 Hands-on Wireless Communications using Software Defined Radios. This course is an experimental approach to wireless communications. The topics will include analog/digital transmission, ADC/DAC, and wireless channel modeling. Students will be exposed to MATLAB, software defined radios (USRP boards), GNU Radio, GRC (GNU Radio Companion) as part of homework assignments and projects. GNU Radio (http://gnuradio.org) software development platform is based on Python and C++ languages. At the end of the class, students will be able describe design challenges associated with building a wireless digital communication system. Prerequisite: EE210 (may be taken concurrently). 3 units.

ASIC/VLSIDesign/Analog/Mixed-Signal ICs

EE220 Radio Frequency Integrated Circuit Design I (RFIC Design I) Study of transmitter and receiver architectures and their building blocks for modern wireless communication standards, high frequency modeling of passive and active circuit components realized in CMOS and BiCMOS technologies, networks theory, wideband matching, nonlinearity and noise link budgets. Prerequisite: Graduate standing or instructor consent. 3 units.

EE222 Semiconductor Devices II. Continuation of EE 221. MOS devices; short channel effects; Device Scaling; NMOS, CMOS and BiCMOS technologies; device modeling and simulation, memory cell design. Optoelectronic and microwave devices. Prerequisite: EE221. 3 units.

EE223 Analog Integrated Circuits. Introduction to analog integrated circuits. Bipolar and MOS transistor models. Analysis and design of monolithic operational amplifiers. Frequency response. Feedback amplifier theory and design. Applications to specific case studies, such as phase-locked oscillators and wide-band amplifiers. Switched-capacitor filters. Prerequisite: Graduate standing or instructor consent. 3 units.

EE224 High Speed CMOS Circuits. Analysis and design of digital integrated circuits; bipolar and MOS inverters and logic gates; semiconductor memories; gate arrays; standard cells; programmable logic array; computer-aided design; SPICE program will be used extensively. Prerequisites: Graduate standing or instructor consent. 3 units

EE224B Advanced High Speed CMOS Circuits. EE224B covers advanced high speed CMOS design circuit design and challenges. The course will focus on design of advanced circuits such as arithmetic circuits, memory. Overall concepts will be tied together by a design project. Team work will be stressed. Prerequisite: Graduate standing or instructor consent. 3 units.

EE225A Analog IC Transistor Process Design. Advanced process design, fabrication and testing of transistors for analog integrated circuits, design of statistical process control procedures for yield management, industry standard TCAD tools (Synopsys) and IC fabrication equipment will be used extensively in lab. Prerequisites: EE221. 3 units.

EE226 VLSI Technologies. CMOS/BiCMOS technologies for VLSI circuits; theoretical and practical aspects of individual fabrication steps; necessity of particular steps in order to achieve required device/circuit parameters; trade-offs in optimizing device performance; CMOS memory design projects. Prerequisite: EE221. 3 units.

EE227 Signal Integrity in AMS IC. This course studies essential blocks for wire-line communication integrated circuits such as analog equalizer circuits, Decision-Feedback Equalization (DFE), Phase Looked Loop (PLL) and Clock and Data Recovery (CDR) circuits. True understanding of system level modeling and behavioral of the PLL will be discussed. Matlab/Simulink Modeling techniques will be introduced as new vehicle for system level design and simulation. Performance metrics, such as random jitter, BER, jitter transfer, jitter tolerance, phase noise, will be introduced. Integrated circuit design consideration for the key essential blocks for PLL and equalizer block will be covered. Prerequisite: EE221 (may be taken concurrently). 3 units.

EE228 Design Projects in VLSI Systems. Students must complete modest sized MOS projects through layouts, simulation and design rule checking. Topics include: design tools, logic simulation, placement, routing, floor planning, cell library, test pattern generation, and design for testability. Prerequisite: EE226 or EE227. 3 units

EE229 Advanced Topics in Microelectronics. Current topics in electronic devices, technology and design; applications to state of the art topics in the microelectronics area. Prerequisite: EE221 or consent of instructor. Repeatable for credit. 3 units.

EE230 Radio Frequency Integrated Circuit Design II. Low noise amplifiers, mixers, power amplifiers, LC voltage controlled oscillators, phase shifters, patch antennas and advanced layout to improve noise, stability, efficiency and bandwidth performance of nanoscale CMOS integrated circuits. Prerequisite: EE 220 or instructor consent. 3 units.

EE240 Introduction to Nanoelectronics. This course introduces basic concept of nanoelectronics. The course covers related concepts in solid state physics, quantum mechanics, and general nanoelectronic device fabrication and characterization. Prerequisites: EE 221 or Instructor consent. 3 units.

EE241 Fundamental of Signal Integrity. EE241 aims to introduce the essential knowledge on signal integrity. The course covers transmission line theory, channel loss, coupling, signal lunch and termination, timing issues on clock distribution and EDA tools usage for modeling and analysis of signal integrity in a system. Prerequisite: Graduate Standing. 3 units.

EE249 Integrated Circuits for Biomedical Application. EE249 aims to introduce the essential knowledge and techniques for designing integrated circuits for biomedical applications. An introduction to the deep-submicron effects and noise in transistors, the principles for designing low-power, low-noise electronics and RF/inductive coupling links will be discussed. Prerequisite: EE221 (may be taken concurrently). 3 units.

EE287 ASIC CMOS Design. CMOS ASIC design principles. Topics include ASIC architectures, cell libraries, synthesis issues, latches, clocking multiple clock synchronizers, delay calculation, timing closure, I/O specification, and testing. Prerequisites: EE271 (may be taken concurrently) or instructor. 3 units.

EE288 Data Conversion for Analog and Mixed Signal ICs. Study of different architectures for analog to digital convertors and digital to analog convertors. System level modeling & simulation. Design considerations and techniques for circuit implementation. Data conversion testing methods. Prerequisites: EE221. 3 units.

Logic/Digital/Embedded Systems Courses

EE 242 Embedded Hardware Design. See CMPE 242. 3 units

EE270 Advanced Logic Design. Logic design theory, advanced logic minimization, design and analysis of sequential circuits, asynchronous circuit design, logic circuit testing and design for testability. Review Verilog/VHDL. CAD tools are used for design, modeling and simulation. Prerequisite: Graduate Standing. 3 units.

EE271 Digital System Design and Synthesis. In depth study of concepts and practices in modern digital system design, such as high- speed arithmetic, cache memory design, advanced pipelining and processor design. Verilog or VHDL is used for simulation and synthesis. Prerequisites: Graduate standing. Experiences in digital/logic design. 3 units.

EE272 SoC Design and Verification with SystemVerilog. The course covers topics in System-on-Chip design and verification with SystemVerilog. Major topics include top-down SoC design; design metrics, techniques, and system-level synthesis; IP integration and system-level verification; SystemVerilog design hierarchy, data types, assertions, interfaces, verification constructs, and testbench structures. Prerequisite: EE271 or EE287. 3 units.

EE274 VLSI Design for Testability. Test generation methods for analog, digital logic, memories and microprocessors. Design to enhance testability of analog, digital, and mixed-signal circuits including data converters and frequency synthesizers. Built-in-self-test and built-in-self-repair. SOC testing. Prerequisites: EE270 or EE271 or EE287. 3 units.

EE275 Advanced Computer Architectures. Performance metrics, instruction set architectures, instruction pipelining and pipeline hazards, instruction-level parallelism, multithreading, cache and virtual memory, I/O performance and advanced topics in storage systems, topologies and hardware/software issues of interconnection networks. Prerequisite: Graduate standing & knowledge of HDL. 3 units.

EE276 Parallel Computer Systems. Advanced concepts in parallel computer architectures and algorithms. Cache memory for multiprocessor systems, multistage networks, pipelined vector processors, massive parallel processors, systolic arrays and array processors, parallel processing algorithms and time complexity analyses. Prerequisite: EE275 or instructor consent. 3 units.

EE277A Embedded System Design Challenge and Metrics. Processor and compiler technologies. Software and hardware architectures for embedded system design. Design flow and tools. The design of co-processors, parallel processors, and MpSOC processors. Basic concepts of high performance computing (HPC). **Prerequisite**: EE 210 or instructor's consent. 3 units

EE278 Digital Design for DSP/ Communications. Digital Circuit Design for DSP and Communication Circuits; Applications include FIR Filters, FFT, Modulation, Error Detection/Correction Circuits, CDMA and Video Imaging; CAD/FPGA/MATLAB, and HDL are used throughout the course for modeling, simulation, and synthesis. Prerequisite: EE270 or EE271. 3 units.

EE279 Special Topics in Digital Systems. Advanced topics in digital systems. Content varies from semester to semester. Prerequisite: Instructor consent. Repeatable for credit. 3 units.

Networking Courses

EE209 Network Security. Network security protocols and applications, cryptography algorithms, authentication systems, intrusion detection, network attacks and defenses, system-level security issues, and how to build secure systems. Prerequisite: CMPE 206 or EE 281. 3 units.

EE281 Internetworking. Network layers, packet networks, ATM, SONET, TCP/IP protocols, high-performance switches and routers, queuing theory, error detection coding, quality of service, multicast, IPv6. Prerequisites: EE250 (may be taken concurrently). 3 units.

EE282 Internet Security and Cryptography. Internet security principles, protocols and crypto hardware designs, private and public key cryptosystems, DES, RSA, and AES, GPF(p) and encryption engines, hash functions and digital signatures, authentication, key management and security assessments. Prerequisites: EE281 (may be taken concurrently). 3 units.

EE283 Broadband Communication Networking. Packet Delay Modeling, Network of Queues, Quality of Service in Broadband Networks and Bandwidth Allocations, Architecture of High-Speed Switches and Routers, Multicast Protocols, VPNs, Overlay Networks, Multi-Protocol Label Switching, and Broadband Network Architectures. Prerequisites: EE281 (may be taken concurrently). 3 units.

EE284 Convergent Voice and Data Networks. Network Convergence: Telecommunication standards, Evolution to IP network. Voice in telecommunications: transmission, switching, signaling, multimedia in data network: network requirements, QoS, coding signaling, inter-working. Transport in data network: protocols, voice over frame relay, ATM, IP; FAX. Broadband access network. Prerequisites: EE281 (may be taken concurrently). 3 units.

EE285 Fiber Optic Networking. Principles of photonic communication systems. Photonic components, optical fibers, detectors, sources, modulation methods, electrical interfaces, multiplexing strategies, optical-electronic-optical systems, all-optical systems, switches, routers, optical networking architectures. Prerequisites: EE281. 3 units.

EE289 Special Topics in Networking. Advanced topics in networking that are currently of high interest to both industry and academia. Content varies from semester to semester, and may include, but not limited to, network security, virtual private network, network availability and reliability, network management. Prerequisites: EE281. 3units

Controls and Power Electronics Courses

EE231Automatic Control Theory. Fundamentals of state space techniques in the analysis and synthesis of dynamic control systems; relationship to classical control theory via the Laplace transform; controllability; observability; performance indices discrete systems; introduction to optimal control and Kalman filtering. Prerequisites: Graduate standing. 3 units.

EE232 Sampled-Data Control Systems. Reconstruction of sampled systems. Root-locus analysis of sampled data control systems, the discrete compensation method and physical realization of discrete compensators. Statistical analysis and design of sampled data systems with emphasis on robotics applications. Prerequisites: EE231. 3 units.

EE233 Optimal Control Systems. Optimization of discrete and continuous systems with applications from aerospace, robotic and process control areas. Variational calculus, numerical solutions, dynamic programming and steepest descent algorithms. Optimal linear regulator problem, matrix Ricatti equation and stochastic processes. Prerequisite: EE231. 3 units.

EE235 Nonlinear Control Systems Analysis. Linearized approximations, Polynomial approximations, phase plane analysis; numerical integration and describing function techniques of analysis and computer simulation. Prerequisites: EE210 and EE231. 3 units.

EE 237 Vector Control of AC Machines. This course introduces modeling and control of electrical drive for AC motors and generators including induction, permanent magnet, and synchronous machines. The dynamic model, control methods, current regulation, and space vector modulation are discussed by both analysis and computer simulation. Prerequisites: EE 210. 3 units

EE238 Advanced Power Electronics. Adv. study of switching regulators in power management, including energy conversion topologies, state space averaging techniques, assessing voltage mode/current mode control to embedded hardware. Applications include photo-voltaic /solar grid-tied inverters, active power factor correction, analysis, computer simulation. Prerequisite: Graduate Standing. 3 units.

EE239 Selected Topics in Systems and Control. Critical analysis of current literature pertinent to control systems. Prerequisite: EE231 or consent of instructor. Prerequisites: EE231 or instructor consent. 3 units.