

Electrical and Computer Engineering

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Mercedes Cabrerizo, *Assistant Professor*
Irene Calizo, *Assistant Professor*
Hei Deng, *Assistant Professor*
Jeffrey Fan, *Assistant Professor*
Luis Galarza, *Undergraduate Program Advisor*
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Ismail Guvenc, *Assistant Professor*
Arif Islam, *Assistant Professor*
Faisal Kaleem, *Instructor*
Sakhrat Khizroev, *Professor*
Grover Larkins, *Professor*
Osama Mohammed, *Professor*
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Gang Quan, *Associate Professor*
Shaolei Ren, *Associate Professor*
Gustavo Roig, *Professor*
Mario Sanchez, *Associate Director for Undergraduate Advising*
Frank Urban, *Associate Professor*
Herman Watson, *Lecturer and Undergraduate Program Director*
Kang Yen, *Professor and Director of International Program Development*

Master of Science in Electrical Engineering

The Department of Electrical and Computer Engineering offers both thesis and non-thesis options for the Master's Degree. The program provides a broad and multidisciplinary education, followed by in-depth studies of areas of interest.

All work counted for the Master's degree must be completed during the 5 years immediately following the date of admission.

Admission Requirements

The following is in addition to the University Graduate School admission requirements:

1. A student seeking admission into the program must have a bachelor's degree in engineering, physical sciences, computer science or mathematics from an accredited institution, or, in the case of foreign students, from an institution recognized in its own country as preparing students for further study at the graduate level.
2. An applicant must have a GPA score of 3.0 or higher in upper level undergraduate work.
3. Applicants who have not satisfied the above score may be evaluated for conditional admission.
4. International students whose native language is not English, must take the Test of English as a Foreign Language (TOEFL) or the International English

Language Testing System Test (IELTS). Minimum required score is: 550 on the paper-based test (PBT TOEFL), or 80 on the iBT TOEFL, or 6.5 overall on the IELTS test.

5. Applicants from science areas other than electrical or computer engineering will be expected to complete sufficient background material at the undergraduate level prior to unconditional acceptance into the graduate program.

Graduation Requirements

The degree will be conferred when the following conditions have been met:

1. Recommendation of the advisor and faculty of the Department.
2. Certification by the Dean of the College that all requirements of the degree being sought have been completed.
3. A GPA of at least 3.0 has been earned for certain courses required by the program.
4. Met the undergraduate deficiencies, if any existed in the student's graduate program, as additional courses toward the degree.
5. Completed the required semester hours of graduate level credit (not more than 6 graduate semester hours with a grade of "B" or higher can be transferred from other accredited institutions).
6. Students must maintain an overall GPA of 3.0. No grade below "C" will be accepted in a graduate program. In the event that a student is placed on a probationary status, he or she must obtain a directed program from his or her advisor and approved by the Dean prior to continuing further course work toward the degree. The student must satisfy the directed course of action within the prescribed time limit; otherwise he or she will be academically dismissed.
7. Complied with all University policies and regulations.

Thesis Option

A student must complete 24 semester credit hours of technical course work plus 6 semester credit hours of EEL 6971 - Master's Thesis. The candidate's Thesis committee shall approve an appropriate thesis topic.

The course requirements include a minimum of 12 hours of 6000 level course credit and a minimum of 9 hours at the 5000-6000 level in Electrical Engineering.

Upon the successful completion of all course work, including thesis work, and after the determination by the student's advisor that he or she has completed the objectives of the thesis research, the student must pass a final oral examination which is primarily a defense of the thesis research.

The courses are chosen by mutual agreement between the student and the thesis advisor.

Non-Thesis Option

Students may choose the non-thesis option for their master's degree. The degree requirements differ from the thesis option in one aspect. The student must either:

- Complete 27 credits of coursework approved by his advisor and successfully finish EEL 6916 Graduate Project with at least a 'B'.

OR

- Complete 30 credits of coursework approved by the Graduate Program Director.

Students choosing the non-thesis option must take:

1. Two sets of graduate level Electrical Engineering approved sequence courses from the catalog. Each set includes a minimum of 6 semester credit hours.
2. Six semester credit hours at the 5000-6000 level in mathematics.

Math Electives in ECE

EEL 5171	Advanced System Theory	3
EEL 5543	Random Signal Principles	3
EEL 6020	Numerical Analysis of Electrical Devices	3

The above list may be changed or expanded by the Graduate Advisory committee.

The remaining elective courses can be chosen from Science, Technology Engineering, and Mathematic (STEM) discipline based upon student plan of study and will be selected by the student and his advisor based on the student's career objectives.

Any course taken without the proper prerequisites and corequisites will be dropped automatically before the end of the term, resulting in a grade of "DR" or "DF".

Students, who are dismissed from the University due to low grades, may appeal to the Dean for reinstatement. A second dismissal results in no possibility of reinstatement.

Combined BS/MS in Electrical Engineering

Students who have completed at least 75-90 hours towards their Bachelors of Science degree in Electrical Engineering and have earned at least a 3.3 GPA on both overall and upper division courses may, upon recommendation from three ECE faculty members, apply to enroll in the combined BS/MS program. These students should also meet the admissions criteria for the graduate program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees. In addition to the admission requirements of the combined BS/MS program, students must meet all the admission requirements of the University Graduate School.

Students enrolled in the program may count up to 6 hours of ECE graduate courses as credits for both the BS and MS degrees. The combined BS/MS program has been designed to be a continuous program. During this combined BS/MS program, upon completion of all the requirements of the undergraduate program, students will receive their BS degree. Students in this program have up to one year to complete the master's degree after receipt of the bachelor's degree. Students who fail to meet this one year post BS requirement or who elect to leave the combined program at any time and earn only the BS degree will have the same access requirements to regular graduate programs as any other students, but will not be

able to use the 6 credits in both the bachelor's and master's degrees.

For each of the graduate courses counted as credits for both BS and MS degree, a minimum grade of "B" is required. Students enrolled in the program may count up to 6 credit hours of EE graduate courses toward the elective engineering BSEE requirements as well as toward the MSEE degree. Only graduate courses with formal lectures can be counted for both degrees. The students are responsible for confirming the eligibility of each course with the undergraduate advisor.

Students interested in the program should consult with the undergraduate advisor on their eligibility to the program. The students should also meet the graduate advisor to learn about the graduate program and available courses before completing the application form and submitting it to the undergraduate advisor. Applicants will be notified by the department and the University Graduate School of the decision on their applications.

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2. Certification by the Dean of the College that all requirements of the degree being sought have been completed.
3. A GPA of at least 3.0 has been earned for certain courses required by the program.
4. Met the undergraduate deficiencies, if any existed in the student's graduate program, as additional courses toward the degree.
5. Completed the required semester hours of graduate level credit (not more than 6 graduate semester hours with a grade of "B" or higher can be transferred from other accredited institutions).
6. Students must maintain an overall GPA of 3.0. No grade below "C" will be accepted in a graduate program. In the event that a student is placed on a probationary status, he or she must obtain a directed program from his or her advisor and approved by the Dean prior to continuing further course work toward the degree. The student must satisfy the directed course of action within the prescribed time limit, otherwise he or she will be academically dismissed.
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Students enrolled in the program may count up to 6 hours of ECE graduate courses as credits for both the BS and MS degrees. The BS/MS combined program has been designed to be a continuous program. Students in this program have up to one year to complete the master's degree after receipt of the bachelor's degree. Students who fail to meet this one year post B.S. requirement or who elect to leave the combined program at any time and earn only the BS degree will have the same access requirements to regular graduate programs as any other students, but will not be able to use the 6 credits in both the bachelor's and master's degrees.

For each of the graduate courses counted as credits for both BS and MS degree, a minimum grade of "B" is required. Students enrolled in the program may count up to 6 credit hours of CpE graduate courses toward the elective engineering BSCpE requirements as well as toward the MSCpE degree. Only graduate courses with formal lectures can be counted for both degrees. The students are responsible for confirming the eligibility of each course with the undergraduate advisor.

Students interested in the program should consult with the undergraduate advisor on their eligibility to the program. The students should also meet the graduate advisor to learn about the graduate program and available courses before completing the application form and submitting it to the undergraduate advisor. Applicants will be notified by the department and the University Graduate School of the decision on their applications.

Doctor of Philosophy in Electrical Engineering

Admission Requirements

The requirements for admission to the doctoral program in Electrical Engineering are:

1. Applicants having a Master's degree in Electrical Engineering from an accredited institution must satisfy the following requirements for admission to the doctoral program:
 - GPA of at least 3.3/4.0 in the master's program
 - GRE scores
 - Three letters of recommendation in the forms provided by the department
 - International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.5 overall on the IELTS is required.
2. Credentials of all other applicants will be examined by the Graduate Admission Committee on a case by case basis.

In addition to the departmental requirements, all students must satisfy the University's Graduate Policies and Procedures.

Identification of Research Area

Within 12 months upon acceptance into the Ph.D. program, the student has to identify an area of research of his or her interest by contacting and being accepted by a professor willing to guide the dissertation research. If no such professor can be found, the student will be dismissed from the Ph.D. program. Contact the Department for a list of the faculty members with Dissertation Advisor status and their research interests.

Course Requirements

The Ph.D. in Electrical Engineering requires at least 78 credit hours beyond the bachelor's degree. A maximum of 30 credit hours of course work earned in a Master's degree in Electrical Engineering, from FIU or another accredited institution, may be counted toward the Ph.D. provided that a minimum grade of "B" is earned in each course.

Degree Requirements

1. Students must complete at least 9 credits in their major area and at least 6 credits in two different breadth areas (a grade of "B" or better in each course). The appropriate areas of study and specific courses are determined by the dissertation advisor.
2. The student must have completed a minimum of 45 credits of graduate course work toward the Ph.D. before the student is eligible to apply to take the written comprehensive examination. This includes up to 30 transfer credits. However, EEL 5935, 6905, 6916, 6932, 6971, and 6977 do not count toward this 45 credit requirement.
3. Registration for EEL 7910 Advanced Research is allowed only after successful completion of the written comprehensive examination.

4. At least 24 credits of EEL 7980 are required. Registration for EEL 7980 Ph.D. Dissertation is allowed only after the student is admitted to candidacy.
5. Fifty percent of the total hours counted toward the doctoral degree have to be at the 6000 and 7000 level (including EEL 7980).

Residency Requirements

The Ph.D. student must spend at least one academic year in full-time residency. Usually, this will be after being admitted to candidacy. To satisfy the residency requirement for a Ph.D. E.E. degree, the candidate must complete a minimum of 18 credit hours within a period of 12 months in residency at the University.

Graduate Supervisory and Research Committee

The student's Ph.D. Graduate Supervisory and Research Committee should be appointed as soon as possible and not later than 15 months after being admitted to the Ph.D. program. Consult the Graduate Handbook in the Department for more details on how to select the committee members.

Ph.D. Course Breadth Requirements

The student must submit information about how the breadth requirement has been satisfied to the Graduate Program Director at the time he/she signs up for the Ph.D. E.E. Qualifying Examination.

Qualifying Examination

To be eligible for the written qualifying examination, the student must have satisfied the Ph.D. course breadth requirements in his or her area of specialization and in two other areas. The students can take the candidacy examination no earlier than the semester in which all the required coursework for the degree is completed. Failure to do this is causation for dismissal from the Ph.D. program.

The student must pass all parts of the examination. Failing any part implies failure of the entire examination. The exam must be retaken the next time it is offered. Failing a second time is causation for dismissal from the Ph.D. program.

Consult the Graduate Handbook available in the Department for details on examination procedures, dates, duration, application and grading criteria.

Proposal Defense

Proposal defense must be taken within one semester after the satisfactory completion of the qualifying examination.

Admission to Candidacy

Candidacy status indicates that a doctoral student is ready to commence working the dissertation. A student is admitted to candidacy upon successfully completing all required course work and passing the qualifying examination and proposal defense.

Oral Defense and Submission of Doctoral Dissertation

A dissertation is required of all candidates for the doctoral degree. A proposal must be submitted to the student's Dissertation Committee for approval, following the general guidelines in the "Regulations for Thesis and Dissertation

Preparation". A student must enroll for dissertation credits in the semester in which he or she expects to be admitted to candidacy, and must maintain continuous enrollment for not less than 3 credits of EEL 7980 every semester, including Summers, until the semester in which the doctoral degree is awarded. Upon completion of the dissertation, the degree candidate will submit to the Dean of the Graduate School an application for dissertation defense signed by the student's Dissertation Committee with sufficient time to allow for publishing a notice in the monthly calendar of dissertation and theses defenses to invite members of the university community to observe the defense.

Following the successful defense of the dissertation, as determined by a majority vote of the student's research committee, the dissertation must be forwarded to the Dean of the College of Engineering and Computing and the Dean of the Graduate School for their approval.

All dissertations submitted in fulfillment of requirements for graduate degrees must conform to University guidelines (see "Regulations for Thesis and Dissertation Preparation"). One final, approved copy of the dissertation must be delivered to the Chairperson of the Department of Electrical & Computer Engineering. Library copies must conform to University guidelines, also published in "Regulations for Thesis and Dissertation Preparation".

Financial Aid

Consult the Department for information on research and teaching assistantships available for doctoral students.

Graduate Certificate in Electric Power Engineering and Management (EPEM)

This graduate certificate program is open to all students with a Bachelor's Degree in electrical engineering, computer engineering, and other closely related fields of study from an accredited institution. The **EPEM** program plans to develop managerial talents for a technological environment in the electrical energy industry. The program blends a mix of electrical engineering and management courses. The **EPEM** program is designed to provide specialization opportunities in Electrical Energy area and Management. The skills, concepts and techniques learned will be related to, but not dependent upon, knowledge of power engineering. The emphasis will be on management and organizational skills appropriate for the electrical energy industry.

To earn a graduate certificate in **EPEM**, the students must successfully complete the program's core and elective courses.

The **EPEM** curriculum consists of 18 credit hours – 6 courses. These courses cover functional areas of electrical power engineering, management and specialized technical and engineering functions.

Courses

EIN 5322	Engineering Management
ESI 6455	Advanced Engineering Project Management
EIN 5346	Logistics Engineering
EEL 5270	Electrical Transients in Power Systems
EEL 6261	Power Systems Engineering
EEL 6273	Power Systems Stability and Control

Additional information about this program can be found at:

URL: www.eng.fiu.edu/ece
 E-mail: mohammed@fiu.edu
 Tel: (305) 348-3040
 Fax: (303) 348-3707

Academic Standard

The Department of Electrical and Computer Engineering requires that students receive no grade less than a "C", with an overall GPA of 3.0 in order to be awarded the graduate certificate.

Course Descriptions

Definition of Prefixes

EEE-Engineering: Electrical and Electronic; EEL-Engineering: Electrical; TCN-Telecommunications/Networkings

EEE 5261 Bioelectrical Models (3). Engineering models for electrical behavior of nerve and muscle cells, electrode-tissue junctions, volume conductions in tissue and the nervous system as an electrical network. Prerequisites: EEE 4202C or permission of the instructor. (F)

EEE 5275 Bioradiation Engineering: Detection and Measurement (3). Spectrum of radiation sources, types of fields, properties of living tissue, mechanisms of field propagation in tissue. Application in imaging and therapy, hazards and safety. Prerequisites: EEL 4410 or permission of the instructor. (S)

EEE 5348 Digital Electronics (3). Analysis and design of logic gates using saturated and non-saturating elements, transmission gates, interfacing of logic families, bistable circuits, A/D and D/A converters. Prerequisites: EEE 4304 or permission of the instructor.

EEE 5352 Bipolar Junction Transistors (3). Bipolar junction transistor physics. Semiconductor bulk properties at equilibrium and nonequilibrium. PN junction theory. Theory of the bipolar junction transistor. Prerequisites: EEE 3396 or permission of the instructor. (S)

EEE 5353 Field Effect Transistors (3). Field effect device physics and technology. MOS capacitor. DC and AC characteristics of the MOS transistor. The MOS transistor in dynamic operation. Prerequisites: EEE 3396 or permission of the instructor. (F)

EEE 5366 Industrial Electronics (3). A study of solid state devices for the control of power, their applications and limitations in power switching circuits and in the control of physical transducer. Prerequisites: EEL 4213, EEE 4304 or permission of the instructor. (F, every third year)

EEE 5371 High Frequency Amplifiers (3). Analysis and design of high frequency amplifiers and oscillators: stability, scattering parameters, use of the Smith chart and other practical design tools, noise. Prerequisites: EEE 4304, EEL 4410 or permission of the instructor. (F, every third year)

EEE 5425 Introduction to Nanotechnology (3). Nanoscale electrical, optical and magnetic device operation. Overview of new devices enabled by nanotechnology, methods for fabrication and

characterization of nanoscale and devices. Prerequisite: EEE 3396.

EEE 5427C Advanced Nanofabrication of Electronic Devices (3). This course covers the advanced theory and technology for fabrication of micro/nano-scale electronic devices. Includes lectures and laboratory sessions on techniques such as lithography and etching. Prerequisites: EEE 5425 or permission of the instructor.

EEE 6285 Biosignal Processing I (3). Characterizing biosignals by application of time and frequency domain analytic methods. Comparison of analog and digital processing. Engineering design for VLSI implementations in implantable devices. Prerequisites: EEL 6505 or permission of the instructor. (F)

EEE 6286 Biosignal Processing II (3). Engineering design of advanced systems for processing biosignals. Methods for signal compression. Adaptive systems for automatic recognition. Application of artificial intelligence for signal classification. Prerequisites: EEE 6285 or permission of the instructor. (S)

EEE 6311 Advanced Electronic Systems I (3). Principles of analog and digital electronics network. Advanced analysis, modeling and computer simulation of op amps. Analog design techniques and practical examples are covered. Prerequisites: EEE 4314 or permission of the instructor. (F, alternating years)

EEE 6312 Advanced Electronic Systems II (3). Study of linear properties of electronic systems and design of fault tolerant systems using A/D and D/A and control algorithms. Prerequisites: EEE 6311 or permission of the instructor. (S, alternating years)

EEE 6315 Advanced Solid State Electronics (3). IC technologies, properties and fabrication concepts. Bipolar, MOS, I²L, CCD, bubble technologies. Ion implantation characteristics. Lithography techniques. Prerequisites: EEE 3396, EEE 4304 or permission of the instructor. (SS, every third year)

EEE 6332 Thin Film Engineering (3). Thin films used in microelectronics and optoelectronics; deposition methods; evolution of film microstructure; film growth modeling; introduction to film analysis. Prerequisite: EEE 3396. (SS, alternating years)

EEE 6335 Electrical Transport in Semiconductors I (3). This course focuses on carrier transport fundamentals, beginning at the microscopic level and progressing to the macroscopic effects relevant to semiconductor devices. Prerequisite: EEE 5352. (F, alternating years)

EEE 6337 Electrical Transport in Semiconductors II (3). This course focuses on quantum phenomena occurring in carrier transport in modern small-size semiconductor devices. Prerequisite: EEE 6335.

EEE 6395 Applied Superconductivity (3). Covers the basic physical properties of superconductors. Superconducting devices: squids, memory & logic elements. Emphasis is placed on applications of superconductors. Prerequisites: EEE 3396 and EEL 4410. Corequisite: Permission of the instructor. (S)

EEE 6397 Semiconductor Device Theory (3). Device physics and modeling of GaAs FETS. GaAs analog and digital integrated circuits. Modulation doped field effect

transistors. Heterojunction bipolar transistor theory. Prerequisite: EEE 3396. (S)

EEE 6399C Electronic Properties of Materials (3). Properties of materials from which electronic components and structures are fabricated; electrical conduction in metals, semiconductors and insulators; thermal; magnetic; optical. Prerequisite: EEE 3396. (F, alternating years)

EEL 5145 Advanced Filter Design (3). Graduate course in the design and advance analysis of passive and active high order circuits. Use of computer as a design tool. Prerequisites: EEL 4140 or permission of the instructor. (S, alternating years).

EEL 5171 Advanced Systems Theory (3). State-space representations for continuous and discrete-time systems, controllability and observability, pole-zero allocation, Lyapunov stability theorem, state observers. Prerequisites: EEL 3657 or permission of the instructor. (S)

EEL 5270 Electrical Transients in Power Systems (3). Traveling waves on transmission and multi-conductor systems, successive reflections, distributed parameter systems, transients on integrated power systems. Prerequisites: EEL 4213 or permission of the instructor.

EEL 5275 Power Systems Protection (3). Analysis of power systems under faulted conditions using linear transformation. The study of surge, transient and waves on power lines. Computer-aided analysis and design emphasizing protection of equipment. Prerequisites: EEL 4215 or permission of the instructor. (F)

EEL 5285C Sustainable and Renewable Energy Sources and Their Utilization (3). Alternative energy techniques, solar power, wind power, biomass, and other sources, electric power grid and integration of renewables, energy storage and smart energy utilization and public policy. Prerequisites: EEL 4213 or equivalent.

EEL 5437 Microwave Engineering (3). Microwave guides. Microwave tubes. Microwave solid state devices. Microwave integrated circuits, Microwave enclosures. Prerequisites: EEL 4410 or permission of the instructor. (S, every third year)

EEL 5482 Fields and Waves Engineering (3). Concepts and theorems in fields and waves, analytic techniques for guided waves, radiation and scattering, numerical techniques for analysis of electrical devices. Prerequisites: EEL 4410 or permission of the instructor. (S)

EEL 5500 Digital Communication Systems I (3). This course will consider the most important aspects of digital communication systems such as noise related subjects, random signals, linear systems, and baseband digital modulation and multiplexing. Prerequisites: EEL 3514 or permission of the instructor. (SS)

EEL 5501 Digital Communication Systems II (3). This course will consider more important aspects of digital communication systems such as matched filters, digital base and modulation, multiplexing, carrier digital modulation and error correction coding. Prerequisites: EEL 5500 or permission of the instructor. (F)

EEL 5543 Random Signal Principles (3). Noise, random processes, correlation, spectral analysis in the analysis and design of communication systems. Optimization

techniques; minimum mean square error. Prerequisite: EEL 3514. (SS, alternating years)

EEL 5563C Introduction to Optical Fibers (3). Use of fiber optics as a communication medium. Principles of fiber optics; mode theory; transmitters, modulators, sensors, detectors and demodulators; fiber data links. Prerequisites: EEL 3514, EEE 4314 and EEL 4410 or permission of the instructor. (F, alternating years)

EEL 5587 Long Term Evolution Communication: From Theory to Practice (3). Introduction to the basic concepts in Long Term Evolution (LTE) technology and beyond. Prerequisite: Permission of the instructor.

EEL 5653 Digital Control Systems (3). Analysis and design of digital control systems. Z-transforms, analysis and control of discrete-time systems, digital control of analog systems. Several digital controller design methods. Computer simulation and microprocessor implementation. Prerequisite: EEL 3657. (SS)

EEL 5718 Computer-Communication Network Engineering (3). System engineering synthesis, analysis, and evaluation of computer-communication networks. Network design, routing and flow control, telecommunication traffic engineering, transmission, switching, etc. Prerequisite: Permission of the instructor. (SS)

EEL 5719 Digital Filters (3). Analysis, design and implementation of digital filters. Hardware and software approach to design. Prerequisite: Permission of the instructor. (F)

EEL 5725 Hardware Description Languages (VHDL or Verilog) (3). This course involves systematic studies of Fault Tolerant Digital Systems, VHDL and VERILOG based dynamic digital system designs, and system implementations with CPLDs, FPGAs, ASICs. Prerequisite: EEE 4304, EEL 4746 or Permission of the instructor. (F)

EEL 5741 Advanced Microprocessor Systems (3). Interfacing of various microprocessors together. Concepts of master-slave systems, virtual memory and I/O control techniques. Digital system evaluation and optimization. Prerequisites: EEL 4746 or permission of the instructor. (SS, alternating years)

EEL 5757 Real-Time Digital Signal Processing Implementations (3). Techniques for the implementation of Digital Signal Processing (DSP) algorithms in dedicated processors, for assessing real-time performance of audio, control, and communication systems. Prerequisites: EEL 4510 or permission of the instructor.

EEL 5813 Neural Networks-Algorithms and Applications (3). Various artificial neural networks and their training algorithms will be introduced. Their applications to electrical and computer engineering fields will be also covered. Prerequisite: Permission of the instructor. (SS)

EEL 5820 Digital Image Processing (3). Image Fundamentals, Image Transforms, Image Enhancement, Edge Detection, Image Segmentation, Texture Analysis, Image Restoration, and Image Compression. Prerequisite: EEL 3135 and knowledge of any programming language (FORTRAN, Pascal, C). (F)

EEL 5935 Advanced Special Topics (1-3). A course designed to give groups of students an opportunity to pursue special studies in an advanced topic of Electrical Engineering not otherwise offered. Prerequisite: Consent of instructor.

EEL 5941 Graduate Electrical and Computer Engineering Internship (1-3). Graduate students acquire practical experience through supervised internship in industry. The student prepares an internship proposal, and the work performed is documented in a report and presented. Prerequisite: Permission of the student's advisor.

EEL 5945 Electrical and Computer Engineering Teaching Practicum (1). Graduate students acquire practical teaching experience through supervised course teaching. The student prepares an internship proposal, and the work performed is documented in a report and presented. Prerequisite: Permission from student's advisor and department. Corequisite: Teaching at least one full course during that semester.

EEL 6020 Numerical Analysis of Electrical Devices (3). Numerical techniques for the analysis of static and diffusion eddy current type field problems and associated phenomena in electrical devices. Emphasis on implementation and applications to practical problems. Prerequisites: EEL 4213, MAP 3302 or equivalent or permission of the instructor. (SS)

EEL 6141 Advanced Network Analysis (3). Modeling and analysis of networks by t-domain and s-domain techniques. Topics include topology, formulation of loop eqs and node pair eqs., state space networks, computer solutions. Prerequisites: EEL 3112 or permission of the instructor. (S, every third year)

EEL 6167 VLSI Design (3). Study of VLSI Design concepts in MOS/CMOS environment, CAD techniques, VLSI array processors and wavefront array processors, and implementation of array processors. Prerequisites: EEL 5741, EEE 4314. (SS, alternating years)

EEL 6219 Electric Power Quality (3). Modeling of networks under non-sinusoidal conditions, loads which may cause power quality problems, analysis of harmonics, flickers, impulses, standards, power quality improvement methods. Prerequisites: EEL 4213 or permission of the instructor.

EEL 6235 Motor Drives Control (3). Switched, resonant and bidirectional power supplies, DC motors: single, three phase and chopper drives. AC motors: voltage, current and frequency control. Closed loop control. Prerequisites: EEL 4213, EEE 3303, EEL 3657. (SS, alternating years)

EEL 6253 Computer Analysis of Power Systems (3). Power systems analysis and designs by computer solutions. Interactive solutions, power flow, optimum solutions. Dynamic solutions and stability. Prerequisites: EEL 4215 or permission of the instructor. (F, every third year)

EEL 6254 Power Systems Reliability (3). Expansion planning, load forecasting, reliability and availability application to generation planning, bulk power supply systems, generation system operation and production costing analysis. Prerequisites: EEL 4215 or permission of the instructor. (S)

EEL 6261 Power Systems Engineering (3). Steady-state analysis, fault studies, load flow, dynamic and transient performance, on-line control, practical applications. Prerequisites: EEL 4215 or permission of the instructor. (SS, every third year)

EEL 6267 Application of Intelligent Systems to Power System Operations (3). Power system security assessment using intelligence systems techniques such as pattern recognition, expert systems, and neural networks. Class projects include applying IS to load forecasting, alarm processing. Prerequisites: EEL 4214, EEL 6273. (SS, alternating years)

EEL 6273 Power System Stability and Control (3). Direct methods for system stability, computer analysis of large scale models, Lyapunov stability, longer term stability, security analysis, MW-frequency control, isolated and multiple area control. Prerequisites: EEL 4215 or permission of the instructor. (S)

EEL 6443 Electro-Optical Devices and Systems (3). Introduction to optical devices and systems such as solid state laser systems, their applications in industry. Also holography, linear and non-linear optical modulation and demodulation concepts. Prerequisites: EEL 4410, EEE 4314. Corequisites: EEL 5563 or permission of the instructor. (S, every third year)

EEL 6444 Optical Fiber Communication Systems (3). Course focuses on specification, design and application of fiber optic communication systems considering the fiber optic wave guide, optical device sources, photodetector, receiver and transmitter designs. Prerequisites: EEL 5501 or permission of the instructor. (S, every third year)

EEL 6463 Antenna Theory and Design (3). Radiation patterns of dipoles and loops, array analysis and synthesis, self-impedance and mutual impedance, frequency independent antennas and antenna miniaturization, and reflectors and lens antenna. Prerequisite: EEL 4410. (S, alternating years)

EEL 6505 Digital Signal Processing (3). Treatment of digital signal and system characteristics: Z transforms and FFT theory. Real time and correlation functions. Multidimensional signal processing and digital filtering. Prerequisite: Permission of the instructor. (F)

EEL 6509 Digital Communications by Satellite (3). This course will consider processing and non-processing transponders, earth terminals, propagation link characteristics, multiple access techniques, and spread spectrum techniques. Prerequisites: EEL 5501 or permission of the instructor. (S)

EEL 6536 Spectral Analysis (3). Methods for the analysis and estimation of a signal's spectral content. These include nonparametric, parametric and line spectral estimation, filter bank techniques and array processing. Prerequisites: EEL 5543 or 6505 or permission of the instructor.

EEL 6572 Pictorial Information Systems Design (3). Picture input device design, pictorial information systems hardware, picture processor design, picture storage system design, pictorial database system design, picture communication interface design, and engineering applications. Prerequisites: EEL 4709C or CDA 4400. (SS)

EEL 6575 Data Communications Engineering (3). Digital networks for data communications, CCITT, HDLC, SDLC. Real time switching techniques. Microprocessor based network topologies. Busing schemes such as VME, MULTIB, RS232. Prerequisites: EEL 4746 and EEE 4314 or permission of the instructor. (F)

EEL 6614 Modern Control Theory I (3). Graduate level treatment of modern control systems. Optimal control of feedback systems. Performance measures, Pontryagin's minimum principle, dynamic programming, numerical techniques. Prerequisites: EEL 5171 or permission of the instructor. (F, alternating years)

EEL 6615 Modern Control Theory II (3). Graduate level course in stochastic control. Stochastic processes, linear estimation, Kalman filtering techniques in state estimation. Design of feedback control in the presence of noise. Prerequisites: EEL 6614 or permission of the instructor. (S, alternating years)

EEL 6673 Identification Theory (3). System modeling, off-line methods, on-line methods, order and structure determination, diagnostic tests and model validation. Prerequisite: EEL 5171. (F, alternating years)

EEL 6681 Fuzzy Systems Design (3). Applications of fuzzy theory to develop design methodologies for various engineering systems. Emphasis will be on systems for pattern recognition, model identification, and automatic control. Prerequisite: Permission of the instructor.

EEL 6726 Advanced VLSI Design (3). Advanced design and development of Very Large Scale Integrated Circuit (VLSI) Micro Chip Structures. Micro Chip routing and thermal optimizations will be emphasized for implementing VLSI units. Prerequisite: Permission of the instructor. (S, every third year)

EEL 6751 Wavelet Theory Applied to Signal Processing (3). Application of wavelet theory to transient and non-stationary signal processing; compression and noise reduction of signals, singularity and edge detection, and time-frequency analysis. Prerequisites: EEL 3135 or equivalent.

EEL 6758 Engineering Design of Microprocessor Based Operating Systems (3). Hardware microprocessor based systems, BIOS (basic input and output), Kernel partitions, memory, stack organization and physical design of operating systems. Prerequisites: EEL 4709C and EEL 4746 or permission of the instructor. (S, every third year)

EEL 6787 Network Security (3). Network Security Requirements, Number Theory, Steganography, Encryption Design Principles and Algorithms, Message Authentication and Digital Signature Principle and Designs, Network System Security Design. Prerequisite: Permission of Instructor.

EEL 6795 Power Aware Computing (3). The power/thermal challenges in computing system design; source of the power dissipation and power/thermal modeling; power/thermal aware design techniques at different design abstraction levels. Prerequisites: EEL 4709C or permission of the instructor.

EEL 6812 Advances in Neural Networks (3). Latest concepts in artificial neural networks research and newly developed applications. Implementation, convergence in learning algorithms, accuracy refinement, and optimal

structure of neural networks. Engineering applications. Prerequisite: EEL 5810. (F, alternating years)

EEL 6816 Electronic Neural Systems (3). This course bridges electronics to the understanding of neurobiologically inspired models. Biological tasks and neural computations are studied in the context of networks and processing elements. Prerequisite: Permission of Instructor.

EEL 6821 Computer Vision (3). Image formation and image properties, Radiance and irradiance, introduction to Brain Topography, Color Vision, visual machinery of the brain, statistical pattern classification and decision functions, the eigensystem and its computational aspects, stereo vision, motion vision, size and orientation independence. Prerequisite: EEL 5820. (S)

EEL 6825 Pattern Recognition (3). Pattern recognition techniques via computer: decision functions, optimum decision criteria, training algorithms, unsupervised learning, feature extraction, data reduction, machine intelligence. Prerequisites: EEL 5543 or permission of Instructor.

EEL 6836 Computer Visualization of Brain Electrical Activity (3). Computer techniques for the visualization of brain electrical activity. Analysis of the origin of this activity as it relates to its measurement and visualization through computerized systems. Prerequisites: EEL 4510 or permission of instructor.

EEL 6870 Intelligent Computer Design (3). The course involves self testing and correcting type of modular computer system development. Also concepts relating to Artificial Intelligence and Expert systems will be integrated into the computer system design. Prerequisite: EEL 4709C. (F, alternating years)

EEL 6894 Real-Time Computing and Applications (3). Introduction to real-time computing; real-time system modeling; classic uniprocessor scheduling; power-aware and thermal-aware real-time scheduling; multiprocessor and distributed real-time computing. Prerequisites: EEL 4709C or permission of the instructor.

EEL 6905 Individual Work (1-4). Special problems or projects selected by the students and a faculty member. The student conducts the project with a minimum of supervision. Consent of Department Chairperson and Faculty Advisor.

EEL 6916 Graduate Project (3). Independent research work culminating in a professional practice-oriented report for the requirements of the non-thesis option of the M.S. degree project. Prerequisites: Fifteen graduate credits and approved project plan.

EEL 6931 Special Topics in Electrical and Computer Engineering (1-3). Course covers advanced topics not in existing graduate courses in electrical and computer engineering. Prerequisite: Permission of the instructor.

EEL 6932 Graduate Seminar (1). An examination of recent technical findings in selected areas of concern. Emphasis is placed on presentations (oral and written), research activities, readings, and active discussions among participants. Prerequisite: Consent of graduate advisor.

EEL 6971 Research Master's Thesis (1-6). The student, following the option of the Master's Degree with thesis, should work for his/her thesis through this course. Prerequisite: Graduate standing.

EEL 6977 Extended Thesis Research (0). For Graduate research students who have completed their sequence of thesis credits, but must register for a course to remain on graduate student status.

EEL 7910 Advanced Research (1-6). Advanced research credits under the supervision of the dissertation advisor. Prerequisite: Completion of the written comprehensive examination.

EEL 7980 Ph.D. Dissertation (1-12). Doctoral research leading to Ph.D. Electrical Engineering Dissertation. Prerequisites: Permission of Major Professor and Doctoral Candidacy.

TCN 5155 Wireless Communications with Multimedia Applications (3). Overview of wireless communications systems; interference, blocking, spectral efficiency; performance of digital modulation in presence of fading; diversity techniques; and multimedia applications. Prerequisite: EEL 3514.

TCN 5271 Ubiquitous and Embedded Sensor Network-Centric Telecommunications (3). Techniques impacting ubiquitous, embedded sensor network-centric telecommunications, context-awareness, autonomy, data quality, uncertainty, privacy, trustworthiness and wearable computing. Prerequisites: Graduate standing and permission of the instructor.

TCN 6276 Antennas for Wireless and Body-Centric Communications (3). Advanced antenna theory, simulation, and design as applied to wireless communications, advanced state-of-the art antenna systems, and body-centric wireless communications. Prerequisites: EEL 4410 or permission of the instructor.

TPA 5213 Performing Arts Technology (2). Applications of structural, mechanical, electrical and electronic technologies to prepare performing arts students for management and production roles. Includes basic circuits and NEC codes, control systems. Prerequisite: Permission of graduate advisor.