

## Electrical and Computer Engineering

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## 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 multi-disciplinary 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. The GPA, GRE, and TOEFL scores above are to be considered minimum requirements for admissions. 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 School 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. Successful defense of an acceptable graduate thesis if required by the program.

7. 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.

8. 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 supervisory 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.

### Non-Thesis Option

Students may choose the non-thesis option for their master's degree. The degree requirements differ from the thesis option in two respects. First, the student can petition to be exempt from the thesis requirement, including the 6 credits it entails by substitution of graduate project. Second, the candidate will be required to pass a comprehensive final examination. This exam will be given by a committee selected by the department. The membership of this committee may include faculty and engineers from industry. The exam is intended to test the candidate's general ability in the areas of study and it will be given near the end of the candidate's final semester. A student who fails the exam may not attempt it again until one semester has elapsed or upon the completion of additional course work prescribed by the examining committee. The exam may be retaken only once.

### Math Electives:

Select 2 courses with advisor approval.

EEL 5171	Advanced System Theory	3
EEL 5543	Random Signal Principles	3
EEL 6020	Numerical Analysis of Electrical Devices	3
MAA 4211	Advanced Calculus	3

MAA 4402	Complex Variables	3
MAD 3401	Numerical Analysis	3
MAP 4401	Advanced Differential Equations	3
MAP 5117	Mathematics and Statistics Modeling	3
STA 5446	Probability Theory I	3
STA 5447	Probability Theory II	3
STA 5800	Stochastic Processes for Engineering	3

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

Remaining course work 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.

## Master of Science in Computer Engineering

The Department of Electrical and Computer Engineering offers both thesis and non-thesis options for the Master's Degree.

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

The program provides a broad and multidisciplinary education, followed by in-depth studies of areas of interest.

### 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. The University's required GPA, GRE and TOEFL scores are to be considered minimum requirements for admissions. 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 School 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. Successful defense of an acceptable graduate thesis if required by the program.

7. 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.

8. 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 supervisory 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 Computer 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.

### Non-Thesis Option

Students may choose the non-thesis option for their master's degree. The degree requirements differ from the thesis option in two respects. First, the student can petition to be exempt from the thesis requirement, including the 6 credits it entails by substitution of graduate project. Second, the candidate will be required to pass a comprehensive final examination. This exam will be given by a committee selected by the department. The membership of this committee may include faculty and engineers from industry. The exam is intended to test the candidate's general ability in the areas of study and it will be given near the end of the candidate's final semester. A student who fails the exam may not attempt it again until one semester has elapsed or upon the completion of additional course work prescribed by the examining committee. The exam may be retaken only once.

### Computer Engineering Courses

EEL 5718	Computer Communication Network Engineering
EEL 5725	Digital Systems Engineering I
EEL 5741	Advanced Microprocessor Systems
EEL 6167	VLSI Design
EEL 6726	Digital Systems Engineering II
EEL 6575	Data Communications Engineering
EEL 6444	Optical Fiber Communications Systems
EEL 6505	Digital Signal Processing
EEL 6509	Digital Communications by Satellite
EEL 6253	Computer Analysis of Power Systems
EEL 6681	Fuzzy System Design
EEL 6758	Engineering Design of Microprocessor Based Operating Systems
EEL 6821	Computer Vision
EEL 5757	Real-Time DSP Implementations
EEL 6812	Advances in Neural Networks
EEL 6870	Intelligent Computer Design
EEL 6751	Wavelet Theory Applied to Signal Processing

**Electives Computer Science: (3)**

Courses may be selected by student and advisor from 4000, 5000, and 6000 level Computer Science course listings.

The above lists may be changed or expanded by the supervisory committee.

**Master of Science in Telecommunications and Networking**

The Master of Science in Telecommunications and Networking is intended to educate individuals seeking employment with hardware and/or software companies, service providers, large user organizations, or telecommunications regulatory agencies as well as for those who are employed by these companies/organizations and wish to obtain formal, higher-level, specialized degree in Telecommunications and Networking. Telecommunication and Networking students learn how to lead in the ever changing environment of real-time global information networking, telecommunications, wireless and optical strategies and how to amplify business value through communications, technologies and systems. All courses in the program are categorized under the five following areas. IT2 offers thesis and non-thesis options for the Master's Degree. The Master is a multidisciplinary program that offers two tracks:

- **Systems and Networks:** Focuses on technical aspects of the design of data networks, software, and hardware. A student must have a bachelor's in computer science, electrical, computer, or telecommunications engineering, mathematics, physics or related field.
- **Management and Policy:** It provides the necessary education for individuals involved with service providers, large user organizations and government regulators. A student must have a bachelor's degree in engineering, information systems, technology or sciences. The Doctoral Program is in Electrical Engineering and Industrial and Systems.

**Admissions Requirements**

1. In addition to the FIU graduate requirements, a student admitted to the program must have a bachelor's degree in a related field from an accredited institution, in the case of foreign students, from an institution recognized in its own country as preparing students to continue studies at the graduate level.
2. In addition, foreign students whose native language is not English, must have taken the Test of English as a Second Language (TOEFL) and obtain a score of at least 550 or better.
3. The University's required GPA, GRE and TOEFL scores are to be considered minimum requirements for admissions.

**Graduate Requirements**

The degree will be granted when the following criteria has been met:

1. Recommendation of Advisor and faculty of the Department.
2. Certification by the Dean of the School that all requirements have been met.
3. A GPA of at least 3.0 has been earned for certain courses required in the program. Maintain an overall

GPA of at least 3.0. No grade below "C" will be accepted in any course taken to satisfy graduate program requirements.

4. Completion of all graduate required semester hours of graduate level (not more than 6 with a grade of "B" or better can be transferred from other institution).
5. Successfully defense of an acceptable thesis, or individual project required by the program.

**Telecommunications and Networking Courses****Network Area:**

TCN 6210	Telecommunications Network Analysis and Design
TCN 6230	Optical Networks
TCN 6270	Mobile and Wireless Networks
TCN 6275	Mobile Computing
TCN 6260	Internetworking

**Engineering Area:**

TCN 5150	Multimedia Computer Communications
TCN 5455	Information Theory

**Software Area:**

TCN 5440	Software Development for Telecommunications Networks
TCN 5445	Telecommunication Network Programming
TCN 6420	Modeling and Performance Evaluation of Telecommunications Networks
TCN 6430	Networks Management and Control Standards
TCN 6450	Wireless Information Systems

**Technology Area:**

TCN 5010	Telecommunications Technology Applications
TCN 5030	Computer Communications and Networking Technologies
TCN 5060	Telecommunications Software and Methodologies
TCN 5080	Secure Telecommunications Transactions

**Management Area:**

TCN 5640	Telecommunications Enterprise Planning and Strategy
TCN 6630	Economics of Telecommunications Systems

**Policy Area:**

TCN 6820	Telecommunications Industry Development
TCN 6880	Telecommunications Public Policy Development and Standards

**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:

- a. GPA of at least 3.3/4.0 in the master's program
- b. GRE verbal plus quantitative of at least 1120 points
- c. Three letters of recommendation in the forms provided by the department
- d. 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 6.3 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 graduate faculty members and their research interests.

### Course Requirements

At least 90 credit hours beyond the bachelor's degree, including a maximum of 30 credit hours of course work, with a minimum grade of "B" in each course, earned in a Master's degree in Electrical Engineering received at FIU or another accredited institution. The credit hours earned towards the Ph.D. program have the following requirements and restrictions:

1. At least 12 credits of Ph.D. Course Breadth Requirements.
2. At least 12 credits of course work at 6000 level of major field of interest.
3. Registration for Advanced Research is allowed only after successfully having passed the written comprehensive examination.
4. Registration for EEL 7980 (Research for Doctoral Dissertation) is allowed only after the student is admitted to candidacy. At least twenty-four dissertation hours are required.
5. At least 24 credit hours of 5000 or 6000 level electrical engineering courses are required. EEL 5935, 6905, 6916, 6932, 6971, 6977, and 7980 are not considered course work for the purpose of this 24 credit hours requirement.
6. Fifty percent of the hours accumulated 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 Guidelines in the Department for more details on how to select the committee members.

### Ph.D. Course Breadth Requirements

All potential Ph.D. candidates are required to take two two-course sequences for a total of 12 credits outside of their major area and receive a grade of "B" or better in each course. The appropriate areas of study are determined by the dissertation advisor. The student must submit to the Graduate Coordinator the sequences selected when he or 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 three areas of the examination. Failing one area 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 Guidelines 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 Research 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 Advisory 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 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](http://www.eng.fiu.edu/ece)

E-mail: [mohammed@fiu.edu](mailto: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

EEL - Engineering: Electrical

**EEL 5071 Bioelectrical Models (3).** Engineering models for electrical behavior of nerve and muscle cells, electrode-tissue junctions, volume conduction in tissue and the nervous system as an electrical network. Prerequisites: ELR 4202 or permission of the instructor. (F)

**EEL 5085 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)

**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 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: EEL 4304 or permission of the instructor.

**EEL 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: EEL 3396 or permission of the instructor. (S)

**EEL 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: EEL 3396 or permission of the instructor. (F)

**EEL 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, EEL 4304 or permission of the instructor. (F, every third year)

**EEL 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: EEL 4304, EEL 4410 or permission of the instructor. (F, every third year)

**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 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 5563 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, EEL 4314 and EEL 4410 or permission of the instructor. (F, alternating years)

**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 Digital Systems Engineering I (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: EEL 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 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 6075 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)

**EEL 6076 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: EEL 6075 or permission of the instructor. (S)

**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, EEL 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, EEL 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 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: EEL 4314 or permission of the instructor. (F, alternating years)

**EEL 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: EEL 6311 or permission of the instructor. (S, alternating years)

**EEL 6315 Advanced Solid State Electronics (3).** IC technologies, properties and fabrication concepts. Bipolar, MOS, I<sup>2</sup>L, CCD, bubble technologies. Ion implantation characteristics. Lithography techniques. Prerequisites: EEL 3396, EEL 4304 or permission of the instructor. (SS, every third year)

**EEL 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: EEL 3396. (SS, alternating years)

**EEL 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: EEL 5352. (F, alternating years)

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

**EEL 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: EEL 3396 and EEL 4410. Corequisite: Permission of the instructor.(S)

**EEL 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: EEL 3396. (S)

**EEL 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: EEL 3396. (F, alternating years)

**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, EEL 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, photo-detector, 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 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 4709 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 EEL 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 Digital Systems Engineering II (3).** Analysis and design of time shared digital electronic systems. Artificial intelligence and automation. Robotics and remote control systems. Advanced digital instrumentation and testing. Prerequisites: EEL 5725 or 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 4709 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 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 Patten 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 intergrated into the computer system design. Prerequisite: EEL 4709. (F, alternating years)

**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 (1-3).** 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 disseration 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 5010 Telecommunications Technology and Applications (3).** An in-depth introduction to voice and data networks, signaling and modulation, multiplexing,

frequency band and propagation characteristics, special analysis of signals, and traffic analysis. Prerequisite: Permission of the instructor.

**TCN 5030 Computer Communications and Networking Technologies (3).** Teaches the dynamics related to computer communications, how computers are grouped together to form networks, various networking implementation strategies, and current technologies. Prerequisite: Permission of the instructor.

**TCN 5060 Telecommunications Software and Methodologies (3).** A high-level look into network architectures and distributed applications, client-server models, network software platforms and advanced techniques for programs specifications through implementation. Prerequisites: TCN 5030 or permission of the instructor.

**TCN 5080 Secure Telecommunications Transactions (3).** Telecom and information security issues such as: digital signatures, cryptography as applied to telecom transactions, network policing, nested authentication, and improving system trust. Prerequisites: TCN 5030 or permission of the instructor.

**TCN 5150 Multimedia Computer Communications (3).** Covers multimedia computer communications technologies including, multimedia over networks, videoconferencing, telephone, compression algorithms and techniques for transmitting data efficiently. Prerequisites: TCN 6210 or permission of the instructor.

**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 5440 Software Development for Telecommunication Networks (3).** Focuses on the aspects, tools, and techniques of developing software applications for telecommunications networks. Prerequisites: TCN 5030 or equivalent.

**TCN 5445 Telecommunications Networking Programming (3).** Advanced telecommunications network programming skills including Router and Bridge Software, socket programming and protocol handler. Prerequisite: Permission from instructor.

**TCN 5455 Information Theory (3).** Entropy and measure of information. Proof and interpretation of Shannon's fundamental theorem for various channels, including noiseless, discrete, time-discrete and time-continuous channels. Prerequisite: Permission of the instructor.

**TCN 5640 Telecommunications Enterprise Planning and Strategy (3).** Methodologies for re-engineering, project management, strategic planning, change management, RFPs, and life-cycle management within the telecommunications and IT arena. Prerequisite: Permission of the instructor.

**TCN 6210 Telecommunications Network Analysis and Design (3).** A systematic, analytic and descriptive approach to the evaluation of telecommunications networks, networking principles, and control and quality of service. Prerequisite: Permission of the instructor.

**TCN 6230 Optical Networks (3).** Enabling technologies, multiplexing techniques, WDM, broadcast networks, wavelength-routed networks, network architectures, protocols, network algorithms, and device-network interfaces. Prerequisites: TCN 5030 or equivalent.

**TCN 6260 Internetworking (3).** The course will discuss advanced topics, current trends and control of internetworking. An analytical and descriptive approach will be used to cover the subject of internetworking.

**TCN 6270 Mobile and Wireless Networks (3).** Techniques in the design and operation of wireless networks; LANs, MANs, and WANs; analytical models; application of traffic and mobility models; mobility control, and wireless ATM. Prerequisites: TCN 5030 or equivalent.

**TCN 6275 Mobile Computing (3).** Enabling technologies and impediments of mobile computing. It includes mobile architectural design, mobile-aware and transparent adaptation, mobile data access and file systems, and ad-hoc networks. Prerequisite: Permission of the instructor.

**TCN 6420 Modeling and Performance Evaluation of Telecommunications Networks (3).** Covers methods and research issues in the models and performance evaluation of high-speed and cellular networks. Focuses on the tools from Markov queues, queuing networks theory and applications. Prerequisites: TCN 5030 or equivalent.

**TCN 6430 Networks Management and Control Standards (3).** Protocols for management of telecom networks, including Simple Network Management Protocol and Common Management Information Protocol. Extension of protocols to optimize network performance. Prerequisites: TCN 5030 or equivalent.

**TCN 6450 Wireless Information Systems (3).** Enabling technologies and impediments of wireless information systems. Focuses on software architectures, and information and location management in the wireless environment. Prerequisite: Permission of the instructor.

**TCN 6820 Industrial Development of Telecommunications (3).** This course, from a management perspective, addresses the evolution of the telecom industry, the impact it has on reshaping our world, and the importance of management decisions in telecom.

**TCN 6880 Telecommunications Public Policy Development and Standards (3).** A concept-oriented examination of the domestic and international telecommunications policy processes and standards setting environment. Prerequisite: Permission of the instructor.

**TCN 6XXX Graduate Seminar (0).** Investigation and report by graduate students on topics of current interest in telecommunication and networking. Prerequisites: Ph.D. classification and approval of 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.