

Electrical Engineering Department M.Sc. Study Plan

The Electrical Engineering Department offers the degree of Master of Science (M.Sc.) in two majors:

- 1- Communications and Electronics.
- 2- Control and Power.

The M.Sc. degree is obtained after completion of the following requirements:

L. Communications and Electronics Major

A. Thesis option

1) Compulsory Courses (13 Cr.)

♦ EE701:	Applied Mathematics for Engineers	3 Cr.
♦ EE705:	Random Processes	3 Cr.
♦ EE751:	Digital Data Transmission	3 Cr.
♦ EE760:	Statistical Signal Processing	3 Cr.
♦ EE790:	Electrical Engineering Seminar	1 Cr.

2) Elective Courses (12 Cr.): to be selected from Table 1 (at least 6 Cr.), and Table 2 (the remaining credits).

After approval of the electrical engineering department council, a student may study no more than 3 graduate-level credit hours from other departments in the faculty of engineering.

3) Master thesis (9 Cr.): to be finished within at least two semesters.

B. Comprehensive Exam Option

1) Compulsory Courses (19 Cr.)

♦ EE701:	Applied Mathematics for Engineers	3 Cr.
♦ EE705:	Random Processes	3 Cr.
♦ EE722:	Advanced Electronic Circuits	3 Cr.
♦ EE751:	Digital Data Transmission	3 Cr.
♦ EE753:	Optical Fiber Communications	3 Cr.
♦ EE760:	Statistical Signal Processing	3 Cr.
♦ EE790:	Electrical Engineering Seminar	1 Cr.

2) Elective Courses (15 Cr.): to be selected from Table 1 (at least 9 Cr.), and Table 2 (the remaining credits).

After approval of the electrical engineering department council, a student may study no more than 3 graduate-level credit hours from other departments in the faculty of engineering.

- 3) **EE798: Comprehensive exam.** This exam covers graduate courses, and is to be taken after completing all 34 credit hours above.

II. Control and Power Major

A. Thesis option

1) Compulsory Courses (13 Cr.)

- ♦ **EE701: Applied Mathematics for Engineers** 3 Cr.
- ♦ **EE710: Linear Systems** 3 Cr.
- ♦ **EE730: Advanced Power Systems Analysis** 3 Cr.
- ♦ **EE740: Advanced Analysis of Electrical Machines** 3 Cr.
- ♦ **EE790: Electrical Engineering Seminar** 1 Cr.

- 2) **Elective Courses (12 Cr.):** to be selected from Table 1 (at least 6 Cr.), and Table 2 (the remaining credits).

After approval of the electrical engineering department council, a student may study no more than 3 graduate-level credit hours from other departments in the faculty of engineering.

- 3) **Master thesis (9 Cr.):** to be finished within at least two semesters.

B. Comprehensive Exam Option

1) Compulsory Courses (19 Cr.)

- ♦ **EE701: Applied Mathematics for Engineers** 3 Cr.
- ♦ **EE710: Linear Systems** 3 Cr.
- ♦ **EE712: Advanced Control Systems** 3 Cr.
- ♦ **EE730: Advanced Power Systems Analysis** 3 Cr.
- ♦ **EE731: Power Systems Dynamics and Control** 3 Cr.
- ♦ **EE740: Advanced Analysis of Electrical Machines** 3 Cr.
- ♦ **EE790: Electrical Engineering Seminar** 1 Cr.

- 2) **Elective Courses (15 Cr.):** to be selected from Table 1 (at least 9 Cr.), and Table 2 (the remaining credits).

After approval of the electrical engineering department council, a student may study no more than 3 graduate-level credit hours from other departments in the faculty of engineering.

- 3) **EE798: Comprehensive exam.** This exam covers graduate courses, and is to be taken after completing all 34 credit hours above.

Table 1

EE 702:	Electromagnetic Waves and Radiation Systems
EE 703:	Electromagnetic Compatibility
EE 704:	Numerical Techniques in Electromagnetics
EE 705:	Random Processes
EE 706:	Microwave Circuits
EE 707:	Advanced Antenna Engineering
EE 708:	Advanced Radio Wave Propagation
EE 709:	Special Topics in Electromagnetics
EE 722:	Advanced Electronic Circuits
EE 723:	Surface Acoustic Waves
EE 724:	Solid-State Electronics
EE 725:	Optical Electronics
EE 729:	Special Topics in Electronics
EE 750:	Communication Networks
EE 751:	Digital Data Transmission
EE 752:	Error Control Coding
EE 753:	Optical Fiber Communications
EE 754:	Digital Mobile Communications
EE 755:	Detection and Estimation Theory
EE 756:	Advanced Digital Communications
EE 757:	Spread Spectrum Communications
EE 758:	Information and Coding Theory
EE 759:	Special Topics in Communications
EE 760:	Statistical Signal Processing.
EE 761:	Spectral Estimation.
EE 762:	Digital Image Processing
EE 763:	Multidimensional Spectra
EE 764:	Multirate Filtering and Filter Banks
EE 765:	Adaptive Signal Processing
EE 766:	Time Frequency Analysis
EE 767:	Neural Networks
EE 769:	Special Topics in Digital Signal Processing

Table 2

EE 710:	Linear Systems.
EE 711:	Nonlinear Systems.
EE 712:	Advanced Control Systems
EE 713:	Optimal Control.
EE 714:	Digital Control Systems
EE 715:	Stochastic Control.
EE 716:	Adaptive Control.
EE 719:	Special Topics in Control.
EE 730:	Advanced Power Systems Analysis.
EE 731:	Power Systems Dynamics and Control.
EE 732:	Operation of Power Systems.
EE 733:	Power Systems Planning.
EE 734:	Power Systems Transients.
EE 735:	High Voltage Engineering.
EE 736:	Switched Mode Converters.
EE 739:	Special Topics in Power.
EE 740:	Advanced Analysis of Electrical Machines.
EE 741:	Special Electrical Machines.
EE 749:	Special Topics in Electrical Machines.

Graduate Courses In Electrical Engineering

C. No.	Course Name	C.H.	Prerequisite Or Its Equivalent
EE 701	Applied Mathematics for Engineers	3	G. Standing
EE 702	Electromagnetic Waves and Radiation Systems	3	EE307, EE 701
EE 703	Electromagnetic Compatibility	3	EE307, EE 701
EE 704	Numerical Techniques in Electromagnetics	3	EE 307, EE701
EE 705	Random Processes	3	EE 301
EE 706	Microwave Circuits	3	EE 528
EE 707	Advanced Antenna Engineering	3	EE 702
EE 708	Advanced Radio Wave Propagation	3	EE 507, EE701
EE 709	Special Topics in Electromagnetics	3	Approval Dept. Council
EE 710	Linear Systems	3	G. Standing
EE 711	Nonlinear Systems	3	EE 701, EE 710
EE 712	Advanced Control Systems	3	EE 412
EE 713	Optimal Control	3	EE 712
EE 714	Digital Control Systems	3	EE 412
EE 715	Stochastic Control	3	EE 701, EE 712
EE 716	Adaptive Control	3	EE 712
EE 719	Special Topics in Control	3	Approval Dept. Council
EE 722	Advanced Electronic Circuits	3	EE 420
EE 723	Surface Acoustic Waves	3	EE 307
EE 724	Solid-State Electronics	3	EE 420, EE 701
EE 725	Optical Electronics	3	EE 307, EE 420
EE 729	Special Topics in Electronics	3	Approval Dept. Council
EE 730	Advanced Power Systems Analysis	3	EE 430
EE 731	Power Systems Dynamics and Control	3	EE 430
EE 732	Operation of Power Systems	3	EE 430, EE 701
EE 733	Power Systems Planning	3	EE 430, EE 701
EE 734	Power Systems Transients	3	EE 710, EE 730
EE 735	High Voltage Engineering	3	EE 538, EE 730
EE 736	Switched Mode Converters	3	EE 532
EE 739	Special Topics in Power	3	Approval Dept. Council
EE 740	Advanced Analysis of Electrical Machines	3	EE 431
EE 741	Special Electrical Machines	3	EE 740
EE 749	Special Topics in Electrical Machines	3	Approval Dept. Council
EE 750	Communication Networks	3	EE451
EE 751	Digital Data Transmission	3	EE 451

C. No.	Course Name	C.H.	Its Equivalent
Prerequisite Or			
EE 752	Error Control Coding	3	EE 451, EE 705
EE 753	Optical Fiber Communications	3	EE 307, EE 705
EE 754	Digital Mobile Communications	3	EE 451, EE 705
EE 755	Detection and Estimation Theory	3	EE 705
EE 756	Advanced Digital Communications	3	EE 451, EE 705
EE 757	Spread Spectrum Communications	3	EE705
EE 758	Information and Coding Theory	3	EE 451, EE 705
EE 759	Special Topics in Communications	3	Approval Dept. Council
EE 760	Statistical Signal Processing	3	EE 550, EE705
EE 761	Spectral Estimation	3	EE 760
EE 762	Digital Image Processing	3	EE 550
EE 763	Multidimensional Spectra	3	EE 761
EE 764	Multirate Filtering and Filter Banks	3	EE 760
EE 765	Adaptive Signal Processing	3	EE 760
EE 766	Time Frequency Analysis	3	EE 761
EE 767	Neural Networks	3	EE 550
EE 769	Special Topics in Digital Signal Processing	3	Approval Dept. Council
EE 790	Electrical Engineering Seminar	1	Approval Dept. Council
EE 798	Comprehensive Examination	0	Completion 34 hours
EE 799A	Thesis Research	6	
EE 799B	Thesis Research	3	
EE 799C	Thesis Research	0	EE799A, EE 799B

Graduate Courses In Electrical Engineering **(Course Descriptions)**

EE 701 Applied Mathematics for Engineers (3 Credits)

Sturm-Liouville problems and orthogonal functions in orthogonal coordinate systems, separation of variables, Fourier series, solution of boundary value problems for Laplace's equations, the heat diffusion equation and the wave equation in different coordinate systems, the Fourier integral, Bessel functions and Fourier-Bessel series, Legendre polynomials and Fourier-Legendre series.

Pre.: Graduate Standing.

EE 702 Electromagnetic Waves and Radiation systems (3 Credits)

Time harmonic fields and waves in linear media with applications to radiation, guiding and scattering, wave and surface impedance and admittance concepts, duality, uniqueness, image theory, equivalence principle, induction and compensation theorems, Green's functions and wave functions.

Pre. : EE 307, EE 701

EE 703 Electromagnetic Compatibility (3 Credits)

Interference phenomena, noise reduction techniques, shielding, grounding, EMI filters, noise sources.

Pre.: EE 307, EE 701

EE 704 Numerical Techniques in Electromagnetics (3 Credits)

Analytical methods, variational methods, finite element methods, integral equation techniques and the method of moments, finite difference methods.

Pre: EE 307, EE 701

EE 705 Random Processes (3 Credits)

Stationarity, continuity, ergodicity, power spectrum and systems, filtering and prediction, harmonic analysis, nonstationary normal processes, random processes in linear and nonlinear systems,

Pre: EE 301

EE 706 Microwave Circuits (3 Credits)

Analysis of lossy and lossless transmission lines and waveguides, ferrite materials. analysis of microwave components such as phase shifters and directional couplers scattering parameters, microwave network analysis, analysis and design of filters, dielectric resonators.

Pre.: EE 528

EE 707 Advanced Antenna Engineering (3 Credits)

Radiation phenomenon, design parameters: pattern, radiation intensity, directivity, EIRP, radiation impedance, effective area, aperture theory, aperture antennas: horns, reflectors, feeds, microstrip patch radiators, noise analysis in antennas and radar, array antennas, antenna synthesis, shaped beams and low side lobe designs.

Pre.: EE 702

EE 708 Advanced Radio Wave propagation (3 Credits)

Ground wave, sky wave, and microwave propagation, propagation in urban and rural areas, propagation in buildings, human being modeling for personal communication. design and analysis of antennas used in personal communication, noise analysis.

Pre : EE 507, EE 701

EE 709 Special Topics in Electromagnetics (3 Credits)

Pre: Approval of Department Council

EE 710 Linear Systems (3 Credits)

Mathematical description of systems, fundamental of matrix algebra and quadratic forms, state space solution and realization of linear systems, stability of linear and nonlinear systems, controllability and observability, minimal realization and coprime fractions state feedback and state estimators.

Pre : Graduate Standing

EE 711 Nonlinear Systems (3 Credits)

Discrete and continuous time systems, equilibrium solutions of continuous time systems, periodic solutions, chaos, period-doubling scenario and crisis, numerical methods for continuation of fixed points, turning and branch points, control of bifurcations and chaos.

Pre : EE 701, EE 710

EE 712 Advanced Control Systems (3 Credits)

Input-output stability (BIBO), asymptotic stability of linear time variant and invariant systems, Lyapunov's stability methods, observability and controllability for linear and nonlinear systems, pole-placement, tracking problems, observer design, stabilizability of systems, linear quadratic regulator problem (LQR).

Pre : EE 412

EE 713 Optimal Control (3 Credits)

State variable models, solution of the state equations, stability of linear systems, state feedback, continuous output-feedback; unconstrained optimal control, the linear quadratic control problem, minimum energy control, variational calculus, optimal control in the presence of control constraints, the minimum principle of pontryagin. The course contains lab. simulation components.

Pre: EE 712.

EE 714 Digital Control Systems (3 Credits)

Linear difference equations, Z-transform, sampling theorem, discrete transfer functions, sampled data systems, design of digital control systems using transform techniques and state space methods, quantization effects, system identification, multivariable and optimal control of digital systems, sample rate selection, nonlinear control, application and practice of digital control.

Pre : EE 412

EE 715 Stochastic Control (3 Credits)

Linear filtering theory in continuous time, optimal stochastic control for linear dynamic systems with quadratic payoff, optimal stochastic control with complete and partial observation, optimal control of linear stochastic systems, nonlinear filtering theory, separation

principle, Bellman equation, stochastic maximum principle and dynamic programming for systems with partial observation, application to the stochastic maximum principle.

Pre : EE 701, EE 712

EE 716 Adaptive Control (3 Credits)

Pole-placement design, indirect and direct self-tuning regulators, continuous-time self-tuners, design of minimum-variance and moving average controllers, stochastic self tuning regulators, unification of direct self tuning regulators, linear quadratic STR, adaptive predictive control, MIT rule, Lyapunov theory, design of model reference adaptive systems (MRAS) using Lyapunov theory, application to adaptive control, stochastic adaptive control, auto-tuning, gain scheduling.

Pre : EE 712

EE 719 Special Topics in Control (3 Credits)

Pre: Approval of Department Council

EE 722 Advanced Electronic Circuits (3 Credits)

Models for integrated circuit active devices, analog integrated circuit, single-transistor and two-transistor amplifiers, transistor current sources and active loads, output stages, operational amplifier, frequency response of integrated circuits, stability of feedback amplifiers, the course contains lab./ simulation component.

Pre.: EE 420

EE 723 Surface Acoustic Wave (3 Credits)

Elastic waves, static elasticity, dynamic elasticity, isotropic solids and surface elastic waves, piezoelectricity, elastic waves and surface waves in piezoelectric solids. Generation and detection of surface acoustic waves, SAW delay lines, and acoustic-electric drives.

Pre.: EE 307

EE 724 Solid-State Electronics (3 Credits)

Crystal properties and structure, lattice vibration, Schroedinger wave equation, energy bands and charge carriers in semiconductors, excess carriers in semiconductor junctions, bipolar junction transistor, field-effect transistor.

Pre.: EE 420, EE 701.

EE 725: Optical Electronics (3 Credits)

Propagation in Crystals, optical waveguides, optical resonators, laser oscillation. electro-optics modulation, optical detection, coupled-mode theory, periodic structures, birefringence, gratings, isolators, lasers: DBF, DBR, MQW. Filters, waveguide couplers, transfer matrix method, Bragg reflector, channel waveguides, strip waveguides, polarization manipulation, frequency conversion, integrated optics, laser arrays.

Pre : EE 307, EE 420

EE 729 Special Topics in Electronics (3 Credits)

Pre : Approval Of Department Council

EE 730 Advanced Power Systems Analysis (3 Credits)

Power system matrices, short circuits studies, load flow studies, fast decoupled flow method, DC load flow method, sparsity programming, power system security, state estimation in power systems. The course contains lab. simulation component.

Pre.: EE 430

EE 731 Power Systems Dynamics and Control (3 Credits)

Modeling of power system components: synchronous machines, excitation systems voltage regulators, governors steam turbines, boilers and nuclear reactors, the megawatt frequency control problem, the megavar-voltage control problem, supplementary controls, short-term, mid-term and long – term dynamics of power systems, optimal control of power systems, dynamic equivalents of power systems.

Pre.: EE 430

EE 732 Operation of Power Systems (3 Credits)

Characteristics of power generation units, economic dispatch of thermal units and methods of solution, transmission losses, unit commitment, generation with limited energy supply, hydrothermal coordination, energy production cost models for fuel budgeting and planning, interchange evaluation and power pools.

Pre.: EE 430, EE 701

EE 733 Power Systems Planning (3 Credits)

System planning, load forecast, generation planning: economics and reliability transmission planning and reliability, composite system reliability, VAR planning.

Pre. : EE 430, EE 701

EE 734 Power Systems Transients (3 Credits)

Transients in lumped parameters circuits, transient recovery voltage, resistance damping, current chopping, capacitance switching, restrikes in circuit breakers, magnetizing inrush currents, interruption of direct currents, electrostatic and electromagnetic induction, electromagnetic shielding, wave propagation and reflection in multi-conductor systems, lightning : models and shielding, surge suppression devices.

Pre : EE 710, EE 730

EE 735 High Voltage Engineering (3 Credits)

Electrical insulating materials, field plotting, generation of high voltages, high voltage measurements, high voltage testing, partial discharges, high voltage design and applications.

Pre : EE 538, EE 730

EE 736 Switched Mode Converters (3 Credits)

Overview of power semiconductor devices, DC – DC converters with electrical isolation, voltage mode control, current mode control, DC –AC converters, PWM inverters, H – bridge inverters, , advanced modeling and simulation of switched mode converters.

Pre: EE 532

EE 739 Special Topics in Power (3 Credits)

Pre: Approval of Department Council

EE 740 Advanced Analysis of Electrical Machines (3 Credits)

Unbalanced duty of 3-phase transformers, asymmetrical steady state duties of 3 – phase synchronous generators, unbalanced duty of induction machines, transients of transformers: inrush current, sudden short circuit, mechanical forces at short circuit, the generalized theory of electrical machines, transients and the generalized theory of electrical machines, transients and dynamics of DC and AC machines (synchronous and induction).

Pre. : EE 431

EE 741 Special Electric Machines (3 Credits)

DC servo motors, AC servo motors, reluctance motors, microdrives, propulsion of robot end-effectors, linear induction motors, linear synchronous motors, DC linear motors, magnetic levitation, high speed ground transportation system

Pre.: EE 740

EE 749 Special Topics in Electrical Machines(3 Credits)

Pre: Approval of Department Council

EE 750: Communication Networks (3 Credits)

Design of communication networks, modems, terminals, error control, multiplexing. network architectures. topologies. media. data concentration, switching, routing. traffic control, protocols, case studies.

Pre : EE 451

EE 751: Digital Data Transmission (3 Credits)

Elements of communication theory and information theory applied to digital communication systems, characterization of noise and channel models. analysis of digital data transmission techniques for additive Gaussian noise channels. efficient modulation and coding for reliable transmission.

Pre : EE 451

EE 752: Error Control Coding (3 Credits)

Algebraic Concepts, linear block codes, cyclic codes, decoding of cyclic codes, BCH codes, finite geometry codes, burst error correcting codes, convolutional codes, maximum likelihood decoding, sequential decoding, burst error correcting convolutional codes, automatic repeat request strategies, applications of block coding to data storage systems.

Pre : EE 451, EE 705

EE 753: Optical Fiber Communications (3 Credits)

Wave propagation in fibers, attenuation and dispersion, light sources and detectors, optical detection, receiver noise, intensity modulation systems, heterodyne systems. optical networking.

Pre : EE 307, EE 705

EE 754: Digital Mobile Communications (3 Credits)

Channel characterization: fast and slow fading, Rayleigh, Rician and lognormal models, frequency selectivity, delay spread and coherence bandwidth. Signal transmission, error rate performance of spectrally efficient digital modulation schemes under fading conditions, interference: system performance, diversity schemes, interference and noise. cellular mobile systems: frequency planning, interference control, hand-off and vehicle location techniques, mobile radio systems applications.

Pre : EE 451, EE 705

EE 755: Detection and Estimation Theory (3 Credits)

Decision theory, hypothesis testing, Bayes' criterion, detection of known and random signals, Neyman-Pearson criterion, minimax criterion, optimum receiver design. estimation theory, estimation of signal parameters, Wiener filters, Kalman filters.

Pre : EE 705

EE 756: Advanced Digital Communications (3 Credits)

Digital signaling over channels with ISI and AWGN, error probability analysis. Fading multipath channels in terrestrial line-of-sight (LOS) and mobile/portable communications, diversity concepts, modeling and error probability performance evaluation, synchronization in digital communications, spread spectrum in digital transmission over multipath fading channels.

Pre : EE 451, EE 705

EE 757: Spread Spectrum Communications (3 Credits)

Jamming, energy allocation, system configurations, energy gain. antijam systems: parameters, jammer waveforms, uncoded and coded direct sequence BPSK, uncoded and coded direct sequence BFSK, coded BER bounds, cutoff rates, DS-BPSK and pulse jamming bounds, FH-MFSK and partial band jamming bounds, diversity for FH-MFSK, concatenation of codes, pseudonoise generators, DS and FH multiple access design. code synchronization.

Pre : EE 705

EE 758: Information and Coding Theory (3 Credits)

Source coding, channel coding and data encryption, entropy, mutual information and average mutual information, discrete source coding, stationary sources, ergodic sources, Markovian sources, the source coding theorem, data compression, rate distortion function, channel coding, data transmission over discrete noisy channels, capacity of DMC's, discrete channels with memory, the channel coding theorem, block codes and tree codes, continuous channels and sources.

Pre : EE 451, EE 705

EE 759: Special Topics in Communications (3 Credits)

Pre : Approval of Department Council

EE 760: Statistical Signal Processing (3 Credits)

Discrete time random processes, signal modelling, the Levinson recursion, lattice filters, Wiener filtering, discrete Kalman filters.

Pre : EE 550, EE 705

EE 761 Spectral Estimation (3 Credits)

Review of matrix algebra, classical spectral estimation, parametric modeling, autoregressive spectral estimation, moving average spectral estimation, moving average spectral estimation, regressive moving average, minimum variance spectral estimation,

Pre : EE 760

EE 762: Digital Image Processing (3 Credits)

Two-dimensional discrete systems, design of two-dimensional filters, digital image processing, human perception of images, colour models, picture processing, sampling and data compression, picture enhancement, restoration and analysis hardware and software implementation.

Pre : EE 550

EE 763: Multidimensional Spectra (3 Credits)

Cumulants and cumulants spectra, polyspectra of deterministic signals, estimation of polyspectra, parameter estimation, detection and characterization of nonlinearities

Pre : EE 761

EE 764 Multirate Filtering and Filter Banks (3 Credits)

Review of digital filters, fundamental of multirate systems, maximally decimated filter banks, cosine modulated filter banks, multirate filter banks, the wavelet transform and relation to multirate filter banks.

Pre : EE 760

EE 765 Adaptive Signal Processing (3 Credits)

Linear filtering problem, Wiener filters, steepest descent method, LMS adaptive filter, variants of the LMS, transform domain and suboptimal adaptive filtering. IIR adaptive filtering, least square formulation, lattice filters, applications: equalization, acoustic echo cancellation etc...

Pre : EE 760

EE 766 Time Frequency Analysis (3 Credits)

The time and frequency description of signals, instantaneous frequency, the uncertainty principle, short time Fourier transform, the Wigner distribution, joint scale representations.

Pre : EE 761

EE 767 Neural Networks (3 Credits)

Neural networks for representations, unsupervised and supervised network for classification, neural networks for generalization and restoration, optimization techniques, neurodynamics.

Pre: EE 550

EE 769 Special Topics in Digital Signal Processing (3 Credits)

Pre: Approval of Department Council

EE 790 Electrical Engineering Seminar (1 Credits)

Pre: Graduate Standing

EE 798 Comprehensive Examination (0 Credits)

Pre: Completion of 34 C. H.

EE 799A Thesis Research (6 Credits)

EE 799B Thesis Research (3 Credits)

EE 799 C Thesis Research (0 Credits)

Pre: Student must have completed 9 hours of thesis registration