Electrical & Electronics Engineering Department

Construction of Proposed MSc. Programs in Electronics and Communication and Electrical Power Engineering

The curriculum incorporates uniform requirements for the MSc. program that apply to all students in the department regardless of their area of study. The curriculum allows flexibility in the selection of courses by students and their department advisers, in an effort to promote and encourage multi-disciplinary education and research.

MSc. students may select either the **thesis plan** or the **non-thesis plan**. The selection of courses is tailored to the student's professional objectives and must fallow the categories stated below. The selection between these plans is based on the student choice, however, this is based also on the available plan. The courses should be selected and approved in consultation with the student's department adviser. The required courses for the MSc. Program are as categorized as follows:

Block No. I: General Electrical and Electronics Engineering Courses:

This block contains four compulsory modules designed for all the students registered in Electrical Engineering MSc. Programs.

No.	edoC	eltiT esruoC	stinU	etisiuqererP
1	601EG	scitamehtaM gnE decnavdA.	3	---
2	602EG	sisylanA laciremuN decnavdA	3	---
3	EE603	Digital Signal Processing	3	---
4	EE641	noitalumiS dna gniledoM	3	---

Block No. II: Compulsory Courses

This block consists of three compulsory modules designed for all the MSc. students registered in Electronics and Communication and Electrical Power Engineering Program. The prerequisite for this block modules is passing all the modules in block No. I.

The courses assigned for this block are designed for each of the available majors: Electrical Power Engineering and Electronics and Communication Engineering.

Electrical Power Engineering:

No.	Code	eltiT esruoC	stinU	etisiuqererP
5	681EE	sisylanA senihcaM lacirtcelE	3	GE601
6	EE602	Advanced Power System Analysis	3	GE602+GE641
7	EE621	Advanced Power Electronics	3	EE603

Electronics and Communication Engineering:

No.	edoC esruoC	eltiT esruoC	stinU	etisiuqererP
5	EE631	skrowteN ataD	3	
6	EE602	Probability, Statistics and	3	

		Random Processes		
7	EE621	Advanced Electronics	3	
8	EE651	Wireless Communications	3	

1) Elective Courses

These courses are arranged, based on compulsory courses, into four categories. Each category can include some courses in the same field. The selection of these courses may also be related to the MSc. research project under the supervision of the department.

No.	Course Code	Course Title	Units	Prerequisite
9	EE799	MSc. Research Project	6	
10	EE731	Broadband Convergent Network	3	skrowteN ataD
11	EE732	Wireless Communication Networks	3	skrowteN ataD
12	EE733	Optical Fiber Communication Networks	3	skrowteN ataD
13	EE734		3	skrowteN ataD
14	EE73x	Special Topics in Networking	3	skrowteN ataD
15	EE701	Adaptive Filtering	3	Advanced Digital Signal Processing
16	EE702	Detection and Estimation	3	Advanced Digital Signal Processing
17	EE703	Advanced Digital Image Processing	3	Advanced Digital Signal Processing
18	EE704	Advanced Digital Signal Processing Circuit Design	3	Advanced Digital Signal Processing
19	EE705	Digital Speech Processing	3	Advanced Digital Signal Processing
20	EE706	Optimization Methods	3	Advanced Digital Signal Processing
26	EE707	Signal Processing in Communications	3	Advanced Digital Signal Processing
27	EE70x	Selected Topics in DSP	3	Advanced Digital Signal Processing
28	EE721	Advanced Digital Integrated Circuits	3	Advanced Electronics
29	EE722	Analysis and Design of RF Circuits and Systems	3	Advanced Electronics
30	EE723	Analog Micro-system Design	3	Advanced Electronics
32	EE725	Microwave Circuits Design	3	Advanced Electronics
33	EE726	Data Acquisition and Control	3	
34	EE727	Integrated Circuits Fabrication Processes	3	Advanced Electronics
35	EE72x	Selected Topics in Electronics	3	Advanced Electronics
36	EE751	Estimation and Detection in Communication and Radar Systems	3	Wireless Communications
37	EE752	Information Theory: Channel and Source Coding	3	
38	EE753	Wireless Communication	3	Wireless

		Links and Antennas		Communications
39	EE754	Microwave Wireless Design	3	Wireless Communications
40	EE755	Nonlinear Optics	3	
41	EE756	Fiber Optic System Design	3	
42	EE757	Reflector Antennas Synthesis, Analysis, and Measurement	3	Wireless Communications
43	EE758	Error Correcting Codes	3	
44	EE759	Computational Methods for Electromagnetics	3	Wireless Communications
45	EE7xx	Selected Topics in Wireless Communications	3	Wireless Communications

EE731 -Broadband Convergent Network: Lecture:3 hours.

Introduction / review to the principal of computer networks and protocols, PSTN, Mobile IP. QoS in IP: Integrated Services, Differentiated Services.
Traffic & Congestion control in ATM networks: ATM services, Traffic control mechanisms, Traffic shaping.
GPRS/UMTS/LTE Evolution,4G mobile networks.
VOIP:VOIP QoS issues,Multimedia Control Protocols: H323; H324: Session Initiation Protocol (SIP).
Soft Switching ،Convergent Networks.
Service Delivery Platforms (SDP):IP Multimedia Subsystem (IMS), OSA/Parlay, Next Generation Billing Systems.
Passive Optical Networks (PON):Types of Passive Optical Networks: EPON/APON/GPON, Layer 2& 1 in PON.

EE701 - Probability, Statistics and Random Processes: Lecture:3 hours.

Probability Models in Electrical and Computer Engineering: Mathematical Models as Tools in Analysis and Design, Deterministic Models, Probability Models.
Basic Concepts of Probability Theory: Specifying Random Experiments, The Axioms of Probability, Computing Probabilities Using Counting Methods, Conditional Probability, Independence of Events, Sequential Experiments, Synthesizing Randomness: Random Number Generators, Fine Points: Event Classes, Fine Points: Probabilities of Sequences of Events.
Discrete Random Variables: The Notion of a Random Variable, Discrete Random Variables and Probability Mass Function, Expected Value and Moments of Discrete Random Variable, Conditional Probability Mass Function, Important Discrete Random Variables, Generation of Discrete Random Variables.
One Random Variable: CDF, PDF, Functions of a Random Variable, The Markov and Chebyshev Inequalities, Transform Methods, Reliability Calculations, Computer Methods for Generating Random Variables, Entropy.
Pairs of Random Variables: Two Random Variables, Pairs of Discrete Random Variables, Joint cdf and Joint pdf of Two Continuous Random Variables, Independence of Two Random Variables, Joint Moments and Expected Values of a Function of Two Random Variables, Conditional Probability and Conditional Expectation, Pairs of Jointly Gaussian Random Variables, Generating Independent Gaussian Random Variables.
Vector Random Variables: Expected Values of Vector Random Variables, Jointly Gaussian Random Vectors, Estimation of Random Variables, Generating Correlated Vector Random Variables.
Sums of Random Variables and Long-Term Averages: Sums of Random Variables, The

Sample Mean and the Laws of Large Numbers, Weak and Strong Laws of Large Numbers, Central Limit Theorem, Convergence of Sequences of Random Variables, Long-Term Arrival Rates and Associated Averages, Calculating Distribution's Using the Discrete Fourier Transform
Statistics: Sampling Distributions, Parameter Estimation, Maximum Likelihood Estimation, Confidence Intervals, Hypothesis Testing, Bayesian Decision Methods, Testing the Fit of a Distribution to Data.
Random Processes: Specifying a Random Process, Discrete-Time Processes, Random Walk, Poisson and Associated Random Processes, Gaussian Random Processes, Wiener Process, and Brownian Motion and Stationary Random Processes, Continuity, Derivatives, Integrals of Random Processes, Time Averages of Random Processes and Ergodic Theorems, Fourier Series and Karhunen-Loeve Expansion, Generating Random Processes.
Analysis and Processing of Random Signals: Power Spectral Density, Response of Linear Systems to Random Signals, Bandlimited Random Processes, Optimum Linear Systems, The Kalman Filter, Estimating the Power Spectral Density, Numerical Techniques for Processing Random Signals.
Text Book.: Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition

EE603 - Digital Signal Processing: Lecture:3 hours; laboratory:2 hours.

Review of continuous-time and discrete-time signals, Z-transform, Discrete Fourier transform and Fast Fourier transform. Review of digital filters and digital filter design techniques. Multirate DSP, Multi-rate Filter Banks and Wavelets, Linear Prediction and Optimum Linear Filters, Introduction to Adaptive Digital Filters, Spectrum Estimation and Analysis, Experiments involving A/D and D/A conversion, aliasing, digital filtering, sinusoidal oscillators, Fourier transforms, and finite wordlength effects. Course project involving original design and implementation of signal processing systems for communications, speech, audio, or video using DSP chip.

Text Book:
1) John G. Proakis and Dimitris Manolakis, Digital Signal Processing Principles, algorithms and Applications.
2) Sanjit K. Mitra, Digital Signal Processing A computer-Based Approach, 3rd edition.
3) Emmanuel Ifeachor and Barrie Jervis, Digital Signal Processing Apracticle Approach, 2nd edition.

EE 621- Advanced Electronics: Lecture: 3 hours

Analysis and design of analog integrated circuits. MOS and bipolar device structures and models, single-stage and differential amplifiers, noise, feedback, operational amplifiers, offset and distortion, sampling devices and discrete-time circuits, bandgap references.

Text Book:
1) Gray, Hurst, Lewis, and Meyer, Analysis and Design of Analog Integrated Circuits.
2) Razavi, Design of Analog CMOS Integrated Circuits.

EE 651 - Wireless Communications: Lecture: 3 hours.

Channel and propagation modeling: fading channels, multi-dimensional propagation, analytical MIMO channel representations, physical MIMO channel models. MIMO Capacity: ergodic capacity of iid, correlated and rician fading channels, Outage Capacity

and Diversity-Multiplexing Trade-Off of iid, correlated and rician fading channels. Space-Time Coding in iid channels: Error Probability and information theory based design for fast and slow fading channels, Space-Time Block Coding, Spatial Multiplexing, D-BLAST, Orthogonal and Quasi-orthogonal codes, Linear dispersion codes, Algebraic codes, Space-time trellis codes. MIMO receiver: Linear receivers, decision feedback receiver, lattice and sphere decoding. Space-time coding for general channels: error probability for fast and slow general fading channels, universal code design, catastrophic codes. Space-time coding with partial transmit channel knowledge: channel statistics based precoding, quantized precoding. Space-time coding for frequency selective channels: ergodic capacity and outage capacity, diversity multiplexing tradeoff, code design for single-carrier and multi-carrier. Multi-User MIMO: Capacity of Multi-User MIMO channels (Broadcast and Multiple-access channels), Multi-User Diversity and Scheduling, Multi-User MIMO Linear Precoding, Multi-User MIMO Non-Linear Precoding, Multi-User MIMO Precoding with Partial Transmit Channel Knowledge. Multi-Cell MIMO: Capacity of Coordinated and Cooperative Multi-Cell MIMO Channels, Multi-Cell Resource Allocation, Multi-Cell Coordination and cooperation, coordinated scheduling, beamforming and power control. MIMO in LTE, LTE-Advanced and WiMAX

Text Book: B. Clerckx and C. Oestges, "MIMO Wireless Networks: Channels, Techniques and Standards for Multi-Antenna, Multi-User and Multi-Cell Systems", Academic Press (Elsevier), Oxford, UK, Jan 2013.

Tse, David, and Pramod Viswanath. *Fundamentals of Wireless Communication.* Cambridge: Cambridge UP, 2005. Print.

EE702 - Adaptive Filtering: Lecture: 3 hours, laboratory: 2 hours.

Optimal filtering and estimation, Wiener filters, linear prediction. Steepest descent and stochastic gradient algorithms. Frequency-domain adaptive filters. Method of least squares, recursive least squares, fast fixed-order and order-recursive (lattice) filters. Missadjustment, convergence, and tracking analyses, stability issues, finite precision effects. Connections with Kalman filtering. Nonlinear adaptive filters.

Text Book:

A. H. Sayed, Adaptive Filters, Wiley, NJ, 2008 (main text).
A. H. Sayed, Fundamentals of Adaptive Filtering, Wiley, NJ, 2003

EE703 - Optimal Linear Estimation: Lecture: 3 hours.

Unified treatment of fundamental concepts and basic notions in adaptive filtering, Wiener filtering, Kalman filtering, and H_oo?? filtering. Emphasis on geometric, equivalence, and duality arguments. Development of array methods and fast algorithms. Discussion of practical issues. Examples of applications from fields of signal processing, communications, biomedical engineering, finance, and control.

Ref.: T. Kailath, A. H. Sayed, and B. Hassibi, Linear Estimation, Prentice Hall, NJ, 2000

EE704 - Advanced Digital Image Processing: Lecture: 3 hours; laboratory:2 hours.

Advanced digital image processing theory and techniques. Topics include modeling, restoration, still-frame and video image compression, tomographic imaging, and multiresolution analysis using wavelet transforms.

Text Book:A. K. Jain, Fundamentals of Digital Image Processing

EE705 - Advanced Digital Signal Processing Circuit Design: Lecture: 3 hours

Digital filter design and optimization tools, architectures for digital signal processing circuits; integrated circuit modules for digital signal processing; programmable signal

processors; CAD tools and cell libraries for application-specific integrated circuit design; case studies of speech and image processing circuits.

Text Book:

- Proakis, J.G., Digital Signal Processing : Principles, Algorithms, and Applications (recommended).
- Vaidyanathan, P.P, Multirate Systems and Filter Banks (recommended).
- Wolf, W., Modern VLSI Design: Systems on Silicon (recommended).
- Rabaey, J.M., Digital Integrated Circuits: A Design Perspective (recommended).

EE706 - Digital Speech Processing: Lecture: 3 hours; laboratory, two hours.

Theory and applications of digital processing of speech signals. Mathematical models of human speech production and perception mechanisms, speech analysis/synthesis. Techniques include linear prediction, filter-bank models, and homomorphic filtering. Applications to speech synthesis, automatic recognition, and hearing aids.

Text Book: Digital Speech Processing but Rabiner and Schafer, 2010

EE707 – Optimization Methods: Lecture: 3 hours

Motivation. mathematical review , matrix factorizations, sets and sequences, convex sets and functions, linear programming and simplex method, Weierstrass' theorem, Karush Kuhn Tucker optimality conditions, algorithms, convergence, unconstrained optimization, Line search methods, method of multidimensional search, steepest descent methods, Newton's method, modificationsto Newton's method , trust region methods, conjugate gradient methods, quasi-Newton's methods. constrained optimization, penalty and barrier function methods, augmented Lagrangian methods, polynomial time algorithm for linear programming, successive linear programming, successive quadratic programming.

Text Book:

- R. Fletcher Practical Optimization (2nd Edition) John Wiley & Sons, New York, 1987.
- M. S. Bazaraa , H. D. Sherali and C. Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley and Sons, New York, 1993.
- Conve Optimization by Boyd L. Vandenberghe, 2004
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EE708 - Signal Processing in Communications: Lecture: 3 hours

Basic digital signal processing techniques for estimation and detection of signals in communication and radar systems. Optimization of dynamic range, quantization, and state constraints; DFT, convolution, FFT, NTT, Winograd DFT, systolic array; spectral analysis-windowing, AR, and ARMA; system applications.

EE721 - Advanced Digital Integrated Circuits: Lecture: 3 hours

Analysis and comparison of modern logic families (CMOS, bipolar, BiCMOS, GaAs). MSI digital circuits (flipflops, registers, counters, PLAs). VLSI memories (ROM, RAM, CCD, bubble memories, EPROM, EEPROM) and VLSI systems.

EE722 - Analysis and Design of RF Circuits and Systems: Lecture: 3 hours

Principles of RF circuit and system design, with emphasis on monolithic implementation in VLSI technologies. Basic concepts, communications background, transceiver architectures, low-noise amplifiers and mixers, oscillators, frequency synthesizers, power amplifiers.

EE723 - Analog Microsystem Design: Lecture: 3 hours

Analysis and design of data conversion interfaces and filters. Sampling circuits and architectures, D/A conversion techniques, A/D converter architectures, building blocks, precision techniques, discrete- and continuous-time filters.

EE724 - Signaling and Synchronization: Lecture: 3 hours

Analysis and design of circuits for synchronization and communication for VLSI systems. Use of both digital and analog design techniques to improve data rate of electronics between functional blocks, chips, and systems. Advanced clocking methodologies, phase-locked loop design for clock generation, and high- performance wire-line transmitters, receivers, and timing recovery circuits.

EE725 - Microwave Circuits Design: Lecture: 3 hours

Transmission lines description of waveguides, impedance transformers, power dividers, directional couplers, filters, hybrid junctions, nonreciprocal devices. Theory and design of microwave transistor amplifiers and oscillators; stability, noise, distortion.

EE726 - Integrated Circuits Fabrication Processes: Lecture: 3 hours

Principles of integrated circuits fabrication processes. Technological limitations of integrated circuits design. Topics include bulk crystal and epitaxial growth, thermal oxidation, diffusion, ion-implantation, chemical vapor deposition, dry etching, lithography, and metallization. Introduction of advanced process simulation tools.

EE751 - Estimation and Detection in Communication and Radar Engineering: Lecture: 3 hours

Applications of estimation and detection concepts in communication and radar engineering; random signal and noise characterizations by analytical and simulation methods; mean square (MS) and maximum likelihood (ML) estimations and algorithms; detection under ML, Bayes, and Neyman/Pearson (NP) criteria; signal-to-noise ratio (SNR) and error probabilityevaluations.

EE752 - Information Theory: Channel and Source Coding: Lecture: 3 hours

i. *Fundamental limits on compression and transmission of information. Topics include limits and algorithms for lossless data compression, channel capacity, rate versus distortion in lossy compression, and information theory for multiple users.*
ii. *Fundamentals of error control codes and decoding algorithms. Topics include block codes, convolutional codes, trellis codes, and turbo codes.*

EE753 - Wireless Communication Links and Antennas: Lecture: 3 hours

Basic properties of transmitting and receiving antennas and antenna arrays. Array synthesis. Adaptive arrays. Friis transmission formula, radar equations. Cell-site and mobile antennas, bandwidth budget. Noise in communication systems (transmission lines, antennas, atmospheric, etc.). Cell-site and mobile antennas, cell coverage for signal and traffic, interference, multipath fading, ray bending, and other propagation phenomena.

EE754 - Microwave Wireless Design: Lecture: 3 hours

Microwave integrated circuit design from wireless system perspective, with focus on (1) use of microwave circuit simulation tools, (2) design of wireless frontend circuits including low noise amplifier, mixer, and power amplifier, (3) knowledge and skills required in wireless integrated circuit characterization and implementation.

EE755 - Nonlinear Optics: Lecture: 3 hours

Nonlinear optical susceptibilities. Coupled-wave formulation. Crystal optics, electro-optics,

and magneto-optics. Sum- and difference-frequency generation. Harmonic and parametric generation. Stimulated Raman and Brillouin scattering. Four-wave mixing and phase conjugation. Field-induced index changes and self-phase modulation.

EE756 - Fiber Optic System Design: Lecture: 3 hours

Top-down introduction to physical layer design in fiber optic communication systems, including Telecom, Datacom, and CATV. Fundamentals of digital and analog optical communication systems, fiber transmission characteristics, and optical modulation techniques, including direct and external modulation and computer-aided design. Architectural-level design of fiber optic transceiver circuits, including preamplifier, quantizer, clock and data recovery, laser driver, and predistortion circuits.

EE757 - Reflector Antennas Synthesis, Analysis, and Measurement: Lecture: 3 hours

Reflector pattern analysis techniques. Single and multireflector antenna configurations. Reflector synthesis techniques. Reflector feeds. Reflector tolerance studies, including systematic and random errors. Array-fed reflector antennas. Near-field measurement techniques. Compact range concepts. Microwave diagnostic techniques. Modern satellite and ground antenna applications. Letter grading.

EE758 - Error Correcting Codes: Lecture: 3 hours.

Linear block codes : Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the MacWilliams identities; Perfect codes.;Introduction to finite fields and finite rings;factorization of (X^n-1) over a finite field; Cyclic Codes.; BCH codes; Idempotents and Mattson-Solomon polynomials; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes. ;Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm; Convolution codes; Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm.

Ref.:

- F.J. MacWilliams and N.J.A. Slone, The theory of error correcting codes, 1977.
- R.E. Balahut, Theory and practice of error control codes, Addison Wesley, 1983.

EE759 - Computational Methods for Electromagnetics: Lecture: 3 hours

Computational techniques for partial differential and integral equations: finite- difference, finite-element, method of moments. Applications include transmission lines, resonators, integrated circuits, solid-state device modeling, electromagnetic scattering, and antennas.