Bachelor of Science in Electronics

Department of Electronics
Quaid-i-Azam University
Islamabad

Contents

Division of Courses Compulsory Requirements					
Semester – 1					
1	EN-101	Functional English I	3	Linguistics	Compulsory
2	PS-101	Pakistan Studies	2	FNS	Compulsory
3	CS-101	Introduction to Computing	3	Computer Sciences	Compulsory
4	MA-101	Calculus and Analytic Geometry I	3	Mathematics	Compulsory
5	PH-101	Introduction to Mechanics and Waves	2	Physics	Faculty Elective
6	PH-191	Introduction to Mechanics and Waves-Lab	1	Physics	Faculty Elective
7	EL-101	Engineering Drawing	1	Electronics	Electronics Core
8	CS-105	Problem Solving and Programming	2+1	Computer Sciences	Faculty Elective
		Total Credits	**18**		
Semester – 2					
1	EN-102	Functional English II	3	Linguistics	Compulsory
2	IS-101 OR ET-101	Islamiat (For Muslims) OR Comparative Religions (For Non-Muslims)	2	FNS	Compulsory
3	MA-102	Calculus and Analytic Geometry II	3	Mathematics	Compulsory
4	SS-XXX	Social Science[1]	3	FSS	Compulsory
5	PH-103	Electricity and Magnetism	2	Physics	Faculty Elective
6	PH-193	Electricity and Magnetism-Lab	1	Physics	Faculty Elective
7	CS-121	Object Oriented Programming	3+1	Computer Sciences	Faculty Elective
		Total Credits	**18**		
Semester – 3					
1	EN-203	Functional English III	3	Linguistics	Compulsory
2	EL-204	Introduction to Electronics	2	Electronics	Electronics Core
3	CH-100	General Chemistry	2	Chemistry	Faculty Elective
4	EL-201	Engineering Mathematics-I	3	Electronics	Electronics Core
5	EL-261	Semiconductor Electronics	3	Electronics	Electronics Core
6	MA-203	Discrete Mathematics	3	Mathematics	Faculty Elective
7	EL-293	Introduction to Electronics Laboratory	1	Electronics	Electronics Core
		Total Credits	**17**		

Semester – 4					
1	EL-202	Probability, Statistics and Random Variables	3	Electronics	Electronics Core
2	BY-201	Introduction to Biology	3	Biology	Faculty Elective
3	EL-211	Basic Circuit Theory	3	Electronics	Electronics Core
4	EL-281	Signals and Systems	3	Electronics	Electronics Core
5	EL-221	Digital Logic and Computer Architecture	3	Electronics	Electronics Core
6	EL-291	Digital Logic Design Laboratory	1	Electronics	Electronics Core
7	EL-292	Basic Circuit Laboratory	1	Electronics	Electronics Core
		Total Credits	**17**		
Semester – 5					
1	EL-340	Control System I	3	Electronics	Electronics Core
2	EL-341	Electronics-I	3	Electronics	Electronics Core
3	EL-342	Engineering Mathematics-II	3	Electronics	Electronics Core
4	EL-343	Communication Theory	3	Electronics	Electronics Core
5	EL-344	Microcontroller Interfacing	3	Electronics	Electronics Core
6	EL-391	Communication Laboratory	1	Electronics	Electronics Core
7	EL-392	Analog Circuits Laboratory I	1	Electronics	Electronics Core
8	EL-393	Microcontroller Interfacing Laboratory	1	Electronics	Electronics Core
		Total Credits	**18**		
Semester – 6					
1	EL-350	Electronics-II	3	Electronics	Electronics Core
2	EL-351	Digital Design using VHDL	3	Electronics	Electronics Core
3	EC-201	Introduction to Economics	3	Economics	Faculty Elective
4	EL-352	Engineering Electromagnetics	3	Electronics	Electronics Core
5	EL-353	Signal Processing	3	Electronics	Electronics Core
6	EL-394	Analog Circuits Laboratory II	1	Electronics	Electronics Core
7	EL-397	VHDL Laboratory	1	Electronics	Electronics Core
		Total Credits	**17**		
Semester – 7					
1	EL-400	Project – I	3	Electronics	Electronics Core
2	EL-441	Electrical Machines	3	Electronics	Electronics Core
3	EL-403	Engineering Project Management	2	Electronics	Electronics Core
5	EL-404	Antennas and Wave Propagation	3	Electronics	Electronics Elec.
6	EL-XXX	Electronics Elective[3] – I	3	Electronics	Electronics Elec.
		Total Credits	**14**		

Semester – 8					
1	EL-401	Project – II	3	Electronics	Electronics Core
2	EL-XXX	EL Elective[3] – II	3	Electronics	Electronics Elect.
3	EL-XXX	EL Elective[3] – III	3+ x[4]	Electronics	Electronics Elect.
4	EL-XXX	EL Elective[3]–I V	3	Electronics	Electronics Elect.
		Total Credits	**12+x[4]**		
		Total Credits for 8 semesters	**131+ x[4]**		

Summary	
University requirement/compulsory	25 (first two years)
Faculty Elective	24
Electronics Core	67
Electronics Elective	15
Total Credits	131

1: Social Science: Student may choose any course from social science departments.

2: FNS Elective: Student has to choose 3 elective courses from FNS (other than Electronics)

3: Electronics Elective: Student has to choose 5 elective courses from Electronics.

4: For elective courses with laboratory

Semester-1

EL-101	**Engineering Drawing**	**Credits: 2**

Prerequisite: None

Course Outline:

Introduction to engineering drawing, types of lines and usage, geometrical construction, orthographic projection in first and third angles, projection of points, projection of lines, solids of revolution, section views, auxiliary views, dimensioning, freehand sketching, graphical presentation of data, introduction of computer aided drawing tools.

Suggested Books:

1. Gary R. Bertoline, Eric N. Wiebe , Nathan W. Hartman , William A. Ross , *Fundamentals of Graphics Communication*, 6th Edition, (McGraw Hill Publishing 2011).
2. Frederick E. Giesecke , Alva E. Mitchell, Henry C. Spencer, Ivan L. Hill, John Thomas Dygdon, James E. Novak, Robert Olin Loving, *Engineering Graphics*, 8th Edition, (Prentice Hall 2003).

Semester-3

EL-201	Engineering Mathematics-I	Credits: 3

Prerequisite: MA-102 (Calculus and Analytic Geometry II)

Course Outline:

Basic matrix operations: Vector spaces, inner product spaces, linear transformations, matrix eigen value problem, eigenvalues and eigenvectors

Differential equations: Series solutions of differential equations, special functions

Complex variables: Functions of complex variables, complex integration, complex series, integration by residues.

Suggested Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 10th edition, (John-Wiley 2011).
2. George B. Arfken and Hans J. Weber, *Mathematical Methods for Physicists,* 7th edition, (Academic Press 2013).
3. M. D Greenberg, *Advanced Engineering Mathematics*, 2nd edition, (Pearson 2004).

EL-204	Introduction to Electronics	Credits: 3

Prerequisite: None

Course Outline:

Introduction to various topics in electronics and allied disciplines at freshman level with knowledge of only high school physics and mathematics

Various applications of electronic circuits, digital logic, computers, automatic control, analog and digital communication systems, electromagnetic waves and systems, image and signal processing, opto-electronics, nano-electronics

The lectures will be followed by laboratory demonstrations.

Suggested Books:

1. Alan Pierce and Dennis Karwatka, *Introduction to Technology,* (McGraw-Hill 2005).
2. Zimmerman, *Introduction to Electronics Devices,* (Prentice-Hall 1997).
3. Earl Gates, *Introduction to Electronics,* (Delmar Cengage Learning 2011).
4. D. N. Klyshko, *Physical Foundations of Quantum Electronics,* (World Scientific, 2011).

EL-293	Introduction to Electronics Laboratory	Credits: 1

Prerequisite: None

Course Outline:

Sr. No	Experiment
1.	Laboratory demonstrations of digital circuits such as logic gates, timers and counters. Following the demonstration, students are required to perform simple digital logic experiments using trainer kits. They perform arithmetic operations by providing different inputs to the hardware and observe final output on different types of output devices. The students are also expected to perform simple memory operation, timer and counter experiments using digital trainers.
2.	Laboratory demonstration of Field Programmable Gate Arrays (FPGA) devices. Demonstrates how same hardware circuit can perform different function by reprogramming. Following the demonstration, student are required to load different gate-map on the target boards to observe multiple function of the same FPGA

hardware. The students learn how same hardware can perform simple to complex function without making changes in hardware.

3. Demonstration of modulation and demodulation process for analog communication systems such as Amplitude Modulation (AM) and Frequency Modulation (FM). Following the demonstration, students vary various parameters of analog communication systems such as Signal-to-Noise Ratio (SNR), carrier frequency and bandwidth. They can view the signal bandwidth and quality using spectrum analyzer.
4. Demonstrations of image processing algorithms such as compression and decompression (MPEG). Tradeoff between image quality and compression using video trainers. Following the demonstration, students perform the following experiments: Conversion of RGB images to gray scale image and learn the interpretation of intensity values for different gray level areas in images by using image processing toolbox (MATLAB). They explore the basic digital image filters to view effects of different filtering and image enhancement techniques on digital images. Conduct different arithmetic operations on images and analyze their results. They are also required to perform basic image transformations, such as translation, rotation and scaling to learn the effect of multiple transformations.
5. Study the impact of different types of antennas and their geometry on the communication link using antenna trainers. Student can observe the directional gains of antennas and beam-forming by manipulating antenna directions and varying weights of spatial filter.
6. Demonstration of a digital communication systems using Software Defined Radios (SDR) and demonstration of a base station implementation using SDR. Following the demonstration, students configure a SDR for different modulation methods and observe signal spectrum on the spectrum analyzer. They also see eye-diagram and constellation of different modulation schemes. Students are required to set SNR of the link and measure its effect on throughput. In the demonstration of small SDR based GSM mobile phone network, the students configure the network. In addition, the students learn the necessary steps to setup a base station and establish a mobile telephone call.
7. Demonstration of optical self-imaging using diffraction grating, single and double slit experiments, and Mach-Zehnder Interferometer, Michelson interferometer. Following the demonstration students are required to perform the experiment and develop their understanding in wave propagation, interference, near field and far field diffraction of waves. The objective is to help in developing basic understanding in optics, electromagnetism and wave propagation.

Suggested Books:

1. Alan Pierce and Dennis Karwatka, *Introduction to Technology,* (McGraw-Hill 2005).
2. Zimmerman, *Introduction to Electronics Devices,* (Prentice-Hall 1997).
3. Earl Gates, *Introduction to Electronics,* (Delmar Cengage Learning 2011).
4. D. N. Klyshko, *Physical Foundations of Quantum Electronics,* (World Scientific, 2011).

EL-261	Semiconductor Electronics	Credits: 3

Prerequisite: None

Course Outline:

Nature of electron and atom, crystal structure and reciprocal lattice, energy bands, carrier concentration at thermal equilibrium, generation, recombination and carrier lifetimes, carrier transport phenomena, high field transport, impact ionization, basic diffusion equations and examples

Semiconductor devices: PN Junction and depletion region, I-V characteristics, ideal and non-ideal effects, transient behavior, models for PN Junctions

Suggested Books:

1. B. G. Streetman and S. K. Banerjee, *Solid State Electronic Devices*, 6th edition, (Prentice-Hall, 2006).
2. S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd edition, (Wiley, 2007).
3. R. F. Pierret, *Semiconductor Device Fundamentals*, 2nd edition, (Addison-Wesley, 1996).
4. D. A. Neamen, *Semiconductor Physics and Devices,* 4th edition, (McGraw Hill, 2003).

Semester-4

EL-211	Basic Circuit Theory	Credits: 3

Prerequisite: EL-201(Engineering Mathematics I)

Course Outline:

Basic Concepts: Voltage, current, power and energy, circuit elements, independent and dependent sources, Kirchhoff's laws, node analysis, mesh analysis, linearity, superposition, source transformations, Thevenin's theorem, Norton's theorem, two port networks, first and second-order circuits, sinusoidal steady-state (SSS) analysis, convolution, sinusoidal response

Power Analysis: Instantaneous and average power, power factor and power factor correction, complex power, maximum power transfer theorem.

Suggested Books:

1. William Hayt, Jack Kemmerly, and Steven Durbin, *Engineering Circuit Analysis*, 8th edition, (McGraw-Hil, 2011)
2. Dorf and Svoboda, *Introduction to Electric Circuits*, 9th edition, (John Wiley, 2013).
3. C. A. Desoer and E. S. Kuh, *Basic Circuit Theory,* (McGraw-Hill, 1969).

EL-221	Digital Logic and Computer Architecture	Credits: 3

Prerequisite: MA-203 (Discrete Mathematics)

Course Outlines:

Review of combinational circuit: Adders, subtractors, multiplier, encoder, decoders, multiplexers, de-multiplexer

Combinational circuits: flip-flops, registers, counters, finite state machines,

Microprocessor design: Organization and architecture, ALU design, instruction set architecture, pipelining, memory system, virtual memory, cache memory, DMA, I/O interface, design, polling, exception handling, assembly language programing

Suggested Books:

1. Morris Mano and Michael D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL*, 5th edition, (Pearson, 2012).

2. John F. Wakerly, *Digital Design: Principles and Practices,* 4th edition, (Prentice Hall, 2005).
3. Brian Holdsworth, Clive Woods, *Digital Logic Design*, 4th edition, (Elsevier, 2002).
4. J. Tocci, *Digital systems, Principles and Applications,* (Prentice-Hall, 1995).
5. T Floyd, *Digital Fundamentals* 4th edition (MacMillan publisher 1990).

EL-281	Signals and Systems	Credits: 3

Prerequisite: MA-101 (Calculus and Analytic Geometry I), MA-102 (Calculus and Analytic Geometry II), EL-201 (Engineering Mathematics I)

Course Outline:

Types of continuous and discrete time signals, linear time invariant systems, differential and difference equations, Fourier series, continuous time and discrete time Fourier transformation, Laplace transformation, time frequency characterization of signals and systems, sampling theorem for analog to digital conversion.

Suggested Books:

1. Alan V. Oppenheim, S. Willsky and S. Hamid Nawab, *Signals and Systems,* 2nd edition, (Prentice Hall, 1996).
2. B. P. Lathi, *Principle s of Linear Systems and signals*, 2nd edition (Oxford, 2010).

EL-202	Probability, Statistics and Random Variables	Credits: 3

Prerequisite: MA-101 (Calculus and Analytic Geometry I), MA-102 (Calculus and Analytic Geometry II), EL-201 (Engineering Mathematics I)

Course Outlines:

Probability, joint and conditional probability, Bayes theorem, random variables, distributions and density functions, the Gaussian random variable, expectation, moments, transformation of a random variable, multiple random variables, statistical estimation and testing, confidence intervals, introduction to linear regression, random processes, stationarity and independence, correlation and covariance, power spectral density, colored and white noise.

Suggested Books:

1. A. L. Garcia, *Probability, Statistics, and Random Processes for Electrical Engineering,* 3rd edition, (Pearson, 2008).
2. S. Lipschutz, *Theory and problem of probability*, 2nd edition, (McGraw-Hill, 2011).

EL-291	Digital Logic Design Laboratory	Credits: 1

List of experiments

1. Basic logic gates (AND, OR, NOT)
2. Extended logic gates (Ex-OR, Ex-NOR, NAND, NOR)
3. Implementation of Boolean functions using logic gates
4. Adders and subtractors
5. Flip-flops
6. Multiplexers
7. Encoders and decoders
8. Shift registers
9. Counters
10. Arithmetic logic unit
11. Traffic light controller
12. Implementation of Moore and Mealy state machines
13. Project

EL-292	Basic Circuits Laboratory	Credits: 1

List of experiments

1. Measurement of different resistances using color coding/multimeter
2. DC voltage and current measurements
3. Resistor characteristics using Ohm's law
4. Series-parallel resistive network
5. Kirchhoff's laws
6. Superposition, Theremin's theorem
7. Norton's theorems
8. AC voltage characteristics
9. Characteristics of RC circuits
10. Characteristics of RLC circuits
11. Series resonant circuits
12. Parallel resonant circuits

Semester-5

EL-340	Control Systems I	Credits: 3

Prerequisite: EL-281 (Signal and Systems)

Course Outline:

Control elements: Transducers, switches, actuators, valves, motors

Control Fundamentals: Open loop and closed loop systems, transfer function, signal flow graph, gain formula

Modeling: Mathematical modeling of linear electrical and mechanical systems, state variables, state equations and state diagrams

Analysis and design: Stability, controllability and observability of systems, state variables, state transition matrix, transient and steady state response, root locus method, Nyquist criterion, PID controllers, lead lag compensators, pole-zero cancellations.

Suggested Books:

1. Farid Golnaraghi and B. C. Kuo, *Automatic Control Systems*, 9th edition, (Wiley 2009).
2. B. C. Kuo, *Digital Control Systems*, (Wiley, 2010).
3. J. J. D'Azzo and C H. Houpis, *Linear Control Systems: Analysis and Design,* (Prentice-Hall 1985).

EL-341	Electronics I	Credits: 3

Prerequisite: EL-211 (Basic Circuit Theory), EL-201 (Engineering Mathematics I)

Course Outlines:

Diodes: Diode circuit models, special purpose diodes, diode applications

Bipolar junction transistor (BJT): Operations of BJT in different modes, small and large signal models, configuration, analysis and design of BJT amplifiers

Field effect transistors (FET): Structure and operation of MOSFETS, small and large signal models, PMOS transistor, CMOS technology, FET amplifiers

Digital electronics: Operation and design of digital logic gates using discrete elements

Suggested Books:

1. Behzad Razavi, *Fundamentals of Microelectronics*, 2nd edition, (John Wiley and Sons, Inc., 2013).

2. Adel S. Sedra, Kenneth C. Smith, *Microelectronics circuits*, 7th edition, (Oxford university press, 2014).
3. Donald A. Neamen, *Microelectronics: Circuit Analysis and Design*, 4th edition, (McGraw-Hill, 2009).

EL-342	Engineering Mathematics II	Credits: 3

Prerequisite: EL-201 (Engineering Mathematics I)

Course Description:

Numerical methods: Error analysis, numerical solution of equations, interpolation, numerical integration and differentiation, numerical solution of differential equation, numerical methods in linear algebra

Vector Calculus: Multiple integrals, double integrals, triple integrals, change of variables, line integrals, vector fields, fundamental theorem of line integrals, conservative vector fields, potential functions, Green's theorem, curl, divergence

Surface integrals: Surface integrals, surface integrals of vector fields, Stokes' theorem, divergence theorem

Suggested Books:

1. E. Kreyszig, *Advanced Engineering Mathematics*, 10th edition, (John-Wiley 2011).
2. George B. Arfken and Hans J. Weber, *Mathematical Methods for Physicists,* 7th edition, (Academic Press 2013).
3. M. D Greenberg, *Advanced Engineering Mathematics*, 2nd edition, (Pearson 2004).

EL-343	Communication Theory	Credits: 3

Prerequisite: EL-281 (Signal and Systems)

Course Outline:

Signal distortion over communication channel, signal power and power spectral density

Amplitude modulation: Baseband and carrier communications, double sideband (DSB), single sideband (SSB), vestigial sideband (VSB), Quadrature Amplitude Modulation (QAM), superhetrodyne AM receiver, carrier acquisition

Television angle modulation: Instantaneous frequency, bandwidth of FM/PM, generation of FM/PM, demodulation of FM/PM

Noise: Mathematical representation, signal to noise ratio, noise in AM, FM, and PM systems

Pulse Modulation: Sampling and quantization, pulse amplitude modulation, pulse position and pulse width modulation, quantization noise, signal to quantization noise ratio, pulse code modulation, delta modulation, frequency shift keying, phase shift keying

Suggested Books:

1. B. P. Lathi and Zhi Ding, *Modern Digital and Analog Communication Systems*, 4th edition, (Oxford University press, 2009).
2. B. Sklar, *Digital Communication,* 2nd edition, (Prentice-Hall 1988).
3. S. Haykin, *Communication Systems*, 4th edition, (John-Wiley, 2000).

EL-344	Microcontroller Interfacing	Credits: 3

Prerequisite: EL-221 (Digital Logic and Computer Architecture)

Course Outline:

Microcontrollers, peripherals, interfacing memory and I/O devices, microcontroller based hardware design, programmable logic devices, bootstrap loader design, programming peripheral devices, polling and interrupt based I/O interface (involves programming of embedded hardware), ADC interface with microcontroller using reference design of the controller, development of an embedded application (Project), PCB design and programming

Suggested Books:

1. Muhammad Ali Mazidi, Rolin D. McKinlay, *PIC Microcontroller: Using Assembly and C for PIC18,* (Pearson 2008).
2. J. Fluchen, *An Introduction to Micro-computer System: Architecture and Interacting* (Addison-Wesley 1990).
3. A. Mitchel, *32-bit Microprocessors*, (McGrraw-Hill 1989).
4. Singh, *16-bit and 32-bit Micro-processor Architecture, Software, and interface Techniques*, (Prentice-Hall 1991).

EL-391	Communication Laboratory	Credits: 1

List of experiments:

1. MATLAB® programming
2. Signal generation
3. Power spectral density
4. Basic channel impairment
5. Amplitude modulation
6. Angle modulation

EL-392	Analog Circuits Laboratory I	Credits: 1

List of experiments

1. Basic diode characteristics and biasing
2. Design of rectifier circuits (half and full wave rectifiers)
3. DC filters for rectifier circuits
4. Basics characteristics of Zener diode
5. Zener diode based regulation
6. BJT characteristics
7. BJT amplifiers
8. AC response of BJT amplifiers
9. FET characteristics and biasing
10. FET amplifiers

EL-393	Microcontroller Interfacing Laboratory	Credits: 1

List of experiments:

1. Assembly language programming and debugging
2. C and assembly language interface
3. Observing timing waveform and control signal
4. Communication with I/O devices in polling and interrupt mode
5. Direct memory access (DMA)

Semester-6

EL-350	Electronics II	Credits: 3

Prerequisite: EL-341 (Electronics I)

Course Outline:

Operational amplifier as a black box and its applications, cascade stages and current mirrors, design and analysis of differential amplifiers, high frequency models of BJT and FET, feedback and stability, oscillators, analog filters

Suggested Books:

1. Behzad Razavi, *Fundamentals of Microelectronics*, 2nd edition, (John Wiley & Sons, Inc. 2013).
2. Adel S. Sedra, Kenneth C. Smith, *Microelectronics circuits*, 7th edition (Oxford university press 2014).
3. Donald A. Neamen, *Microelectronics: Circuit Analysis and Design*, 4th edition, (McGraw-Hill 2009).

EL-353	Signal Processing	Credits: 3

Prerequisite: EL-281 (Signal and Systems)

Course Outline:

Discrete-time signals and systems, LTI Systems, systems characterized by difference equations, frequency domain characterization of signals and systems, sampling of continuous time signals, reconstruction, up-sampling and down-sampling, Z-transforms and properties, applications to LTI Systems, transform domain analysis of LTI Systems, system function, rational system function, minimum phase and linear phase systems, implementation structures for FIR and IIR filters, IIR filter design, FIR filter design, discrete Fourier transform, discrete cosine transform, and fast Fourier transform algorithms

Suggested Books:

1. A. V. Oppenheim and R. W. Schafer, *Discrete-Time Signal Processing*, 3rd edition, (Pearson Higher Education Inc., 2010).
2. Ingle and Proakis, Digital Signal Processing using Matlab, 2nd edition, (Thomson-Engineering, 2006).
3. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications*, 4th edition, (Prentice Hall, 2007).

EL-394	Analog Circuits Laboratory II	Credits: 1

List of experiments:

1. Op-amps, characteristics of Op-amps
2. Applications of Op-amps.
3. Data converters (A/D and D/A)
4. Wave-shaping circuits
5. 555 Timer circuits
6. PLL

EL-352	Engineering Electromagnetics	Credits: 3

Prerequisite: EL-342 (Engineering Mathematics II)

Course Outline:

Static electric fields: Fundamental postulates, Gauss's law, conductors and dielectrics in static electric fields, electric flux density, boundary conditions, electrostatic energy

Solution of electrostatic problems: Poisson's and Laplace's equations, method of images, method of separation of variables, method of moments, finite difference method, finite element method, boundary value problems

Steady electric currents: Current density and Ohm's law, static magnetic fields, electromotive force, equation of continuity, boundary condition for current density

Static magnetic fields: Fundamental postulates, magnetic vector potential, magnetic dipole, magnetization, magnetic field intensity

Time varying fields and Maxwell equations: Faraday's law, differential and integral forms of Maxwell equations, electromagnetic boundary conditions, wave equations and their solutions, time harmonic fields; Plane electromagnetic waves: Plane waves in lossless and lossy media, incidence at plane conducting and dielectric boundary, multiple dielectric interfaces

Suggested Books:

1. David K. Cheng, *Field and wave electromagnetics*, 2nd edition, (Addition-Wesley, New York, 2006).
2. Magdy F. Iskander, *Electromagnetic fields and waves*, 2nd edition, (Waveland Press, Inc. USA, 2013).
3. Simon Ramo, John R. Whinnery, Theodore V. Duzer, *Fields and waves in communication electronics*, 3rd edition, (John Wiley & Sons, Inc., 1994).
4. John D. Kraus and Daniel A. Fleisch, *Electromagnetics with applications*, 5th edition, (Mcgraw-Hill Series in Electrical Engineering, 2010).

EL-351	**Digital Design using VHDL**	**Credits: 3**

Prerequisite: EL-221 (Digital Logic and Computer Architecture)

Course Outline:

Introduction to electronic design automation (EDA), hardware modeling with the Verilog HDL, event-driven simulation and test bench, logic system, data types and operators for modeling in Verilog HDL, user define primitives, Verilog models of propagation delays, behavioral description in Verilog HDL, synthesis of combinational logic, synthesis of sequential logic, synthesis of language construct, switch-Level models in Verilog, UART design exercise, BIT-Slice AMD2901 microcontroller design exercise, rapid prototyping with Xilinx FPGA

Suggested Books:

1. M. D. Ciletti, *Modeling, Synthesis and Rapid Prototyping with the Verilog HDL,* (Prentice-Hall 1999).
2. Samir Palnitkar, *Verilog HDL, A guide to Digital Design and synthesis, (*Sun Microsystems 2003).

EL-397	**VHDL Laboratory**	**Credits: 3**

List of experiments:

1. Full adder/subtractor,
2. Flip flops
3. Up/down counter
4. Shift register
5. Multiplexer
6. NxM binary multiplier
7. Random number generation
8. Newspaper vending machine, Traffic light controller
9. FIFO-Buffer for data acquisition
10. UART-Transmitter and receiver

Semester-7

EL-400	Project-I	Credits: 3

Prerequisite: None

Course Outline:

The objective of this course is to apply the theoretical and practical knowledge in the field of electronics by carrying out research and development based final year project design. The project consists of hardware/software implementation by going through research and development phases from inception to completion. The students are expected to clearly define the research and development problem by a presentation in order to proceed to the implementation phase (next semester).

EL-441	Electrical Machines	Credits: 3

Prerequisite: EL-342 (Engineering Mathematics II), EL-281 (Signal and Systems)

Course Outline:

Introduction to electrical machinery principles: Magnetic field and circuits, magnetization curves characteristics of hard and soft magnetic materials, losses

Transformers: Ideal transformer, single phase transformer, operation and equivalent circuit, auto-transformer

DC machinery fundamentals: Basics, loop rotating between pole faces, commutation, windings, armature reaction, induced voltage and torque equation, power flow and losses, types of DC motors, permanent magnet DC motors

AC machinery fundamentals: Rotating magnetic field, magneto motive force and flux distribution, induced voltage and torque, windings, power flow and losses, introduction to induction machines

Special Purpose Motors: Introduction to single phase induction motors, switched reluctance motors, hysteresis motors, stepper, brushless DC motors

Suggested Books:

1. Stephen J. Chapman, *Electric Machinery Fundamentals*, 4th edition, (McGraw-Hill 2005).
2. Fitzgerald, Kingsley and Umans, *Electric Machinery*, 7th edition,(McGraw-Hill 2013).
3. D. P. Kothari, I. J. Nagrath, *Electric Machines*, 3rd edition (McGraw-Hill 2004)

EL-404	Antennas and Wave Propagation	Credits: 3

Prerequisite: EL-352 (Engineering Electromagnetics)

Course Outline:

Theory and applications of transmission lines: Parallel plate transmission line, general transmission line equations, wave characteristics on finite transmission lines, transients on transmission lines, Smith chart, transmission line impedance matching

Waveguides and cavity resonators: Parallel plate waveguide, rectangular waveguides, circular waveguides, dielectric waveguides, cavity resonators

Microwave network analysis: Impedance and equivalent voltages and currents, impedance and admittance, scattering matrix, transmission matrix, signal flow graphs, discontinuities and modal analysis, excitation of waveguides

Antennas theory and radiating systems: Radiation fields of elemental dipoles, antenna patterns and antenna parameters, thin linear antennas, antenna arrays, internal impedance and directional pattern, effective area, back scattering cross section

Suggested Books:

1. Peter A. Rizzi, *Microwave engineering: Passive circuits*, (Prentice-Hall International, 1988).

2. David M. Pozar, *Microwave engineering*, 4th edition, (John Wiley & Sons, 2005).
3. David K. Cheng, *Field and wave electromagnetics*, 2nd edition, (Addition-Wesley, New York, 2006).

EL-403	Engineering Project Management	Credits: 3

Prerequisites: None

Course Outline:

Overview of project management: PMI process groups, software project phases, project charter, statement of work

Planning phase: Development lifecycle models, matching lifecycles to projects, project plans, work breakdown structures, estimation of effort and cost

Scheduling: Project network diagram fundamentals, CPM, PERT, Gantt charts, critical chain scheduling, using MS-Project, assigning resources, resource leveling, team models, managing conflict

Project monitoring and control: Status reporting, project metrics, EVM, communications Techniques

Risk management: Change control, project recovery, documentation, post project reviews, closing.

Suggested Books:

1. Bob Hughes, Mike Cotterell, *Software Project Management*, (McGraw Hill Higher Education, 2005).
2. Dwayne Phillips, *The Software Project Manager's Handbook - Principles that work at work*. 2nd edition, (IEEE Computer Society Press, 2004).

Semester-8

EL-401	Project-II	Credits: 3

Prerequisite: None

Course Outline:

The objective of this course is to apply the theoretical and practical knowledge in the field of electronics by carrying out research and development based final year project. The project consists of hardware/software implementation by going through research and development phases from inception to completion. The phase two of the project course emphasizes more on implementation/simulation focusing on the solution of the proposed problem. The completion requirements of the project include a demonstration/presentation and dissertation.

Elective Courses

EL-450	Information and Coding Theory	Credits 3

Prerequisite: None

Course Outline:

Elements of information theory: Entropy for discrete signals, randomness, self-information, mutual information entropy rate for Markov sources, bits and codes, compression, maximum entropy, mutual information

Source coding: Huffman coding, Shannon-Fano coding, Shannon's first theorem, channel capacity, entropy for continuous random variables, channel capacity, Shannon's second theorem, capacity of a band-limited Gaussian channel

Channel coding: Error correcting codes, linear block codes, cyclic codes, convolutional, codes, Viterbi's decoding algorithm, Hamming space, distance, code applications, Shannon's theory of

information, coding theorem, converse, Shannon theory vs. Hamming theory, linear codes, asymptotically good codes, Limpel-Zev algorithm, Golay codes
Algebraic codes: Reed-Solomon, Reed-Muller, Hadamard, decoding of Reed-Solomon codes, Welch-Berlekamp algorithm, list decoding of Reed-Solomon codes, concatenated codes and decoding, maximum likelihood decoding

1. Monica Borda, *Fundamentals in information theory and coding* (2011)
2. Todd K. Moon, *Error Correction Coding: Mathematical Methods and Algorithms* 1st edition, 2005.
3. Shu Lin, Daniel J. Costello *Error Control Coding*, 2nd edition, 2004
4. Martin Bossert, *Channel Coding for Telecommunications*, (Wiley 1999)

EL-451	Communication Systems	Credits: 3

Prerequisite: EL-281 (Signal and Systems)

Course Outline:

Significance of digital communication, overview of signals, spectra, probability and random variables, SNR and $\frac{E_b}{N_o}$, sampling and quantization (uniform and non-uniform), signal to quantization noise ratio (SQNR), detection of a binary signal in Gaussian noise, matched filters and correlators, Baye's decision criterion, maximum likelihood detector, error performance, inter-symbol interference (ISI), raised cosine pulse, eye-patterns, equalization techniques, vector representation of signals, Gram-Schmidt orthogonality principle, performance analysis of M-array signaling techniques
Error correcting codes: block codes, design and analysis of convolutional codes, advanced techniques for digital communication (e.g. DS-CDMA, FH-CDMA, OFDM, MIMO techniques)

Suggested Books:

1. B. P. Lathi and Zhi Ding, *Modern Digital and Analog Communication Systems*, 4th edition (Oxford University press, 2009).
2. B. Sklar, *Digital Communication*, (Prentice Hall 1988).
3. S. Haykin, *Communication Systems*, 4th edition, (John Wiley, 2000)

EL-460	Control Systems II	Credits: 3

Prerequisite: EL-340 (Control Systems I)

Course Outline: Control of discrete processes, control of continuous processes, design of control systems PID controllers, lead lag compensators, pole-zero cancellations, introduction to digital control, practical systems, analog and microprocessor based control systems, design examples nonlinear control systems, optimal control theory, self-adaptive control systems, review of states space modeling, linearization of nonlinear systems, response of linear systems controllability and observability-concepts and tests, balanced realization/model reduction, introduction to robustness and performance tradeoff, state feedback and observer output feedback, innovation feedback and Q-parameterization, linear quadratic regulator (LQR), deterministic Kalman filter and LQG/LTR, trajectory tracking control, input shaping, internal model control and repetitive control , Lyapunov stability concepts, topic on nonlinear control

Suggested Books:

1. Ronald S. Burns, *Advanced Control Engineering* (2001)
2. Robert Bateson, *Introduction to control system technology*, (Prentice Hall 2001)
3. B. C. Kuo, *Digital Control Systems* (Wiley, 2010).
4. Slotine and Li, *Applied Nonlinear Control*, (Prentice Hall, 1991).
5. Richard C. Dorf, Robert H. Bishop, *Modern Control Systems* (Prentice Hall, 2010)

EL-470	Introduction to Digital Image Processing	Credits: 3

Prerequisite: EL-353 (Signal Processing), CS-121 (Object Oriented Programming)

Course Outline:

Image processing basics: Digital image formation and representation, image sensing and acquisition, arithmetic and logic operations, geometric operations, gray level transformations, histogram processing, neighborhood processing, spatial domain filtering, frequency domain filtering, image restoration, introduction to object recognition, feature extraction, content-based image retrieval, image classification and evaluation, remote sensing and interpretation of satellite imagery, medical image understanding technology

Suggested Books:

1. R. Gonzalez and Richards E. Woods, *Digital Image Processing*, 3rd edition, (Pearson Education Inc Publishing, 2008).
2. M. Sonka, V. Hlavac and R. Boyle, *Image Processing, Analysis and Machine Vision*, 2nd edition, (PWS Publishing, 1998).
3. O. Marques, *Practical Image and Video Processing using MATLAB*, 1st edition, (Wiley-IEEE Press, 2011).
4. Larry S. Davis, *Foundations of Image Understanding,* (Kluwer International Series in Engineering and Computer Science: vol. 628. August, 2001. ISBN: 0-7923-7457-6).
5. S. Ullman and W. Richards (eds). *Image Understanding* 1989, (New Jersey: Ablex Publishing Co., 1990).

EL-471	Pattern Recognition	Credits: 3

Prerequisite: None

Course Outline:

Introduction to pattern recognition, feature generation, feature selection, feature vector representations, linear classifiers, clustering, dimensionality reduction, template based recognition, likelihood ratio test, linear discriminant/perceptron learning, K-nearest neighbor classification, non-parametric techniques and linear discriminant functions, introduction to unsupervised learning, semi-supervised learning and multi-instance learning, performance evaluation techniques, training and testing methods.

Suggested Books:

1. Richard O. Duda, Peter E. Hart, and David G. Stork, *Pattern Classification*, 2nd edition (Wiley 2000, ISBN: 0-471-05669-3)
2. Trevor Hastie, Robert Tibshirani & Jerome Friedman, *The Elements of Statistical Learning* (Springer Verlag, 2001).
3. Tom Mitchell, *Machine Learning*, (McGraw Hill, 1997).
4. A. Webb, *Statistical Pattern Recognition*, 2nd edition (Wiley, 2002).
5. D. MacKay, *Information Theory, Inference, and Learning Algorithms* (Cambridge University Press, 2003).
6. F. van der Heiden, R.P.W. Duin, D. de Ridder, and D.M.J. *Tax, Classification, Parameter Estimation, State Estimation: An Engineering Approach Using MatLab* (Wiley, New York, 2004).

EL-430	Power Electronics	Credits: 3

Prerequisite: EL-350 (Electronics II)

Course Outline:

Principles of power electronics, converters and applications, circuit components and their effects, control aspects, power electronic devices, power diode, power BJT, power MOSFET, IGBT and SCR, GTO and TRIAC and DIAC, construction, characteristics, operations, losses, ratings, control and protection of thyristors, half-wave and full-wave rectifiers with resistive and inductive loads, un-controlled, semi controlled and fully controlled rectifiers, three-phase rectifiers, uncontrolled, semi

controlled and full controlled, six-pulse, twelve-pulse and 24- pulse rectification, PWM converters, DC to AC converters, three-phase inverter, six-pulse, twelve-pulse inverters, PWM inverters, switching mode power supplies, DC to DC conversation, buck converter, boost converter and buckboost converters, isolated converters, forward converters, flyback converters.

Suggested Books:

1. M. H. Rashid, *Power Electronics: Circuits, Devices and Applications*, 3rd edition (Pearson, 2014).
2. C. W. Lander, *Power Electronics*, (McGraw Hill, 1994).
3. Philip T. Krein, *Elements of Power Electronics*, (Oxford University Press, 1998).

EL-480	Real-Time Systems	Credits: 3

Prerequisite: None

Course Outline:

Development environments for embedded software, resource aware programming, hardware programming, developing multi-threaded software, inter-process communication with shared memory and message passing, programming using real time operating systems, a real-time operating system using real-time operating systems (e.g. VxWorks), semaphores synchronization and priority inversion synchronization and communication message queues deadlock.

Suggested Books:

1. J. Catsoulis, *Designing Embedded Hardware,* 2nd edition, (O'Reilly, 2005).
2. Michael Barr, *Programming Embedded Systems in C and C++,* 1st edition, (O'Reilly, 1999).

EL-441	Laser and Fiber Optics	Credits: 3

Prerequisite: None

Course Outline:

Optical fibers and waveguides, ray and wave theory of planar slab and cylindrical waveguides, multimode and single-mode fibers, V-number, fabrication of fiber, attenuation and dispersion in fibers, effects of dispersion on pulse broadening and maximum bit-rate, optical sources, spectral properties of optical sources, Gaussian beams, optical amplifiers, coupling to fibers, photodetectors, optical receivers, noise, errors, calculation of NEP and D∗, bandwidth, bit-error-rate, digital optical communication links, coding, analog systems, coherent detection, WDM, DWDM, multiplexers, filters, Bragg gratings, Fabry-perot filters, optical amplifiers, device physics, performance and applications, optical networks, SONET/SDH, nonlinear effects, network topologies, wavelength conversion, switches

Suggested Books:

1. John Senior, *Optical Fiber Communications*, 3rd edition, (Prentice Hall, 2009).
2. Joseph Palais, *Fiber Optic Communications*, 5th edition, (Prentice Hall, 2004).
3. Gerd Keiser, *Optical Fiber Communications*, 3rd edition, (McGraw-Hill, 2000).
4. L. Kazovsky, S. Benedetto, and A. Willner, *Fiber Communication Systems,* (Artech House, 1996).
5. John Gowar, *Optical Communication Systems*, 2nd edition, (Prentice-Hall, 1993).

EL-440	Transmissions Lines and Antennas	Credits: 3

Prerequisite: None

Course Outline:

Applications of electromagnetic waves, transmission lines, transient waves, lumped model, impedance transformation, Smith chart, uniform plane wave, plane wave at a media interface, waveguides, dielectric waveguides, introduction, types of antennas, radiation pattern, directivity, gain, polarization, impedance, Friis transmission formula, reciprocity, far-field radiation, radiation integral, array of isotropic sources, Hartezian dipole, thin wire antennas, microstrip antenna, modern trends in antennas, antenna measurements, simulation tools

Suggested Books:

1. Matthew N. O. Sadiku, *Elements of Electromagnetics*, 3rd edition, (Oxford University Press, 2001).
2. E. C. Jordan and K. G. Balmain, *Electromagnetic Waves and Radiating Systems,* 2nd edition, (PHI, 2000).
3. John D. Ryder, *Networks, Lines and Fields*, 2nd edition, (PHI, 1999).
4. W. L. Stutzman and G. A. Thiele, *Antenna Theory and Design*, 3rd edition, (Wiley, 2012).

EL-452	**Wireless Communications**	**Credits: 3**

Prerequisite: None

Course Outline:

Cellular wireless networks and system principles, antennas and radio propagation, signal encoding and modulation techniques, spread spectrum, UTRA spreading and modulation, coding and error control, multiple access techniques, generations of wireless systems, UMTS network and radio access technology, CDMA, soft handoff and power control, wireless LANs, IEEE 802.1x

Suggested Books:

1. Andreas F. Molisch, *Wireless Communications*, 2nd edition, (Wiley, 2011).
2. T. S. Rappaport, *Wireless Communications: Principles and Practice*, 2nd edition, (Prentice Hall, 2002).
3. Simon Haykin and Michael Moher, *Modern Wireless Communications,* (Prentice Hall, 2004).
4. David Tse and Pramod Viswanath, *Fundamentals of Wireless Communication,* (Cambridge University Press, 2005).