Study Plan – Bachelors – 2019

1.	School	School of Engineering
2.	Department	Electrical Engineering Department
3.	Program title (English)	B.Sc. in Electrical Engineering
4.	Program title (Arabic)	البكالوريوس في الهندسة الكهربائية

5. Components of Curriculum

The curriculum for the bachelor's degree in Electrical Engineering consists of (164) credit hours distributed as follows

Number	Type of requirement	Credit hours
First	University Requirements	27
Second	School Requirements	27
Third	Department Requirements	110
Fourth	Other Requirements	0
Total		164

6. Course Numbering System

A- Department number (fourth digit from left in course number)

Number	Department
0	General to all departments
1	Civil Engineering
2	Architectural Engineering
3	Electrical Engineering
4	Mechanical Engineering
5	Chemical Engineering
6	Industrial Engineering
7	Computer Engineering
8	Mechatronics Engineering

B- Course domain number (sixth digit from left in course number)

Domain number	Domain title	Domain number	Domain title
0	General	5	Electromagnetics
1	Circuits	6	Electronics
2	Communications	7	Machines
3	Computer	8	Power
4	Measurements & Control	9	Project

C- Course numbers are 7 digit numbers, the meaning of each digit is shown below

School number		Department number		Course level	Course domain	Course serial number
0	**9**	**0 - 9**	**3**	**1 - 5**	**0 - 9**	**0 - 9**

First: University Requirements:

Preparation Program Requirements

All students admitted to the university must apply for a degree examination in Arabic and English and the computer is prepared or approved by the university to determine their level. Based on the results of the examinations, either the student will study one or more of the requirements of the preparatory program

(0 - 15 Credit Hours)

No.	Course Title	Course No.	Credit Hours	Prerequisites	Notes
1	Basics of Arabic	3201099	3		Pass/Fail
2	Arabic Languages Skills	3201100	3	3201099	Pass/Fail
3	Basics of English	3202099	3		Pass/Fail
4	English Language Skills	3202100	3	3202099	Pass/Fail
5	Basics of Computing	1932099	3		Pass/Fail

Compulsory Requirements

(18 Credit Hours)

No.	Course Title	Course No.	Credit Hours	Prerequisites	Notes
1	Military Science	2220100	3		
2	National Culture	3400100	3		
3	Learning & Research Skills	3400101	3	3202099 3201099 1932099	
4	Communication Skills	3400102	3	3400101	
5	Introduction to Philosophy and Critical Thinking	3400103	3	3400101	
6	Human Civilization	3400104	3		
7	Campus Life and Ethics	3400105	(Zero credit; one-hour weekly meeting)		

Electives

(9 Credit Hours)

Elective courses: (9) credit hours to be chosen from the first, second and third groups mentioned below. The student has to choose one course from each of the groups.

(First Group)

No.	Course Title	Course No.	Credit Hours	Prerequisites	Notes
1	Great Books	3400107	3		
2	Islam and Current Issues	0400101	3		
3	Arab-Islamic Civilization	2300101	3		
4	Jordan: History and Civilization	2300102	3		
5	Jerusalem	3400108	3		

Electives

(Second Group)

No.	Course Title	Course No.	Credit Hours	Prerequisites	Notes
1	Legal Culture	1000102	3		
2	Environmental Culture	0300102	3		
3	Physical Fitness Culture	1100100	3		
4	Islamic Culture	0400102	3		
5	Health Culture	0720100	3		

Electives

(Third Group)

No.	Course Title	Course No.	Credit Hours	Prerequisites	Notes
1	Entrepreneurship & Creativity	3400109	3		
2	Foreign Language	2200103	3		
3	Electronic Commerce	1600100	3		
4	Social Media	1900101	3		
5	Appreciation of Arts	2000100	3		
6	Special Subject	3400106	3		
7	Administrative skills	1601105	3		

Second: School courses: distributed as follows:

A. Obligatory school courses: (27) credit hours

B. Elective school courses: (0) credit hours

A. Obligatory school courses: (27) credit hours:

Course Number	Course Title	Contact Hours		Credit Hours	Pre-requisite
		Theory	Practical		
0301101	Calculus I	3	-	3	-
0301102	Calculus II	3	-	3	0301101
0301201	Calculus III	3	-	3	0301102
0302101	General Physics I	3	-	3	-
0302111	Practical Physics I	-	3	1	0302101*
0302102	General Physics II	3	-	3	0302101
0302112	Practical Physics II	-	3	1	0302102*
0904131	Engineering Graphics & Descriptive Geometry	2	2 + 2	3	-
0966111	Engineering Workshops	-	3	1	-
0907101	Computer Skills for Engineers	3	-	3	1902098 & 1932099
0901420	Engineering Economy	3	-	3	0903202

* *Pre-requisite or Co-requisite*

Third: Specialty courses: (110) credit hours distributed as follows:

B. Obligatory specialty courses: (93) credit hours

C. Elective specialty courses: (17) credit hours

A. Obligatory specialty courses: (93) credit hours:

Course Number	Course Title	Contact Hours		Credit Hours	Pre-requisite
		Theory	Practical		
0303101	General Chemistry I	3	-	3	-

0903211	Electrical Circuits (I)	3	-	3	0302102
0903212	Electrical Circuits (II)	3	-	3	0903211
0933219	Electrical Circuits Lab	-	3	1	0903212*
0907231	Digital Logic	3	-	3	0907101
0907234	Digital Logic Lab	-	3	1	0907231
0903261	Electronics (I)	3	-	3	0903211
0903361	Electronics (II)	3	-	3	0903261
0903362	Digital Electronics	3	-	3	0903361
0933368	Electronics Lab	-	3	1	0903361*
0903201	Engineering Analysis (I)	3	-	3	0301201*
0903202	Engineering Analysis (II)	3	-	3	0903201 & 0953221
0943351	Electromagnetics (I)	3	-	3	0302102 & 0903202
0903352	Electromagnetics (II)	3	-	3	0943351
0953221	Signal Analysis & Systems	3	-	3	0903211*
0963321	Probability and Statistics	3	-	3	0953221
0903232	Microprocessor Systems & Languages	3	-	3	0907231
0903233	Microcontroller Applications	2	2	3	0903232
0933239	Microcontroller Applications Lab	-	3	1	0903233
0953421	Communications (I)	3	-	3	0963321*
0953422	Communications (II)	3	-	3	0953421
0943423	Communication Electronics	3	-	3	0903362 & 0903421
0903425	Communication Systems	3	-	3	0903352 & 0953421
0953429	Communications Lab	-	3	1	0953422*
0943301	Engineering Numerical Methods	2	2	3	0903202
0933441	Control Systems	3	-	3	0943301
0943449	Instrumentation and Control Lab	-	3	1	0933441*
0943461	Power Electronics	3	-	3	0903261 & 0953221
0903371	Electrical Machines (I)	3	-	3	0903212
0933372	Electrical Machines (II)	3	-	3	0903371

0903379	Electrical Machines Lab	-	3	1	0933372*
0953481	Power System Analysis	3	-	3	0903371
0943482	Power System Protection	3	-	3	0953481
0903489	Electrical Power Lab	-	3	1	0943482*
0943401	Engineering Ethics	1	-	1	0903361
0903500	Practical Training	-	280	3	Passing 115 credit hours
0973598	Project (I)	-	-	1	0903500
0973599	Project (II)	-	-	2	0973598

** Pre-requisite or Co-requisite.*

B. Elective specialty courses: (17) credit hours:

(15 Credit Hours from First Group and 2 Credit Hours from Second Group)

(First Group: Elective Courses)

Course Number	Course Title	Contact Hours		Credit Hours	Pre-requisite
		Theory	Practical		
0943424	Digital Signal Processing	3	-	3	0953421
0903426	Communication Networks	3	-	3	0953421
0953521	Multimedia Transmission	3	-	3	0953422
0953522	Cellular Communications	3	-	3	0953422*
0963523	Optical Communications	3	-	3	0953421
0953529	Selected Topics in Communications & Electronics	3	-	3	0953421
0933551	Antennas & Wave Propagation	3	-	3	0903352
0963431	Computer Applications	2	2	3	0903233
0903549	Selected Topics in Control	3	-	3	0933441
0943561	Biomedical Electronics	3	-	3	0903362
0903562	Integrated Circuits	3	-	3	0903362
0903563	Electrical Drives	3	-	3	0943461

0973581	Renewables & Power System Quality	3	-	3	0953481
0963582	Power System Planning	3	-	3	0953481
0933583	Power System Operations & Economics	3	-	3	0953481
0933584	High Voltage Engineering	3	-	3	0953481
0943589	Selected Topics in Power & Machines	3	-	3	0953481

(Second Group: Elective Labs)

Course Number	Course Title	Contact Hours		Credit Hours	Pre-requisite
		Theory	Practical		
0953528	Advanced Communications Lab	1	3	2	0953422
0903568	Advanced Electronics Lab	1	3	2	0903362
0963588	Advanced Electrical Power Lab	1	3	2	0943482

Fourth: Courses offered by other schools and departments

Course Number	Course Title	Contact Hours		Credit Hours	Pre-requisite
		Theory	Practical		
0301101	Calculus I	3	-	3	-
0301102	Calculus II	3	-	3	0301101
0301201	Calculus III	3	-	3	0301102
0302101	General Physics I	3	-	3	-
0302111	Practical Physics I	-	3	1	0302101*
0302102	General Physics II	3	-	3	0302101
0302112	Practical Physics II	-	3	1	0302102*
0904131	Engineering Graphics & Descriptive Geometry	2	2 + 2	3	-
0966111	Engineering Workshops	-	3	1	-
0907101	Computer Skills for Engineers	3		3	1902098 & 1932099

0901420	Engineering Economy	3	-	3	0903202
0303101	General Chemistry I	3	-	3	-
0907231	Digital Logic	3	-	3	0907101
0907234	Digital Logic Lab	-	3	1	0907231

Fifth: Courses offered to other schools and departments

Course Number	Course Title	Contact Hours		Credit Hours	Pre-requisite
		Theory	Practical		
0903203	Electrical Engineering	3	-	3	0302102
0903204	Electrical Engineering Lab	-	3	1	0903203
0973373	Electrical Machines	3	-	3	0903203
0953374	Electrical Engineering & Machines Lab	-	3	1	0973373
0913213	Electric Circuits	3	-	3	0302102
0913214	Electric Circuits Lab	-	3	1	0913213

Sixth: Advisory Study Plan

First Academic Year

First Semester			Second Semester		
Course Number	**Course Title**	**Cr. Hr.**	**Course Number**	**Course Title**	**Cr. Hr.**
0301101	Calculus I	3	0301102	Calculus II	3
0302101	General Physics I	3	0302102	General Physics II	3
0302111	Practical Physics I	1	0302112	Practical Physics II	1
0303101	General Chemistry I	3	0904131	Engineering Graphics & Descriptive Geometry	3
0907101	Computer Skills for Engineers	3	0907231	Digital Logic	3
0966111	Engineering Workshops	1	----------	University Requirement	3
Total		**14**	**Total**		**16**

Second Academic Year

First Semester			Second Semester		
Course Number	**Course Title**	**Cr. Hr.**	**Course Number**	**Course Title**	**Cr. Hr.**
0903211	Electrical Circuits (I)	3	0903212	Electrical Circuits (II)	3
0301201	Calculus III	3	0903261	Electronics (I)	3
0903201	Engineering Analysis (I)	3	0903202	Engineering Analysis (II)	3
0953221	Signal Analysis & Systems	3	0903233	Microcontroller Applications	3
0903232	Microprocessor Systems & Languages	3	0907234	Digital Logic Lab	1
----------	University Requirement	3	0933219	Electrical Circuits Lab	1
			----------	University Requirement	3
Total		**18**	**Total**		**17**

Third Academic Year

First Semester			Second Semester		
Course Number	**Course Title**	**Cr. Hr.**	**Course Number**	**Course Title**	**Cr. Hr.**
0943351	Electromagnetics (I)	3	0903352	Electromagnetics (II)	3
0903371	Electrical Machines (I)	3	0933372	Electrical Machines (II)	3
0903361	Electronics (II)	3	0943301	Engineering Numerical Methods	3
0963321	Probability and Statistics	3	0903362	Digital Electronics	3
0933368	Electronics Lab	1	0901420	Engineering Economy	3
0933239	Microcontroller Applications Lab	1	----------	University Requirement	3

----------	University Requirement	3			
Total		**17**	**Total**		**18**

Fourth Academic Year

First Semester			Second Semester		
Course Number	**Course Title**	**Cr. Hr.**	**Course Number**	**Course Title**	**Cr. Hr.**
0953421	Communications (I)	3	0953422	Communications (II)	3
0953481	Power System Analysis	3	0943482	Power System Protection	3
0933441	Control Systems	3	0943449	Instrumentation and Control Lab	1
0943461	Power Electronics	3	0943423	Communication Electronics	3
0903379	Electrical Machines Lab	1	0903489	Electrical Power Lab.	1
----------	University Requirement	3	0953429	Communications Lab	1
			----------	University Requirement	3
Total		**16**	**Total**		**15**

(Training is conducted during the summer period of the fourth year, and counts as 3 Cr. Hr.)

Fifth Academic Year

First Semester			Second Semester		
Course Number	**Course Title**	**Cr. Hr.**	**Course Number**	**Course Title**	**Cr. Hr.**
0973598	Project (1)	1	0973599	Project (2)	2
0903425	Communication Systems	3	0903---	Department Elective	3
0943401	Engineering Ethics	1	0903---	Department Elective	3
0903---	Department Elective Lab	2	0903---	Department Elective	3
0903---	Department Elective	3	----------	University Requirement	3
0903---	Department Elective	3			
----------	University Requirement	3			
Total		**16**	**Total**		**14**

Seventh: Transitional Plan

Old Plan			New Plan		
Course Number	**Course Title**	**Cr. Hr.**	**Course Number**	**Course Title**	**Cr. Hr.**
0903251	Electromagnetics (I)	3	0943351	Electromagnetics (I)	3
0903351	Electromagnetics (II)	3	0903352	Electromagnetics (II)	3
0953321	Probability and Random Variables	3	0963321	Probability and Statistics	3
0903448	Measurements & Control Lab.	1	0943449	Instrumentation and Control Lab	1
0903471	Electrical Machines (II)	3	0933372	Electrical Machines (II)	3
0903478	Machines Lab	1	0903379	Electrical Machines Lab	1
0933481	Power System Analysis (I)	3	0953481	Power System Analysis	3
0933482	Power System Analysis (II)	3	0943482	Power System Protection	3
0943521	Communication Circuits	3	0943423	Communication Electronics	3
0943524	Optical Communications & Laser	3	0963523	Optical Communications	3
0933462	Digital Electronics	3	0903362	Digital Electronics	3
0903561	Medical Electronics .	3	0943561	Biomedical Electronics	3
0943582	Electrical Drives	3	0903563	Electrical Drives	3
0963581	Power System Reliability	3	0963582	Power System Planning	3
0933374	Electrical Machines Lab	1	0953374	Electrical Engineering & Machines Lab	1
0903253	Electromagnetics	3	0943351	Electromagnetics (I)	3
0943529	Selected Topics in Communications	3	0953529	Selected Topics in Communications & Electronics	3

Course Description

Course Number	Course Title	Credit Hours
0301101	Calculus I	3

Prerequisite: (N/A)

Functions: domain, operations on functions, graphs of functions; trigonometric functions; limits: meaning of a limit, computational techniques, limits at infinity, infinite limits; continuity; limits and continuity of trigonometric functions; the derivative: techniques of differentiation, derivatives of trigonometric functions; the chain rule; implicit differentiation; differentials; Roll's Theorem; the mean value theorem; the extended mean value theorem; L'Hopital's rule; increasing and decreasing functions; concavity; maximum and minimum values of a function; graphs of functions including rational functions (asymptotes) and functions with vertical tangents (cusps); antiderivatives; the indefinite integral; the definite integral; the fundamental theorem of calculus ; the area under a curve; the area between two curves; transcendental functions: inverse functions, logarithmic and exponential functions; derivatives and integrals; limits (the indeterminate forms); hyperbolic functions and their inverses; inverse trigonometric functions.

Course Number	Course Title	Credit Hours
0301102	Calculus II	3

Prerequisite: (0301101)

Techniques of integration: integration by substitution; integration by parts, integrating powers of trigonometric functions, trigonometric substitutions, integrating rational functions, partial fractions, rationalization, miscellaneous substitution; improper integrals; application of definite integral: volumes, length of a plane curve, area of a surface of revolution polar coordinates and parametric equations: polar coordinates, graphs in polar coordinates, area in polar coordinates; infinite series: sequences, infinite series, convergence tests, absolute convergence, conditional convergence; alternating series; power series: Taylor and Maclurine series, differentiation and integration of power series.

Course Number	Course Title	Credit Hours
0301201	Calculus III	3

Prerequisite: (0301102)

Three dimensional space and vectors rectangular coordinates in 3-space; spheres, cylindrical surfaces; quadric surfaces; vectors: dot product, projections, cross product, parametric equations of lines and planes in 3-spaces; vector-valued functions: calculus of vector valued functions, change of parameters, arc length, unit tangent and normal vectors, curvature, functions of two or more variables: domain, limits, and continuity; partial derivatives; differentiability; total differentials; the chain rule; the gradient; directional derivatives; tangent planes; normal lines; maxima and minima of functions of two variables; Lagrange multipliers; multiple integrals: double integral, double integrals in polar coordinates; triple integrals; triple integrals in cylindrical and spherical coordinates; change of variables in multiple integrals; Jacobian.

Course Number	Course Title	Credit Hours
0302101	General Physics I	3

Prerequisite: (N/A)

Motion in one dimension. Vectors. Motion in two dimensions. The laws of motion. Circular motion and other applications of Newton's laws. Work and kinetic energy. Potential energy and conservation

of energy. Linear momentum and collisions. Rotation of a rigid object about a fixed axis. Rolling motion and angular momentum.

Course Number	Course Title	Credit Hours
0302111	Practical Physics I	1

Prerequisite or Corequisite: (0302101)

Collection and analysis of data. Measurements and uncertainties. Vectors. Force table. Kinematics of rectilinear motion. Force and motion. Collision in two dimensions. Rotational motion. Simple harmonic motion: simple pendulum. The behavior of gases with changes in temperature and pressure. The falling sphere viscometer. Specific heat capacity of metals.

Course Number	Course Title	Credit Hours
0302102	General Physics II	3

Prerequisite: (0302101)

Electric field. Gauss's law. Electric potential. Capacitance and dielectrics. Current and resistance. Direct current circuits. Magnetic field. Sources of the magnetic field. Faraday's laws of induction.

Course Number	Course Title	Credit Hours
0302112	Practical Physics II	1

Prerequisite or Corequisite: (0302102)

Electric field mapping. Specific charge of copper ions. Resistance measurement and Ohm's law. Power transfer. Potentiometer. Capacitors: RC time constant. Kirchhoff's laws. Magnetic field of a current. Lenses. Young's double slit experiment. Electromagnetic induction.

Course Number	Course Title	Credit Hours
0904131	Engineering Graphics & Descriptive Geometry	3

Prerequisite: (N/A)

Drawing equipment and use of instruments. Lettering, Geometric construction, Sketching and shape description. Basic descriptive geometry, Developments and intersections. Axonometric, oblique and perspective drawings, Multi-view projection, Principal views, Conventional practice, and sectional views. Auxiliary views. Dimensioning techniques. Parallel: Introduction to computer drawing, Drawing aids, Geometrical construction, and the appropriate commands of text, editing, plotting, sections, layers, pictorial views, and dimensioning. Auxiliary views.

Course Number	Course Title	Credit Hours
0966111	Engineering Workshops	1

Prerequisite: (N/A)

General safety, materials and their classifications, measuring devices and their accuracy, fits and tolerances, theoretical background for the practical exercises including fitting, forging, carpentry, casting, welding, mechanical saws, shearers, drills, lathes, milling machines, shapers and grinders.

Course Number	Course Title	Credit Hours
0907101	Computer Skills for Engineers	3

Prerequisite: (1902098 & 1932099)

This course presents the fundamental concepts of programming using one high level programming language, such as C++, Java or Python. It covers the basic structures of the programming language such as variables; data types; control structures; arrays; functions; and introduction to records (struct) and object oriented programming (classes and objects). The course will focus on providing the students with practical programming skills through homeworks and exams which require writing whole programs. Also the course prepares the students to global programming competitions.

Course Number	Course Title	Credit Hours
0901420	Engineering Economy	3

Prerequisite: (0903202)

Major elements of feasibility studies. Principles of engineering Economy. Equivalence and compound interest formula. Single payment model. Uniform payment model. Gradient payment model. Exponential payment model. Decision criteria for single and multiple alternatives: present worth, annual worth, future worth, internal rate of return, benefit cost ratio and payback methods. Income-tax effect on decision making. Management concepts, management cycle. Theories of management. Project scheduling techniques using Gantt and Precedence methods.

Course Number	Course Title	Credit Hours
0303101	General Chemistry I	3

Prerequisite: (N/A)

Measurements and significant figures, chemical reactions; stoichiometry; the gaseous state; thermochemistry; electronic structure and periodicity; chemical bonding; molecular shapes; states of matter and intermolecular forces.

Course Number	Course Title	Credit Hours
0903211	Electrical Circuits (I)	3

Prerequisite: (0302102)

Units, definitions and simple electrical circuits. Series and parallel connections. Voltage and current division. Circuit analysis techniques. Superposition theorem. Thevenin's and Norton's theorems. Inductance and capacitance. Analysis of source-free RL and RC circuits. The application of unit-step forcing functions to RL and RC circuits. Analysis of source-free RLC circuits. The complete response of RLC circuits. The sinusoidal forcing function. The phasor concept. The phasor relationships for R, L and C. Impedance and admittance. The sinusoidal steady state response. Circuit analysis using MATLAB and SPICE.

Course Number	Course Title	Credit Hours
0903212	Electrical Circuits (II)	3

Prerequisite: (0903211)

Current and voltage RMS values. Instantaneous, average, real, reactive and complex power. Power factor. Polyphase circuits. Three-phase wye and delta connections. Power in three phase systems. Frequency response transfer function. Principles of filtering. Basic passive and active filters. Parallel and series resonance. Bode plots. Magnetically coupled circuits. Mutual coupling. Linear and ideal transformers. General two-port networks. Impedance, admittance, and transmission parameters. Circuit analysis using software simulation.

Course Number	Course Title	Credit Hours
0933219	Electrical Circuits Lab	1

Prerequisite or Corequisite: (0903212)

Electrical measurement devices. Resistors and DC Circuits. Series/parallel combinations. Voltage/current division. Kirchhoff's laws. Nodal/mesh analysis. Network Theorems. Maximum power transfer. Transient analysis in RL and RC circuits. Impedance concept. Inductive and capacitive reactance. AC power measurement and power factor. Series and parallel resonant RLC circuits. Quality factor. Three-phase wye and delta circuits. Parameters of two-port networks. Filters including: low-pass filter (LPF), high-pass filter (HPF) and band-pass filter (BPF). Coupled circuits. Residential wiring and electrical safety considerations.

Course Number	Course Title	Credit Hours
0907231	Digital Logic	3

Prerequisite: (0907101)

Number Systems and digital waveforms. Basic gates and logic functions. Boolean algebra, Boolean expressions. Logic minimization techniques. VHDL basics. Design, simulation and synthesis tools for programmable logic devices. Combinational logic building blocks including decoders, encoders, multiplexers, demultiplexers, magnitude comparators. VHDL for combinational circuits. Digital arithmetic, adders, subtractors. VHDL for arithmetic circuits. Basics of sequential circuits. Basic latches and flip-flops. Timing parameters and diagrams. Counters, shift registers. Basic PLDs, CPLDs and FPGAs architectures. VHDL for binary counters and shift registers. State machines. System design with state machines using VHDL. Memory devices and systems including RAM, ROM, FIFO, LIFO and dynamic RAM.

Course Number	Course Title	Credit Hours
0907234	Digital Logic Lab	1

Prerequisite or Corequisite: (0907231)

Basic TTL and CMOS logic gates, including simulations to explore functionality and timing parameters. Simulation and practical hardware implementation on CPLDs or FPGAs, using VHDL for combinational and sequential circuits including multiplexers, demultiplexers, decoders, encoders counters, shift registers, latches and memory. Logic design using state machines. Design project using CPLDs or FPGAs.

Course Number	Course Title	Credit Hours
0903261	Electronics (I)	3

Prerequisite: (0903211)

Introduction to semiconductors. Electrical properties of intrinsic and doped semiconductors. Diffusion process in semiconductors. The P-N junction. Open-circuit P-N junction. Forward and reverse biased junction. Temperature effects. Small and large-signal models. Junction capacitance and switching times. Diode types and common applications. Rectification. Rectifier filters. Limiting and clamping circuits. Zener, varactor and Schottky diodes. Light Emitting Diodes (LED) and photodiodes. Analysis of circuits containing P-N junction diodes. The Bipolar Junction Transistor (BJT): structure, characteristics, models, and configurations. DC biasing and load line analysis. BJT transistor as a switch and amplifier. BJT transistor ratings. The Field-Effect Transistor (FET): structure, characteristics, models, and configurations. Types of FET transistor: Junction Gate Field-Effect Transistor (JFET) and Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET). DC biasing and load line analysis. FET transistor as a switch and amplifier. Analysis of amplifier circuits at low frequencies.

Course Number	Course Title	Credit Hours
0903361	Electronics (II)	3

Prerequisite: (0903261)

Biasing of transistor (BJT and FET). Amplification. Single-stage amplifier. Cascaded BJT and FET amplifiers. Composite transistor stages. AC load line analysis. Operational amplifiers and Applications. Operational amplifier architectures. Gain with active load. DC level shifting. Differential amplifier. Frequency response of amplifiers. The low-frequency response of all amplifier configurations. The high-frequency response of all amplifier configurations. The frequency response of cascaded stages. Feedback Amplifiers. Properties of negative-feedback amplifiers. Analysis of

feedback amplifiers.

Course Number	Course Title	Credit Hours
0903362	Digital Electronics	3

Prerequisite: (0903361)

Digital signal characteristics. Digital gates characteristics: voltage transfer curve, fan-in/fan-out, and static/dynamic power dissipation. Transistor models (Ebers-Moll model). Characteristics and analysis of BJT logic families: Resistor-Transistor Logic (RTL), Diode Transistor Logic (DTL), Transistor-Transistor Logic (TTL), Schottky TTL, and Emitter-Coupled Logic (ECL). CMOS logic circuits analysis, design, and evaluation. Logic CMOS circuits types and dynamic logic. CMOS Tri-state gates. Programmable logic devices. Memory architecture analysis and evaluation: ROM, EEPROM, Static Random Access Memory (SRAM), and Dynamic Random Access Memory (DRAM). Waveform generating blocks: Astable and Monostable circuits. Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC). Introduction to VLSI design flow and CMOS fabrication. Using computer-aided design software for digital electronics.

Course Number	Course Title	Credit Hours
0933368	Electronics Lab	1

Prerequisite or Corequisite: (0903361)

Diode characteristics and applications. Half-Wave Rectifier (HWR). Full-Wave Rectifier (FWR). Clipper, clamper and peak detector. Zener diode characteristics and voltage regulators. Bipolar Junction Transistor (BJT) characteristics and biasing. BJT transistor applications: amplification and switching. Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) characteristics and biasing. MOSFET transistor applications: amplification and switching. Frequency response of transistor amplifiers. Operational Amplifiers (Op-Amp) and their applications. Introduction to advanced circuits such as cascaded amplifiers, feedback amplifiers, differential amplifiers and oscillators.

Course Number	Course Title	Credit Hours
0903201	Engineering Analysis (I)	3

Prerequisite or Corequisite: (0301201)

First-order ordinary differential equations. Separable, exact and linear ordinary differential equations. Second-order ordinary differential equations. Homogeneous and non-homogeneous ordinary differential equations. General and particular solution. Euler-Cauchy equation. Higher-order linear ordinary differential equations. Linear systems of equations and their solution. Determinants, eigenvalues and eigenvectors. Systems of differential equations. Solving homogeneous and non-homogeneous system of differential equations. Series solutions of differential equations. Orthogonal functions. Laplace transform and its inverse. Solving initial value problem using Laplace transform. Properties of Laplace transform. Solving system of ordinary differential equations using Laplace transform.

Course Number	Course Title	Credit Hours
0903202	Engineering Analysis (II)	3

Prerequisite: (0903201 & 0953221)

Vector differential calculus. Gradient of scalar field. Divergence and Curl of vector field. Vector integral calculus. Line and surface integrals. Green's theorem. Divergence theorem of Gauss. Stokes' theorem. Partial differential equations (PDE). Solution of PDE by separating variables. Solution of PDE by Fourier series. Solution of PDE by Fourier integrals and transforms. Linear algebra. Matrices, determinants, and systems of linear equations. Gauss elimination. Cramer's rule. Linear dependence. Inverse of a matrix. Vector spaces and subspaces. Rank and nullity. Inner product spaces. Orthonormal bases. Eigenvalues and eigenvectors. Linear transformations. Linear algebra applications.

Course Number	Course Title	Credit Hours
0943351	Electromagnetics (I)	3

Prerequisite: (0302102 & 0903202)

Introduction. Review of vector analysis and coordinate systems. Coulomb's law and the electric field. Potential and gradient. Electric flux density. Gauss law and divergence theorem. Electric fields in material space. Capacitors. Boundary conditions. Poisson's and Laplace's equations. Method of images. Biot-Savart's law. Ampere's law. Magnetic vector potential. The curl and Stock's theorem. Magnetic force, torque and moment. Magnetic dipole. Practical applications. Magnetic properties of materials. The B-H curve and the hysteresis concept. Boundary conditions. Inductors. Magnetic circuits. Interaction between fields and charged particles. Faraday's law. Displacement current. Maxwell's equations. Continuity equation and the relaxation relationship. Time varying potential. Time-harmonic fields.

Course Number	Course Title	Credit Hours
0903352	Electromagnetics (II)	3

Prerequisite: (0943351)

Introduction. Maxwell's equation. Wave equation. Plane wave (PW) in general medium. Wavelength, wave number, direction of wave propagation, phase velocity, group velocity, phase and attenuation constants and wave impedance. PW propagation in lossless, lossy and good conducting media. Skin effect and the surface impedance in lossy and good conducting media. Generalized form of the PW. Poynting vector. Normal incidence on one and multiple media and oblique incidence of the UPW. Wave polarization. Consideration of some practical problems. Transmission lines (TL). Transient analysis of lossless TL. Analysis of TL for harmonic source using vector and crank diagram. Short TL (stubs). TL charts. Matching using single stub, double stubs and quarter wavelength TL. Impedance measurement. Time Domain Reflectometer (TDR). Waveguides. Rectangular and circular waveguides. Slots in waveguide. The concept of resonant cavity. Waveguide Excitation. Introduction to antennas including the different parameters of an antenna. Short and half-wavelength dipoles. Loop antennas. Antenna characteristics.

Course Number	Course Title	Credit Hours
0953221	Signal Analysis & Systems	3

Prerequisite or Corequisite: (0903211)

Signal classification and system models. Continuous time signals. Signals and vectors. Generalized Fourier series representation. Amplitude and phase spectra of signals. Energy and power content of signals. Bandwidth of signals. The Fourier transform and its applications. Sampling of signals. Convolution of signals. Power and energy spectral densities. Correlation functions. Time-domain analysis of continuous time systems. The system impulse response. Communication channels. Filters: low-pass filter, high-pass filter, band-pass filter and band-stop filter. Discrete time signals. The discrete Fourier transform (DFT) and the Fast Fourier transform (FFT). Spectral analysis of DFT systems. Unit sample response to arbitrary input sequences. Introduction to the Z-transform. Project.

Course Number	Course Title	Credit Hours
0963321	Probability and Statistics	3

Prerequisite: (0953221)

Introduction to probability and random variables. Discrete random variables. Continuous random variables. The probability distribution function. The probability density function. Examples of popular distributions: Bernoulli, binomial, Poisson, geometric, normal, etc. Conditional probability. Joint

distributions. Statistics of random variables. The central limit theorem. Analyzing measurements using statistical techniques. Measures of central tendency (mean, median, mode). Measures of variation (range, interquartile, variance, standard deviation, coefficient of variation, Chebyshev's rule and empirical rule). Measures of position (Z-score, percentiles and outliers). Graphical data analysis, frequency distributions, standard error, goodness of fit. Linear regression. Confidence intervals and sample size. Counting methods, combinations and permutations. Statistical inference about one and two population parameters. Hypothesis testing. Random processes. Ergodicity and stationarity.

Course Number	Course Title	Credit Hours
0903232	Microprocessor Systems & Languages	3

Prerequisite: (0907231)

Microprocessor organization, architecture and software model. Modern architectures and their evolution: Intel x86 architecture, ARM architecture, RISC-V architecture, etc. Memory hierarchy: Cache memory, main memory and external memory. Cache organization. Instruction set architecture. Complex instruction set computer (CISC) versus reduced instruction set computer (RISC). Machine language and program execution. Data representation. Microprocessor memory addressing modes. Assembly language fundamentals. Data Transfer Instructions. Arithmetic and logic instructions. String comparisons. Program control instructions. Jump instructions. Stacks and subroutines. Software interrupts. Development of simple assembly programs. Using the assembler/linker. Microprocessor arithmetic and logic unit (ALU): adders, subtractors, multipliers and dividers. Binary representation of floating-point numbers and their arithmetic. Control unit. Data path design. Processor cycles and pipelining. Introduction to branch prediction and speculative execution. Basics of processor performance evaluation. The microprocessor bus architecture. Introduction to memory and I/O interfacing. Introduction to DMA-controlled input/output, and modern system buses: PCI, USB, etc.

Course Number	Course Title	Credit Hours
0903233	Microcontroller Applications	3

Prerequisite: (0903232)

Prevalence of microcontrollers and embedded systems in modern-day electrical systems. Microcontroller types. Microcontroller architecture. Using Assembly language and toolchain for programming microcontrollers. Status and control registers. Memory access. Programming microcontrollers using the ANSI C language. Pointers and arrays. Inline Assembly. Debugging microcontroller programs. Using general purpose input/output pins to interface external hardware to the microcontroller. Timers, counters and pulse width modulation. Internal and external interrupts. Serial communications: UART and SPI. Reading analog signals and Analog/Digital Converters (ADC). Software and hardware design basics. Project.

Course Number	Course Title	Credit Hours
0933239	Microcontroller Applications Lab	1

Prerequisite: (0903233)

Experiments using both simulation and practical implementation. Arduino system design and C-language program development tools. Using general purpose input/output ports to interface with external hardware, such as LEDs, switches, communication devices, sensors, and actuators. Using timers and counters. Internal and external interrupts. Serial communications. Analog/Digital Converters (ADC). Design project.

Course Number	Course Title	Credit Hours
0953421	Communications (I)	3

Prerequisite or Corequisite: (0963321)

Classification of communication systems. Channel impairments: attenuation, distortion, noise, etc.

Continuous-wave (CW) modulation. Double Sideband Suppressed Carrier (DSB-SC), Amplitude Modulation (AM) and Quadrature Amplitude Modulation (QAM). Bandwidth. Mixers. Coherent detection and effects of frequency/phase errors. Frequency Modulation (FM) and Phase Modulation (PM). AM and FM transmitters, receivers and radio broadcasting. Noise sources and noise representation in CW modulation. Signal-to-Noise Ratio (SNR) calculations. Frequency Division Multiplexing (FDM) and Time Division Multiplexing (TDM). Introduction to baseband transmission: sampling, quantization, line coding, and pulse shaping. Introduction to digital modulation techniques: ASK, FSK, PSK and QPSK. Introduction to performance of digital modulation schemes in the presence of noise.

Course Number	Course Title	Credit Hours
0953422	Communications (II)	3

Prerequisite: (0953421)

Review of baseband transmission: sampling, quantization, line coding and pulse shaping. Power spectral density of line coding techniques. Performance of line coding techniques. PAM, PWM, PPM and Pulse Code Modulation (PCM). Differential PCM. Digital modulation formats: ASK, FSK, PSK, QPSK and QAM. Optimum receiver design. Matched filter derivation and design for digital modulation formats. Signal space representation. Performance evaluation for digital modulation in AWGN channel. Probability of symbol and bit error for the different modulation formats. Channel coding and its effect on probability of bit error. Hamming codes. Convolutional codes. Linear block codes. Error correcting capability of linear block codes.

Course Number	Course Title	Credit Hours
0943423	Communication Electronics	3

Prerequisite: (0903362 & 0903421)

Overview of communication system blocks. RF oscillator types and circuits. Loop gain analysis. Negative resistance analysis. Voltage controlled Oscillators (VCO). RF active mixers. Gilbert cell. Conversion loss. Nonlinear effects. Mixers applications in modulation, demodulation and frequency conversion. Tuner and resonant circuits. RF filter design: LPF, HPF, BPF and BSF. RF power amplifiers. RLC high-frequency system model. Impedance matching and transformations. Automatic gain control (AGC) circuits. Design of Low Noise Amplifiers (LNA). RF and IF tuned amplifiers. Phase locked loop design and applications. PCB RF design. Case studies. Project on the design, implementation and testing of RF circuits.

Course Number	Course Title	Credit Hours
0903425	Communication Systems	3

Prerequisite: (0903352 & 0953421)

Communication system block diagram. Brief history of telecommunications. Wired versus wireless communication systems. Modeling of wireless channels. Radio-wave prorogation models. Link budget calculations. Antenna types and system gain. Multipath transmission. Small-scale and large-scale fading. Performance evaluation of bit error rate within fading channels. Terrestrial (microwave) and satellite communication systems (including uplink and downlink budget calculations). Satellite applications and GPS Systems. Multiplexing and multiple access techniques: TDMA, FDMA, CDMA, OFDMA. Orthogonality and spread spectrum techniques. Modern wireless communication technologies: Wi-Fi, Bluetooth, Zigbee, NFC, IoT, etc. Classical wired communication systems: Telephony systems and voice communications. Voice companders. Echo canceling. Signaling systems. Plesiochronous and Synchronous digital hierarchies (PDH and SDH). Long-distance optical fiber transmission. Introduction to source coding and the entropy concept.

Course Number	Course Title	Credit Hours

0953429	Communications Lab	1

Prerequisite or Corequisite: (0953422)

Amplitude Modulation (AM) transmission and reception. AM modulation index, power efficiency, synchrony and asynchronous demodulation. Frequency Modulation (FM) modulators and demodulators. Quadrature detector. Phase-locked loop (PLL). Measurements using the spectrum analyzer. Baseband binary transmission and line coding techniques: Unipolar, Polar and Manchester. Clock synchronization. Generation and reception of binary Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), and Frequency Shift Keying (FSK) signals. Eye diagram. Hardware design project.

Course Number	Course Title	Credit Hours
0943301	Engineering Numerical Methods	3

Prerequisite: (0903202)

Mathematical preliminaries. Numerical errors. Loss of significance and error propagation. MATLAB as a mathematical analysis tool. MATLAB variables, vectors and matrices. Operator precedence. Matrix indexing. Built-in and user-defined functions. Relational operators and conditional statements. Flow control structures and loops. Plotting. Numerical solution of nonlinear algebraic equations. Numerical solution of systems of linear equations. Numerical solutions of systems of non-linear algebraic equations. Interpolation, approximation and curve fitting. Numerical differentiation and integration. Numerical solution of ordinary differential equations. Eigenvalue problems. Numerical solution of partial differential equations. MATLAB symbolic engine. Using symbolic capabilities for liner algebra, calculus and other problems. Introduction to Simulink and its libraries. Simulating some engineering systems and finding solutions. Practical exercises.

Course Number	Course Title	Credit Hours
0933441	Control Systems	3

Prerequisite: (0943301)

Open-loop and closed-loop (feedback) control systems. Examples of feedback control systems. Review of complex variables and Laplace transform. Poles and element transfer function and block diagram. Modeling of physical systems: electrical, mechanical, hydraulic and pneumatic systems. Linearization of nonlinear systems. System representations: system block diagrams and signal flow graphs. Overall transfer function, block diagram reduction techniques and Mason's gain formula. Introduction to state-space representation. Sensitivity of open loop and closed loop control systems. Time response analysis and performance indices of first and second order systems. Dominant poles of high order systems. Routh-Hurwitz stability criterion. Steady state error coefficients. Design and effects of basic control actions and their combinations: proportional, integral and derivative. Effects of velocity feedback. Stability analysis using root locus. Bode diagrams and Nyquist stability criterion. Gain and phase margins, and obtaining transfer function using Bode diagrams. Introduction to analysis and design using state-space equations.

Course Number	Course Title	Credit Hours
0943449	Instrumentation and Control Lab	1

Prerequisite or Corequisite: (0933441)

Experiments on oscilloscope. Data acquisition systems and software data processing. Instrumentation and measurement errors. Signal generators. Measurement of earth resistance. Thermocouple and time constant measurements. Open and closed loop systems. Servomechanism principles. The effect of gain, integral and derivative control, and velocity feedback on system performance. Frequency response measurements. Electro-pneumatic control systems. Introduction to fuzzy-logic control. Introduction to programmable logic controllers (PLC) and ladder logic.

Course Number	Course Title	Credit Hours

0943461	Power Electronics	3

Prerequisite: (0903261 & 0953221)

Basic elements of power electronics systems. Power electronics concepts and applications. Converters classification. Power electronics switches and semiconductor devices. DC-DC converters: the choppers concept, buck, boost, and buck-boost converters, and switched mode DC power supplies. Inverters: half-bridge and full-bridge inverters, PWM and SPWM techniques, three phase inverters, and six step inverter. Fourier analysis and total harmonic distortion analysis for inverters. Half-wave and full-wave rectifiers, half-wave rectifier with RL loads, half-wave rectifier with capacitive loads. Controlled half-wave rectifiers. Single-phase and three-phase full-wave rectifiers. Controlled full-wave rectifiers. AC controllers, single-phase AC voltage controllers, three-phase voltage controllers.

Course Number	Course Title	Credit Hours
0903371	Electrical Machines (I)	3

Prerequisite: (0903212)

Magnetic circuits. Single-phase transformers: principles, analysis and performance characteristics. Three-phase transformers: construction, connections and vector groups. Single-phase and three-phase transformer testing. Electromechanical energy conversion. Basic principles of DC mechanics. Principles and classification of DC generators. DC motors: analysis, performance characteristics, starting and speed control. DC machines testing. Rotating field. Synchronous generators: classification, analysis, performance characteristics, synchronization process and parallel operation.

Course Number	Course Title	Credit Hours
0933372	Electrical Machines (II)	3

Prerequisite: (0903371)

Synchronous motors: analysis, performance characteristics, application in power factor correction, and starting methods. Testing of synchronous machines. Three-phase induction motors: classification, analysis, performance characteristics, starting methods, testing, and speed control. Single-phase induction motors. Special types of motors: stepper motor, universal motor, reluctance motor, and brushless DC motor.

Course Number	Course Title	Credit Hours
0903379	Electrical Machines Lab	1

Prerequisite or Corequisite: (0933372)

Transformer magnetic circuits. Testing of single and three-phase transformers. DC generators. Speed control of DC motors. Testing and operational characteristics of alternators. Testing and operational characteristics of synchronous motors. Testing and operational characteristics of induction motors.

Course Number	Course Title	Credit Hours
0953481	Power System Analysis	3

Prerequisite: (0903371)

Introduction to electrical energy sources and power system components. The one-line diagram. Models for transformers, generators and loads. Per unit quantities. Per unit calculations applied to power systems. Models of transmission lines. Transmission lines analysis: currents, voltages and power relationships at both ends. Reactive power compensation. Power flow analysis: problem formulation, Gauss-Seidal method, Newton-Raphson technique, decoupled power flow and DC load flow. Symmetrical 3-phase fault calculations. Symmetrical components. Unsymmetrical fault calculations.

Course Number	Course Title	Credit Hours
0943482	Power System Protection	3

Prerequisite: (0953481)

Power system protection: basic principles and aspects. Protection system components, electromechanical relays, solid state relays and digital relays. Current and voltage transformers. Steady state and transient analysis of current transformers. Overcurrent relays: directional and non-directional relays. Distance protection basics. Communication-based pilot distance relays schemes. Load encroachment and power swings. Differential protection: Generator, line, bus-bar, and motor. Generator protection: differential, overcurrent, V/Hz, and loss of potential. Fuses: mechanisms and short circuit interruptions. Circuit breakers: construction and classifications.

Course Number	Course Title	Credit Hours
0903489	Electrical Power Lab	1

Prerequisite or Corequisite: (0943482)

Voltage distribution over a string of suspension insulators, I-t fuse characteristic. Measurement of symmetrical components in unbalanced systems; negative and zero sequence filters. Power and voltage relations at the ends of short and medium transmission lines. Grounding of power system neutrals: solid, resistive and inductive grounding. Characteristics of instantaneous overcurrent and under-voltage relays. Comparison of the characteristics of static, electromechanical, and numerical relays. Overcurrent time lag relays. O/C directional overcurrent relays. Differential protection schemes.

Course Number	Course Title	Credit Hours
0943401	Engineering Ethics	1

Prerequisite: (0903361)

Moral frameworks. Professionalism. Codes of ethics. Safety/risk. Workplace ethics. Honesty. Environmental, societal and global impact of engineering disciplines. Effects of technological changes on modem society. Volunteerism/humanitarian engineering. Social justice. Engineering ethics via theoretical and/or case-study approach with special focus on cases from electrical engineering disciplines.

Course Number	Course Title	Credit Hours
0903500	Practical Training	3

Prerequisite: (Passing 115 credit hours)

The student shall undertake field training for eight consecutive weeks, equivalent to a minimum of 280 practical working hours. The training should be full-time without periods of interruption in a local or international organization related to electrical engineering and approved by the department. The training should adhere to the B.Sc. degree in Engineering guidelines, and adhere to National Accreditation regulations.

Course Number	Course Title	Credit Hours
0973598	Project (I)	1

Prerequisite: (0903500)

The senior design project spans two regular semesters, after which the final grade is assigned. Students can register for the senior design project only after finishing their professional training period (as per National Accreditation rules). In part one of the project, a design problem is assigned to the student in one of the different electrical engineering disciplines. The student is asked to work within a team (supervised by a faculty member) to find a solution for the problem (which could be practical or theoretical). It is expected from the student to develop the abilities of research and teamwork and to train himself to observe a time table to perform his project and to be capable of explaining and expressing his findings in a professional manner.

Course Number	Course Title	Credit Hours
0973599	Project (II)	2

Prerequisite: (0973598)

In the second part of the senior design project, the student is required to use the appropriate and available hardware and/or software to solve his problem, simulate his solution, to build a prototype, perform all needed measurements and finally recognize the impact of his engineering solutions in the global, economic, environmental, and societal contexts. The student is required to write down his findings as a technical report (dissertation) according to the department guidelines.

Course Number	Course Title	Credit Hours
0943424	Digital Signal Processing	3

Prerequisite: (0953421)

Introduction to digital signal processing (DSP). Discrete time signals and systems. Z-transform. Modeling and implementation forms of discrete time systems. Time- and frequency-domain analysis of digital processors. Design and analysis of finite impulse response filters (FIR). Analog filter approximations. Design and analysis of infinite impulse response (IIR) filters. Digital filter networks. Digital equalizers. The discrete Fourier transform (DFT) and fast Fourier transform (FFT) algorithms. DSP algorithms and applications. Project.

Course Number	Course Title	Credit Hours
0903426	Communication Networks	3

Prerequisite: (0953421)

Introduction to communication networks and the OSI model. Circuit switching and packet switching. Physical layer and transmission media. Asynchronous and synchronous transmission. Local loop access technologies. Data Link Layer Principles. IEEE 802.x Medium Access Control (MAC) protocols: LANs, MANs, WANs and PANs. The concept of internetworking and the Internet Protocol (IP). IP Specifications and supporting protocols (ARP, DHCP, ICMP, etc). Routing and switching in IP networks. Repeaters, Switches, Hubs, Bridges, Routers and Gateways. UDP and TCP transport layers. Internet applications.

Course Number	Course Title	Credit Hours
0953521	Multimedia Transmission	3

Prerequisite: (0953422)

Introduction to information theory and source coding. Huffman coding and decoding. Voice encoding schemes and standards: PCM, CELP, Vocoding, etc. Voice-over-IP (VoIP). Voice quality and traffic characterization. Image and video encoding schemes and standards. MPEG compression. Video quality and traffic characterization. Analog and digital TV broadcasting systems. Video streaming over the Internet and Quality-of-Service (QoS) requirements. IP unicast and multicast routing protocols. Internet QoS frameworks: Integrated Services (IntServ) and Differentiated Services (DiffServ). Real-Time Transport Protocol (RTP). Real Time Streaming Protocol (RTSP). Session Initiation Protocol (SIP). Secure access to information, privacy issues, digital rights and watermarking.

Course Number	Course Title	Credit Hours
0953522	Cellular Communications	3

Prerequisite or Corequisite: (0953422)

Introduction to telephony and traffic theory. Calculating the probability of blocking for parallel and series links. Cellular communication design and frequency re-use patterns. Performance enhancement by proper cell site design and sectorization. C/I ratio calculations. Traffic management, call setup and hand-off. Propagation models: Knife edge model and effect of multiple edges. Fading: small-scale, frequency-selective, and Doppler shift. Modulation for cellular systems. Cellular telephony standards and systems: 1G, 2G, 3G, 4G, 5G, etc. Voice coders and compression formats for cellular systems. Error correcting and convolutional codes. Interleaving and deinterleaving. Encryption and decryption

in cellular systems. Case studies.

Course Number	Course Title	Credit Hours
0963523	Optical Communications	3

Prerequisite: (0953421)

Introduction. Step- and graded-index optical fibers. Multi-mode and single-mode optical fibers. Attenuation and dispersion in optical fiber. Guided wave propagation. Fields and modes in optical fiber. Principles of laser generation. Semiconductor lasers. Light amplifiers and their applications. Optical modulation techniques: Direct modulation and external modulation. Multiplexing methods. Optical detectors and receivers: PIN and APD. Optical system performance. Optical integrated circuits. Practical considerations in optical systems. Optical communication systems: Optical modem, digital optical networks. Introduction to nonlinear optics and soliton systems. Numerical simulation techniques in optical systems.

Course Number	Course Title	Credit Hours
0953529	Selected Topics in Communications & Electronics	3

Prerequisite: (0953421)

Modern subjects in communications and/or electronics presented to students within the new systems in the world of digital communications and/or electronics; including the advantages of such systems, their applications, proper design and performance analysis.

Course Number	Course Title	Credit Hours
0933551	Antennas & Wave Propagation	3

Prerequisite: (0903352)

Introduction and Overview. Antenna Types. Antenna Parameters. Free Space Path loss. Mathematical formulation. Wire antennas: Short dipole, long and half-wavelength dipoles, standing and traveling wave antennas, wire antennas above the surface of the earth. Loop antennas. Antenna arrays analysis. Microstrip Antennas. Wave equation. Plane, cylindrical, and spherical waves. Wave components and wave polarization. Reflection, refraction and transmission of waves. Huygence's principal. Physics of the atmosphere. Wave propagation in the troposphere. Space wave. Surface wave. Physics of the ionosphere. Wave propagation in the ionosphere. Sky wave. Effect of the earth magnetic field. Case studies.

Course Number	Course Title	Credit Hours
0963431	Computer Applications	3

Prerequisite: (0903233)

Fundamental data structures: Arrays, stacks, queues, heaps (priority queues), lists, maps (associative arrays), search trees and graphs. Algorithms to manipulate the above structures. Sorting and tree-exploration algorithms. Divide-and-conquer algorithms. Basic graph algorithms. Asymptotic analysis of algorithm time complexity and correctness proof. Design, analysis and implementation that uses data structures and algorithms to solve practical and modern-day engineering problems, such as machine learning, artificial intelligence, fuzzy control, system simulation, etc.

Course Number	Course Title	Credit Hours
0903549	Selected Topics in Control	3

Prerequisite: (0933441)

Selected topics in modern digital and analog control systems and the advantages of such systems, their applications, proper design and performance analysis.

Course Number	Course Title	Credit Hours
0943561	Biomedical Electronics	3

Prerequisite: (0903362)

Introduction to op-amp circuits, Bio-potential instrumentation amplifier, and active filters. Introduction to biopotential signals. Introduction to medical instrumentation. Sensors and electrodes: resistive, inductive, and capacitive sensors. Thermistors. Optical measurements. Introduction to Cardiovascular system and instrumentation. Non-invasive blood pressure measurement. Heart-sound measurement. Physics and engineering principles for ECG, EMG, EEG, and EOG systems. Introduction to medical imaging systems: radiography, computed tomography and ultrasound. Therapeutic and prosthetic devices: Cardiac pacemakers. Defibrillators. Ventilators. Infant incubators. Drug delivery devices. Electrosurgical unit. Electrical Safety.

Course Number	Course Title	Credit Hours
0903562	Integrated Circuits	3

Prerequisite: (0903362)

Basic concepts of operational amplifier. Input differential amplifier stage characteristics. Operational Amplifier: voltage transfer characteristic, analysis, and design. Practical Op-Amp limitations. The common mode rejection ratio (CMRR). Op-amp circuits and applications: Linear circuits and nonlinear circuits. Integrated circuit fabrication, layout and design rules. Device physics and MOS models. Single-stage amplifiers. Differential amplifiers. Multiple-stage amplifiers. Current mirrors and references. Frequency response. Noise. Feedback techniques for Integrated Circuits. Introduction to switched-capacitor circuits. Nanometer design issues.

Course Number	Course Title	Credit Hours
0903563	Electrical Drives	3

Prerequisite: (0943461)

Elements of electrical drives. Fundamental of mechanics. Classifications of mechanical loads. Speed-torque characteristics of electrical motors: brush-type DC motors, brushless DC motors, induction motors and synchronous motors. Joint speed-torque characteristics of electrical motors and mechanical loads: bidirectional and four-quadrant electrical drives. Dynamics of electrical drives and stability. Velocity time profiling. DC drive system: speed control, phase-controlled DC drive, chopper-controlled DC drive and electrical braking. AC drive system: speed control, variable voltage drive, variable frequency drive, scalar control, soft starters, vector control and electrical braking.

Course Number	Course Title	Credit Hours
0973581	Renewables & Power System Quality	3

Prerequisite: (0953481)

The solar energy source: Altitude and tilt angles, sun path diagrams for shading analysis, clear sky insolation. Photovoltaic materials and electrical characteristics. Photovoltaic cell model, modules and arrays, I-V curves under standard test conditions and shading impacts. Crystalline silicon and thin film technologies. Photovoltaic systems: Current-voltage curves for loads. Grid connected and stand-alone systems. Wind energy systems: Types of wind turbines, power in the wind, wind turbine generators, speed control of generators, wind turbine economics. Power system quality: current and voltage total harmonic distortion, harmonics sources, effects and mitigation. Voltage flickers, sags and swells.

Course Number	Course Title	Credit Hours
0963582	Power System Planning	3

Prerequisite: (0953481)

Restructured power systems: models and electricity market. Load and energy forecasting: short and long terms. Planning of power generation, transmission and distribution. Reliability evaluation of generation, transmission and distribution systems. Production costing analysis.

Course Number	Course Title	Credit Hours
0933583	Power System Operations & Economics	3

Prerequisite: (0953481)

Introduction to power system economics. System optimization techniques. Economic dispatch. Unit commitment. Introduction to optimal power flow. Electricity markets. Reliability from operation perspectives. Ancillary services. Generation and transmission expansion.

Course Number	Course Title	Credit Hours
0933584	High Voltage Engineering	3

Prerequisite: (0953481)

Introduction to high voltage engineering. Conduction and breakdown in gases, liquids and solids. Generation of high voltages and high currents. Measurement techniques for high voltages and currents. Performance of high-voltage line insulators and calculation of voltage distribution along insulators. High voltage cables. Corona discharge. Applications of insulating materials, power circuit breakers and switchgear.

Course Number	Course Title	Credit Hours
0943589	Selected Topics in Power & Machines	3

Prerequisite: (0953481)

Modern topics in electrical power systems or electrical machines to keep the student up-to-date in the areas of power generation (their policies and economics), energy sources, distribution systems and special machines.

Course Number	Course Title	Credit Hours
0953528	Advanced Communications Lab	2

Prerequisite: (0953422)

Antennas and their main parameters. Using a vector network analyzer to study antenna parameters. Spectrum analyzers. Software-Defined Radio (SDR) systems. Optical fiber systems. Dispersion in optical fiber and the Eye diagram. Multiplexing in telephony and operating a PBX (private branch exchange).

Course Number	Course Title	Credit Hours
0903568	Advanced Electronics Lab	2

Prerequisite: (0903362)

Instrumentation amplifiers and active filters. Field-programmable gate array (FPGA). VLSI design and software development, Combinational and sequential circuits. Analog-to-Digital and Digital-to-Analog converters. Digital signal processing and filters. Pulse Width Modulation. Power Electronics. DC-DC converters. Half-bridge and full-bridge inverters. Electronic PCB Manufacturing.

Course Number	Course Title	Credit Hours
0963588	Advanced Electrical Power Lab	2

Prerequisite: (0943482)

Power system protection. Relays. Using Supervisory Control And Data Acquisition (SCADA) systems to monitor and control various parts of a power system. High-voltage insulators and its testing. Special types of electric machines. Motor speed control. Variable-frequency motor drive.

Course Number	Course Title	Credit Hours

0903203	Electrical Engineering	3

Prerequisite: (0302102)

Ohm's and Kirchhoff's laws. Series and parallel connections. Voltage and current division. Nodal and mesh analysis. Superposition theorem. Thevenin's and Norton's theorems. Source transformation. Maximum power transfer. Inductance and capacitance. Behavior of R, L and C under steady-state DC or AC conditions. Characteristics of sinusoids. The phasor concept. Phasor relationships for R, L, and C elements. Impedance and admittance. Effective values of current and voltage. Instantaneous, average and apparent power. Power factor. Resonance. Three-phase systems. Three-phase wye and delta connections. Introduction to semiconductors. The PN junction. Diode characteristics. Applications of diodes: switches, rectifiers, etc. Transistors: operation, model, voltage-current characteristics. Applications of transistors: amplifiers, switches, etc. Operational Amplifiers. Safety considerations. Protective grounding.

Course Number	Course Title	Credit Hours
0903204	Electrical Engineering Lab	1

Prerequisite: (0903203)

Electric measurement equipment. Ohm's law. Resistors and DC Circuits. Series and parallel connections. Voltage and current division. Nodal and mesh analysis. Superposition theorem. Thevenin's and Norton's theorems. Maximum power transfer. Inductance and capacitance. AC systems. Impedance concept and phase shift in RL and RC circuits. Measurement of power and power factor. Resonance. Three-phase wye and delta connections. Diodes and their applications: half-wave rectifiers, full-wave rectifiers, etc. Transistors and their applications: amplifiers, switches, etc. Residential wiring and safety considerations.

Course Number	Course Title	Credit Hours
0973373	Electrical Machines	3

Prerequisite: (0903203)

Magnetic circuits. Single-phase and three-phase transformers: principles, analysis, performance characteristics and testing. Electromechanical energy conversion. DC generators and DC motors: analysis, performance characteristics, and motor speed control. Three-phase synchronous generators. Three-phase synchronous motors: analysis, performance characteristics, applications, starting and testing. Three-phase induction motors: analysis, performance characteristics, testing, starting and speed control. Introduction to single-phase induction motors. Introduction to special types of motors: stepper motors, universal motors, reluctance motors, burshless DC motors.

Course Number	Course Title	Credit Hours
0953374	Electrical Engineering & Machines Lab	1

Prerequisite: (0973373)

Electric measurement equipment. Ohm's law. Resistors and DC Circuits. Series and parallel connections. Voltage and current division. Nodal and mesh analysis. Superposition theorem. Thevenin's and Norton's theorems. Maximum power transfer. Inductance and capacitance. AC systems. Impedance concept and phase shift in RL and RC circuits. Measurement of power and power factor. Diodes and their applications: half-wave rectifiers, full-wave rectifiers, etc. Single-phase transformers. DC motors: characteristics and speed control. Testing and operational characteristics of three-phase synchronous motors. Testing and operational characteristics of three-phase induction motors. Testing and operational characteristics of single-phase induction motors.

Course Number	Course Title	Credit Hours
0913213	Electric Circuits	3

Prerequisite: (0302102)

Ohm's and Kirchhoff's laws. Series and parallel connections. Voltage and current division. Nodal and mesh analysis. Superposition theorem. Thevenin's and Norton's theorems. Source transformation. Maximum power transfer. Inductance and capacitance. Behavior of R, L and C under steady-state DC or AC conditions. Transient analysis. Unit-step forcing function. Natural, forced and complete response of first-order RL and RC circuits. Natural, forced and complete response of second-order RLC circuits. Characteristics of sinusoids. The phasor concept. Phasor relationships for R, L, and C elements. Impedance and admittance. Effective values of current and voltage. Instantaneous, average and apparent power. Power factor. Three-phase systems. Three-phase wye and delta connections. Resonance and filters. Safety considerations. Protective grounding.

Course Number	Course Title	Credit Hours
0913214	Electric Circuits Lab	1

Prerequisite: (0913213)

Electric measurement equipment. Ohm's law. Resistors and DC Circuits. Series and parallel connections. Voltage and current division. Nodal and mesh analysis. Superposition theorem. Thevenin's and Norton's theorems. Maximum power transfer. Inductance and capacitance. Transient Analysis. First-order RL and RC circuits. AC systems. Impedance concept and phase shift in RL and RC circuits. Measurement of power and power factor. Three-phase wye and delta connections. Series and parallel resonance. Quality factor. Filters, including LPF, HPF and BPF. Residential wiring and safety considerations.