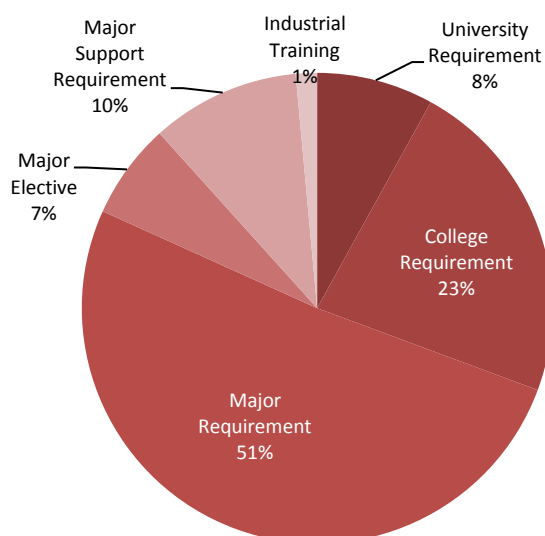


# B.Sc. in Electrical Engineering 2014

## Program Components

| Course Type                      | CRD        |
|----------------------------------|------------|
| University Requirement (UR)      | 11         |
| College Requirement (CR)         | 31         |
| Major Requirement (MR)           | 70         |
| Major Elective (ME) <sup>1</sup> | 9          |
| Major Support Requirement (MSR)  | 14         |
| Minor Requirements (Minor)       | -----      |
| MR- Industrial Training          | 2          |
| <b>Total Credit (CRD)</b>        | <b>137</b> |



<sup>1</sup> Student must choose three elective courses from Major Elective Courses lists.

**Teaching Language:** English

## Detailed Study Plan

### Year 1 - Semester 1

| Course Code | Course Title                                      | Course Hours |      |     | Course Type | Pre requisite | Major GPA |
|-------------|---|--------------|------|-----|-------------|---------------|-----------|
|             |   | LEC          | PRAC | CRD |             |               |           |
| MATHS 101   | Calculus I  | 3            | 0    | 3   | CR          | -----         | No        |
| CHEMY 101   | General Chemistry I                               | 3            | 3    | 4   | CR          | -----         | No        |
| PHYCS 101   | General Physics I                                 | 3            | 3    | 4   | MSR         | -----         | No        |
| CSC 103     | Computer Programming for Scientists and Engineers | 3            | 2    | 3   | CR          | -----         | No        |
| ENGL 101    | Communication Skills I                            | 3            | 0    | 3   | CR          | -----         | No        |

### Year 1 - Semester 2

| Course Code | Course Title               | Course Hours |      |     | Course Type | Pre requisite | Major GPA |
|-------------|----------------------------|--------------|------|-----|-------------|---------------|-----------|
|             |                            | LEC          | PRAC | CRD |             |               |           |
| MATHS 102   | Calculus II                | 3            | 0    | 3   | CR          | MATHS 101     | No        |
| PHYCS 102   | General Physics II         | 3            | 3    | 4   | MSR         | PHYCS 101     | No        |
| ENGL 102    | Composition and Reading II | 3            | 0    | 3   | CR          | ENGL 101      | No        |
| STAT 273    | Probability and Statistics | 3            | 0    | 3   | CR          | MATHS 101     | No        |
| HRLC 107    | Human Rights               | 2            | 0    | 2   | UR          | -----         | No        |
| EENG 100    | Circuit Theory I           | 3            | 1    | 3   | MR          | MATHS 101     | Yes       |

### Year 2 - Semester 3

| Course Code | Course Title                                    | Course Hours |      |     | Course Type | Pre requisite        | Major GPA |
|-------------|---|--------------|------|-----|-------------|----------------------|-----------|
|             |   | LEC          | PRAC | CRD |             |                      |           |
| MATHS 205   | Differential Equations                          | 3            | 0    | 3   | CR          | MATHS 102            | No        |
| MENG 230    | Thermal Sciences                                | 3            | 1    | 3   | MSR         | -----                | No        |
| EENG 204    | Computer Applications in Electrical Engineering | 0            | 6    | 2   | MR          | EENG 100 & CSC103    | Yes       |
| EENG 261    | Electronic Devices and Circuits                 | 3            | 1    | 3   | MR          | EENG 100 & PHYCS 102 | Yes       |
| EENG 200    | Circuit Theory II                               | 3            | 1    | 3   | MR          | EENG 100 & MATHS 101 | Yes       |
| EENG 242    | Technical Report Writing and Presentation       | 1            | 1    | 1   | MR          | ENGL 102             | Yes       |

### Year 2 - Semester 4

| Course Code | Course Title        | Course Hours |      |     | Course Type | Pre requisite        | Major GPA |
|-------------|---------------------|--------------|------|-----|-------------|----------------------|-----------|
|             |                     | LEC          | PRAC | CRD |             |                      |           |
| EENG 290    | Junior Project      | 0            | 3    | 1   | MR          | EENG 242             | Yes       |
| MATHS 203   | Calculus III        | 3            | 0    | 3   | CR          | MATHS 102            | No        |
| EENG 271    | Signals and Systems | 3            | 1    | 3   | MR          | EENG 200 & MATHS 205 | Yes       |
| EENG 262    | Analog Electronics  | 3            | 1    | 3   | MR          | EENG 261             | Yes       |
| EENG 205    | Numerical Analysis  | 2            | 3    | 3   | MR          | MATHS 205            | Yes       |
| EENG 251    | Digital Systems I   | 3            | 1    | 3   | MR          | -----                | Yes       |

### Year 3 - Semester 5

| Course Code | Course Title                                  | Course Hours |      |     | Course Type | Pre requisite         | Major GPA |
|-------------|---|--------------|------|-----|-------------|-----------------------|-----------|
|             |   | LEC          | PRAC | CRD |             |                       |           |
| EENG 355    | Microprocessors and Applications              | 3            | 1    | 3   | MR          | EENG 251              | Yes       |
| EENG 333    | Power Electronics I                           | 3            | 1    | 3   | MR          | EENG 261              | Yes       |
| EENG 341    | Electrical Machines I                         | 3            | 1    | 3   | MR          | EENG 200              | Yes       |
| EENG 371    | Electromagnetics                              | 3            | 1    | 3   | MR          | MATHS 203 & PHYCS 102 | Yes       |
| EENG 372    | Communication Systems I                       | 3            | 1    | 3   | MR          | EENG 271              | Yes       |
| MATHS 342   | Linear Algebra and Complex Analysis Variables | 3            | 0    | 3   | MSR         | MATHS 102             | No        |

### Year 3 - Semester 6

| Course Code | Course Title                              | Course Hours |      |     | Course Type | Pre requisite            | Major GPA |
|-------------|---|--------------|------|-----|-------------|--------------------------|-----------|
|             |   | LEC          | PRAC | CRD |             |                          |           |
| EENG 311    | Power Systems I                           | 3            | 1    | 3   | MR          | EENG 341                 | Yes       |
| EENG 334    | Power Electronics II                      | 3            | 1    | 3   | MR          | EENG 333                 | Yes       |
| EENG 342    | Electrical Machines II                    | 3            | 1    | 3   | MR          | EENG 341                 | Yes       |
| EENG 381    | Control Systems                           | 3            | 1    | 3   | MR          | EENG 271                 | Yes       |
| MENG 300    | Engineering Economics                     | 3            | 1    | 3   | CR          | Completion of 60 Credits | No        |
| HIST 122    | Modern History of Bahrain and Citizenship | 3            | 0    | 3   | UR          | -----                    | No        |

#### Training Requirement

| Course Code | Course Title        | Course Hours |      |     | Course Type | Pre requisite            | Major GPA |
|-------------|---------------------|--------------|------|-----|-------------|--------------------------|-----------|
|             |                     | LEC          | PRAC | CRD |             |                          |           |
| EENG 390    | Industrial Training | 0            | 6    | 2   | MR-Training | Completion of 85 credits | Yes       |

### Year 4 - Semester 7

| Course Code | Course Title          | Course Hours |      |     | Course Type | Pre requisite                       | Major GPA |
|-------------|-----------------------|--------------|------|-----|-------------|-------------------------------------|-----------|
|             |                       | LEC          | PRAC | CRD |             |                                     |           |
| EENG 412    | Power Systems II      | 3            | 1    | 3   | MR          | EENG 311                            | Yes       |
| EENG 444    | Electric Drives I     | 3            | 1    | 3   | MR          | EENG 333 & EENG 342                 | Yes       |
| EENG 490    | Senior Design Project | 0            | 9    | 3   | MR          | Completion of 85 Credits & EENG 290 | Yes       |
| EENG 4xx    | Elective I            | 3            | 1    | 3   | ME          | See ME List <sup>1</sup>            | Yes       |
| EENG 400    | Engineering Ethics    | 2            | 0    | 2   | MR          | Completion of 85 Credits            | Yes       |
| ISLM 101    | Islamic Culture       | 3            | 0    | 3   | UR          | -----                               | No        |

### Year 4 - Semester 8

| Course Code | Course Title                   | Course Hours |      |     | Course Type | Pre requisite            | Major GPA |
|-------------|--------------------------------|--------------|------|-----|-------------|--------------------------|-----------|
|             |                                | LEC          | PRAC | CRD |             |                          |           |
| EENG 413    | Power Systems Protection       | 3            | 1    | 3   | MR          | EENG 311                 | Yes       |
| EENG 447    | Electric Drives II             | 3            | 1    | 3   | MR          | EENG 444                 | Yes       |
| EENG 4xx    | Elective II                    | 3            | 1    | 3   | ME          | See ME List <sup>1</sup> | Yes       |
| EENG 4xx    | Elective III                   | 3            | 1    | 3   | ME          | See ME List <sup>1</sup> | Yes       |
| EENG 491    | Electrical Engineering Seminar | 0            | 2    | 1   | MR          | Completion of 85 Credits | Yes       |
| ARAB 110    | Arabic Language Skills         | 3            | 0    | 3   | UR          | -----                    | No        |

### Major Elective Courses<sup>1</sup>

Three electives (9 credits) will be chosen from the following major options.

#### Major in Industrial Drives and Power Electronics

| Course Code | Course Title                               | Course Hours |      |     | Course Type | Pre requisite       | Major GPA |
|-------------|--|--------------|------|-----|-------------|---------------------|-----------|
|             |  | LEC          | PRAC | CRD |             |                     |           |
| EENG 438    | Flexible AC Transmission Systems           | 3            | 1    | 3   | ME          | EENG 334            | Yes       |
| EENG 446    | Solar and Wind Energy Conversion           | 3            | 1    | 3   | ME          | EENG 342 & EENG 262 | Yes       |
| EENG 448    | Industrial Applications of Electric Drives | 3            | 1    | 3   | ME          | EENG 444            | Yes       |
| EENG 486    | Intelligent Control Systems                | 3            | 1    | 3   | ME          | EENG 381            | Yes       |

## Major in Power Engineering

| Course Code | Course Title                            | Course Hours |      |     | Course Type | Pre requisite       | Major GPA |
|-------------|---|--------------|------|-----|-------------|---------------------|-----------|
|             |   | LEC          | PRAC | CRD |             |                     |           |
| EENG 438    | Flexible AC Transmission Systems        | 3            | 1    | 3   | ME          | EENG 334            | Yes       |
| EENG 414    | High Voltage Engineering                | 3            | 1    | 3   | ME          | EENG 311            | Yes       |
| EENG 415    | Power Systems Operation and Reliability | 3            | 1    | 3   | ME          | EENG 311 & STAT 273 | Yes       |
| EENG 416    | Power Systems Dynamics and Control      | 3            | 1    | 3   | ME          | EENG 412 & EENG 381 | Yes       |

## Electives common to both options

| Course Code | Course Title              | Course Hours |      |     | Course Type | Pre requisite       | Major GPA |
|-------------|---------------------------|--------------|------|-----|-------------|---------------------|-----------|
|             |                           | LEC          | PRAC | CRD |             |                     |           |
| EENG 439    | HVDC Transmission Systems | 3            | 1    | 3   | ME          | EENG 334            | Yes       |
| EENG 483    | Digital Control Systems   | 3            | 1    | 3   | ME          | EENG 381            | Yes       |
| EENG 485    | Nonlinear Control Systems | 3            | 1    | 3   | ME          | EENG 205 & EENG 381 | Yes       |
| EENG 479    | Digital Signal Processing | 3            | 1    | 3   | ME          | EENG 271            | Yes       |

## Course Description

**Course Code:** EENG 100

**Course Title:** Circuit Theory I

Circuit elements, Lumped circuits Kirchhoff's laws. Network theorems. Sinusoidal steady-state analysis, single phase and 3-phase balanced and unbalanced networks. Coupled networks, series and parallel magnetic circuits.

**Course Code:** EENG 200

**Course Title:** Circuit Theory II

Natural and forced response of first and second order RLC networks. Laplace transform and application phase concept. Analysis of linear time-invariant circuits. Convolution network graphs. Tellegen's theorem. More on time domain solution of networks by Laplace transformation. Frequency response, bandwidth and quality factor. Transfer function. State equation and Two-port networks. Computer aided analysis of circuits.

**Course Code:** EENG 204

**Course Title:** Computer Applications in Electrical Engineering

Laplace Transforms. Software packages used in electrical and electronics engineering. Programming with MATLAB, Simulink, MATCAD, PSPICE, Circuit Maker, Electronics Workbench and LABVIEW. Intensive hands on applications of these packages on Electrical and Electronics Engineering topics in PC Laboratories.

**Course Code:** EENG 205

**Course Title:** Numerical Analysis

Roots of nonlinear equations. Roots of simultaneous equations: Matrix Inversion, Gauss, Gauss-Jordan, Gauss-Sidel, Cholesky methods, Solution of nonlinear simultaneous equations. Numerical solution of ordinary differential equations, Numerical differentiation and integration. Interpolation and curve fitting methods. Introduction to Finite Difference and Finite Element methods.

**Course Code:** EENG 242

**Course Title:** Technical Report Writing and Presentation

Technical Report Writing prepares students to design and compose effective technical documents, with particular emphasis on technical reports and oral presentations. The lecture hour is dedicated to theories, techniques and presentations. The tutorial hour is assigned to discuss the written reports feedbacks.

**Course Code:** EENG 251

**Course Title:** Digital Systems I

Number systems; Basic logic gates; Boolean algebra; Simplification of logic functions: Karnaugh maps, Quine-McCluskey method, NAND and NOR gates networks; Multiple output networks; MSI combinational logic circuits: Multiplexers, Decoders, Adders, Comparators; Tri-State logic; combinational logic circuits design with programmable logic devices: Memories, PLA, PAL; Flip-Flops; Design and analysis of counters and registers.

**Course Code:** EENG 261                      **Course Title:** Electronic Devices and Circuits

Semiconductor fundamentals: carrier transport and recombination, doped materials, physics and applications of pn junction diode, Zener diode characteristics and applications, special purpose diodes, Fundamentals of BJTs and FETs, DC analysis of transistors circuits, Transistors as a switch, Transistor as an amplifier, Small signal equivalent circuits, Biasing techniques, Basic single stage amplifiers.

**Course Code:** EENG 262                      **Course Title:** Analog Electronics

Differential amplifiers, Multistage amplifiers: Cascade, cascade and Darlington pair configurations, Basic building blocks of op amp. Ideal op amp characteristics, positive and negative feedback applications of ideal op amp, Non-ideal op amp, Frequency response of amplifiers, Feedback concepts and topologies, Filters, Output stage and power amplifiers.

**Course Code:** EENG 271                      **Course Title:** Signals and Systems

Elementary continuous and discrete-time signals signal decomposition and convolution, sampling theory and Nyquist theorem, Laplace and Z transforms, Fourier series and integral with applications, Linear Time-Invariant (LTI) systems: Properties, impulse and frequency responses, Pole-zero description, input-output difference and differential equations, transient and steady-state time responses to elementary signals.

**Course Code:** EENG 290                      **Course Title:** Junior Project

The course is meant to develop creative design skills in the students by exposing them to some ongoing important projects in the country and requiring them to submit report on a chosen project highlighting various design components. Field trips may be arranged in coordination with the industry. The project will emphasize independent learning and teamwork. The lectures will include introduction to electrical engineering profession, description of various areas of specialization, professional report writing techniques and the role of electrical engineers in the society.

**Course Code:** EENG 301                      **Course Title:** Elements of Electrical Engineering

Circuit Elements: Resistance, capacitance and inductance. Fundamental circuit laws. Resistive circuit analysis. Sinusoidal steady-state analysis of AC circuits. Three phase circuits. Magnetic circuits and transformers. Three and single phase induction motors: Operating principles, equivalent circuits, torque-speed characteristics, speed control. DC motors: Operating principles, equivalent circuits, torque-speed characteristics, speed control.

**Course Code:** EENG 311                      **Course Title:** Power Systems I

Introduction, per unit system. Synchronous machines: steady-state and parallel operation, operational limits. Transformers: three-phase, three winding, phase shifting, vector grouping, tap changing and harmonics. Transmission lines: parameters, sequence impedances, representation of short, medium and long transmission lines. High voltage cables, reactive power compensation. Travelling waves and overvoltages.

**Course Code:** EENG 333                      **Course Title:** Power Electronics I

Characteristics of power semiconductor devices: thyristor, GTO, diac, triac, power transistor, UJT, PUT, UJT and PUT, MOSFET and IGBT. Oscillators. Thyristor ratings and protection. Triggering circuits. Rectifiers: Uncontrolled and controlled, single and three phase, half and full wave rectifiers. Ripple filters. Voltage and current doublers. Single phase AC voltage regulators and inverters.

**Course Code:** EENG 334                      **Course Title:** Power Electronics II

Review of characteristics of Power Devices: SCR, MOSFET, IGBT and light activated devices. Commutation techniques, DC-to-DC converters, Choppers, 3-phase AC voltage controllers, 3-phase voltage source and current source inverters based, Harmonics in rectifiers and inverters. Switch mode power supplies, Buck, Boost Buck-Boost and Cuk Converters, Protection of power devices. Application of power electronics to power systems.

**Course Code:** EENG 341                      **Course Title:** Electrical Machines I

Magnetic circuits. Transformers: construction, equivalent circuit, parallel operation, auto-transformers. Electromechanical energy conversion, Force and torque produced in multi-winding devices. Production of rotating magnetic field. Machine windings: DC field windings, AC armature windings, EMF and MMF distribution in DC and three-phase AC windings. Single and Three-phase induction motors, SEIGs, Reluctance motors, full performance analysis.

**Course Code:** EENG 342                      **Course Title:** Electrical Machines II

Synchronous Generators and Motors, Permanent Magnet Machines and Brushless DC machines: Theory of operation, Time constants and reactances, active and reactive power control, starting, full performance analysis. Direct and quadrature axis representation. DC Motors and Generators: Theory of operation, armature reaction, commutation, full performance analysis. Servo motors: Theory of operation, performance analysis.

**Course Code:** EENG 355                      **Course Title:** Microprocessors and Applications

Basic microprocessor and microcomputer architecture models. Programming Techniques. Addressing modes. Assembly language. Standard Microprocessor instruction set. Assembly-language programming. Computer buses and parallel I/O. Interfacing Methods. Interrupts and interrupt service routines. Timers and Sequential Applications. Serial input/output. Analog input and output. Typical Applications of Microprocessors in Power Engineering.

**Course Code:** EENG 371                      **Course Title:** Electromagnetics

Vector Analysis: Vector algebra and calculus. Electrostatics: Fields, potentials and boundary conditions. Magnetostatics: Fields and boundary conditions. Maxwell's equation; Time varying fields and potentials, harmonic fields. Electromagnetic waves propagation: Plane waves and reflection. Antenna fundamentals. Radiation from linear wire antennas.

**Course Code:** EENG 372                      **Course Title:** Communication Systems I

Overview of telecommunication systems, amplitude modulation (DCB-SC, DSB-LC, SSB, VSB) and angle modulation (PM, FM): Block diagram implementation, Bandwidth requirements, modulation efficiency, demodulation. Frequency Division Multiplexing (FDM) and applications pulse modulation (PAM, PCM, PWM, PPM) and demodulation comparison. Time Division Multiplexing (TDM).

**Course Code:** EENG 381                      **Course Title:** Control Systems

Introduction to control systems. Representation of physical control system elements. Analogies, Transfer functions, Signal flow graphs. State space analysis. Sensitivity, static accuracy and transient response. Stability of control systems : Routh criterion, Root locus, Frequency response methods, Nyquist stability criterion. Compensation techniques. Introduction to digital control and the Z transform. Discrete time control system.

**Course Code:** EENG 390                      **Course Title:** Industrial Training

In this industrial training course all students must participate in an approved training program in the relevant industry, developing a multidisciplinary and teamwork experience. At the completion of 300 hours of supervised training each student must submit a formal report and oral presentation

**Course Code:** EENG 400                      **Course Title:** Engineering Ethics

Scope of engineering ethics. Moral reasoning and resolving ethical dilemmas. Codes of ethics. Engineering as experimentation, Engineers as responsible experimenters. Commitment to safety: Safety and risk, Teamwork: Definition, types of teams and groups. Confidentiality and conflict interest. Conflict management. Honesty, Environmental ethics, Global issues, Engineering and technological progress: Optimism, pessimism and realism, shared responsibility, moral leadership.

**Course Code:** EENG 412                      **Course Title:** Power Systems II

Power systems modeling: Generators, transformers, transmission lines and loads. Network calculations: Bus admittance and impedance matrices, matrix partitioning, node elimination. Power flow solutions. Economic operation of power systems. Load frequency control. Symmetrical components and fault studies. Transient stability.

**Course Code:** EENG 413                      **Course Title:** Power Systems Protection  
Protective systems. Current and voltage transformers performance. Electromagnetic and static relays. Digital Relays. Typical static and digital relays. Transmission lines protection: Over-current, over-voltage, distance and pilot protection. Generator protection: Phase fault, earth fault, pole slipping, reverse power and negative phase sequence current protection. Transformer protection. Bus-bar protection. Motor protection. Current interrupting elements: Fuses, circuit breakers.

**Course Code:** EENG 444                      **Course Title:** Electric Drives I  
Motor rating for different types of duty loads, stability of drive systems. Breaking: Dynamic breaking, regenerative breaking and plugging. Natural characteristics. Mechanical sharing. DC drives: Classical control methods, L and Mayer connections, Chopper control. Single and three phase half and full wave rectifier control including all modes of operation in each case. Closed loop control of dc drives. AC drives: Rotor side chopper control and constant volt/hertz control.

**Course Code:** EENG 446                      **Course Title:** Solar and Wind Energy Conversion  
Estimation of solar radiation. Solar cells: types, characteristics. Modeling characteristics and sizing of Photovoltaic Systems (PV). Maximum Power Point Tracking. Interfacing between PV systems and power networks. Introduction to wind structure and statistics. Weibull and Raleigh distributions of wind speeds. Wind turbines: types, principles of operation, performance analysis. Economics of Solar and wind energy conversion systems.

**Course Code:** EENG 490                      **Course Title:** Senior Design Project  
Senior students are required to carry out a project, having a design component, topic of which may be theoretical /or experimental. The topic enables the students to apply the engineering knowledge acquired during his studies. The students will make use of the expertise and skills developed in engineering design courses in their senior projects. Written formal report and oral presentation are required.

**Course Code:** EENG 491                      **Course Title:** Electrical Engineering Seminar  
The course is intended to enhance students' capability to use available resources, like library and internet, to prepare seminars on selected topics in order to develop skills and apprise them of lifelong learning and contemporary issues. The students will work in teams on the assigned seminar topics and give oral presentations. The invited guest speakers will give talks on topics related to engineering profession. The students' attendance is compulsory and they will be required to submit summary of the lecture giving important salient features, which will be evaluated.

**Course Code:** EENG 414                      **Course Title:** High Voltage Engineering  
Basic ionisation and decay processes. Self-sustained discharge to breakdown in gases. Discharge and breakdown mechanisms in various gases in non-uniform field gaps. Liquid dielectric materials. Mechanisms leading to breakdown in liquids. Solid dielectric materials and basic breakdown mechanisms in solids. Generation and measurement of DC, AC and impulse high voltages, high voltage testing methods and standards. Non-destructive test techniques.

**Course Code:** EENG 415                      **Course Title:** Power Systems Operation and Reliability  
Unit commitment. Automatic generation control: Isolated state two areas. Voltage control. Basic probability theory. Introduction to contingency evaluation and security assessment. Reliability concepts: General reliability functions, MTTF, series parallel systems, Markov's process. Generation model. Load model. Reliability evaluation of a power system: LOLP, LOEP.

**Course Code:** EENG 416                      **Course Title:** Power Systems Dynamics and Control  
Review of transient and steady state stability concepts. Modeling of synchronous machines. Prime Mover models. Governor and exciter models. Linearized models of power systems. Power and frequency control. Voltage and reactive power control. Stabilisation of electromechanical oscillations via excitation control.

**Course Code:** EENG 438                      **Course Title:** Flexible AC Transmission Systems (FACTS)  
Power flow in AC transmission lines. Power electronics converters for FACTS devices. Shunt Compensation: Thyristor-Controller Reactor and capacitor, SVC, STATCOM, Transient Stability. Forced-Commutation-Controlled Series Capacitor. Series SVC. Static phase Shifters. Unified Power Flow Controllers. Comparisons of Compensators. Interline Power Flow Controllers. Controller design of FACTS.

**Course Code:** EENG 439                      **Course Title:** HVDC Transmission Systems  
Review converters, Comparison Between AC and DC transmission systems. Principles of High Voltage DC (HVDC) power transmission based on CSC and VSC: configuration, control strategies (Power, current and voltage control). AC-DC sides interactions, harmonic filtering, modeling techniques. Back to back HVDC. Application of HVDC system in wind energy conversion and power systems.

**Course Code:** EENG 445                      **Course Title:** Electromechanical System Design  
Design of magnetic circuits and AC armature windings. Heating and cooling of electric machines. Complete design of transformers, three phase induction, synchronous machines and DC machines including output equations, specific electric and magnetic loading, main dimensions and winding designs. Computer aided electric machine design

**Course Code:** EENG 447                      **Course Title:** Electric Drives II  
Economical aspects of VSDs. Closed loop control of ac drives. Constant volt/hertz and constant flux control with voltage source and current source PWM inverters, slip power recovery drives. Reference frame theory and space vector theory. High performance ac drives: Direct and indirect field oriented control, direct flux and torque control, adaptive, optimal and intelligent control schemes.

**Course Code:** EENG 448                      **Course Title:** Industrial Applications of Electric Drives  
Electric drives requirements. Speed control with rate of change limiter. Multiple motor drives. Linear position control (PCON). Time optimal PCON with fixed or moving reference point. Linear and Rotating Electric Drive application in rolling mills, cement industry, textile industry, machine tools, electrical traction, marine engineering, automotive and electric vehicles. DSP control of electrical drives.

**Course Code:** EENG 479                      **Course Title:** Digital Signal Processing  
Review of discrete time signals and systems, Z-transform, sampling and aliasing, discrete time convolution and correlation, DFT and FFT, relating frequency response of analogue and digital filters, analysis, design and implementation of FIR and IIR filters. Noise in digital filters. Applications and typical real time implementation of digital filters.

**Course Code:** EENG 483                      **Course Title:** Digital Control Systems  
Discrete time systems, digital signal processing fundamentals, data conversion and quantization, sample and hold devices. Z-Transform. A/D and D/A conversion, Zero order hold, stability of digital control systems, state variable technique, time domain analysis, digital controller design, microprocessor control, machine language programming, time delay in microprocessor control systems.

**Course Code:** EENG 485                      **Course Title:** Nonlinear Control Systems  
State-space analysis methods. Phase plane construction: the isocline Lienard's methods, classification of singularities. Variable structure control. Stability definitions. Lyapunov's second methods; Popov stability criterion. Describing functions. Optimal control and state estimation. Conservative and Lagrangian systems. Kalman-Bucy algorithm and Prediction.

**Course Code:** EENG 486                      **Course Title:** Intelligent Control Systems  
Introduction: History, methods, current thrusts. Nonlinear control system. Uncertain dynamic systems. Computational intelligence, neural networks, fuzzy logic systems, genetic programming and optimization, simulating annulling, and learning control techniques. Controller synthesis and design using computational intelligence techniques. Optimization techniques and Biometric methods. Foraging: prey model from behavioural ecology, autonomous robot applications, and Multi-agent system. Examples of applications in plant control, and robotics.

**Course Code:** MATHS 342                      **Course Title:** Linear Algebra and Complex Analysis  
System of linear equations, Matrices, Determinants, Vector spaces, Subspaces, Linear independence, Linear transformations, Complex numbers, Analytical functions, Cauchy Integral theorem and formula, Residues, contour integration.

**Course Code:** PHYCS 101                      **Course Title:** General Physics I  
Units and measurements; brief review of vectors; Newton's laws of motion; projectile motion; work and energy; impulse and momentum; rotational dynamics; equilibrium of a rigid body; periodic motion.

**Course Code:** PHYCS 102      **Course Title:** General Physics II

Electric charges and fields; Coulomb's and Gauss's laws; electric potential; capacitors and dielectrics; direct current circuits; Kirchoff's rules; magnetic field and flux; ampere's law; induced emf; Lenz's law; mutual and self inductance; AC circuits; RLC circuit.)

**Course Code:** MENG 230      **Course Title:** Thermal Sciences

Basic concepts of thermodynamic, properties of pure substances, phase equilibrium, properties tables. The ideal gas equation of state. The First Law of thermodynamics: heat, work applications to closed and open systems. The Second Law of Thermodynamics: the concept of entropy. Power cycles. Introduction to heat transfer, modes of heat transfer: conduction, convection and radiation. Heat exchangers.

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## College Requirement Courses Descriptions

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**Course Code:** CHEMY 101      **Course Title:** General Chemistry I

Significant figures, chemical formulas and equations; mass relations, limiting reactions and theoretical yield; Physical behavior of gases; electronic structure, periodic table, covalent bonding; Lewis structures, Molecular structures, hybridization; molecular orbitals, solutions; colligative properties. Related practical work.

**Course Code:** CSC 103      **Course Title:** Computer Programming for Scientists and Engineers

Introduction to computers, their uses, development, components, hardware, and software. Internal representation and numbering systems. Algorithmic problem solving principles. Introduction to a modern programming language (e.g. C++). Input/Output, conditional statements, iteration, files, strings, functions and arrays. Lab assignments to practice programming.

**Course Code:** ENGL 101      **Course Title:** Communication Skills I

This course focuses on reading skills and strategies and language development. The reading section concentrates on high-interest contemporary topics and encourages students to increase speed and efficiency. The writing component, integrated to the reading materials, reviews grammatical structures, develops language accuracy and introduces paragraph writing. Students are required to upgrade their grammar, reading, and listening skills on the internet.

**Course Code:** ENGL 102      **Course Title:** Composition and Reading II

A continuation of English 101 which further develops the students' skills in reading and writing. The course exposes students to wider range of reading material aimed at developing their understanding of different styles of English.

**Course Code:** MATHS 101      **Course Title:** Calculus I

Algebra. Functions and graphs. Trigonometry. Conic sections. Limits and continuity. Derivatives and integrals. Applications of derivatives which include mean value theorem, extrema of functions and optimization. Definite integrals and the Fundamental Theorem of Calculus.

**Course Code:** MATHS 102      **Course Title:** Calculus II

Applications of definite integrals, including areas, volumes and surface areas of solids of revolution, arc length and centroids. Transcendental functions, indeterminate form and L'Hopital's Rule. Techniques of integration and improper integrals. Infinite series, power series. Maclaurin and Taylor Theorem.

**Course Code:** MATHS 203      **Course Title:** Calculus III

Parametric equations and polar coordinates. Vectors and surfaces. Limits, derivatives, and integrals of vector-valued functions. Partial differentiation. Multiple and line integrals and their applications. Green's and Stokes' Theorems.

**Course Code:** MATHS 205      **Course Title:** Differential Equations

Differential equations of first order and their solution. Separable and exact equations. Equations convertible to separable type. Higher order linear equations with constant coefficients (homogeneous and non-homogeneous). Power series method for second order linear equations. Variation of parameters. Laplace transform technique. Applications of differential equations.

**Course Code:** MENG 300      **Course Title:** Engineering Economics

Introduction to engineering economics. Principles of money time relationships. Present worth analysis. Annual worth analysis. Rate of return analysis. Benefit/cost analysis. Breakeven analysis and payback period. Capital rationing among independent proposals. Replacement and retention analysis. Cost estimation and indirect cost allocation. Depreciation and depletion. Inflation and deflation. Decision making under risk. Case studies. \*(One tutorial hour)

**Course Code:** STAT 273      **Course Title:** Probability and Statistics

Descriptive statistics, Introduction to probability and probability distributions. Some of probability Densities, Sampling distributions. Central limit theorem. t and F distributions. Estimation. Tests of hypotheses. Goodness of fit tests. Regression and correlation.

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## University Requirements Courses Descriptions

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**Course Code:** ARAB 110

**Course Title:** Arabic Language Skills

This course focuses on basic Arabic skills including form, function, and meaning. It also helps the student to appreciate and understand structures and approach them from a critical point of view, through various genres in literature.

**Course Code:** HIST 122

**Course Title:** Modern History of Bahrain and Citizenship

Spatial identity of Bahrain: Brief history of Bahrain until the 18th century; the historical roots of the formation of the national identity of Bahrain since the 18th century; the modern state and evolution of constitutional life in Bahrain; the Arabic and Islamic dimensions of the identity of Bahrain; the core values of Bahrain's society and citizenship rights (legal, political, civil and economic); duties; responsibilities and community participation; economic change and development in Bahrain; Bahrain's Gulf, Arab and international relations.

**Course Code:** HRLC 107

**Course Title:** Human Rights

This course deals with the principles of human rights in terms of the definition of human rights, scope, sources with a focus on the International Bill of Human Rights; The Charter of the United Nations; Universal Declaration of Human Rights; The International Covenant on Economics, Social and Culture rights; Convention against Torture and other Cruel, Inhuman or Degrading Treatment or Punishment; Mechanics and the Constitutional Protection of Rights and Public Freedoms in Kingdom of Bahrain.

**Course Code:** ISLM 101

**Course Title:** Islamic Culture

An introduction to the general outline and principles of Islamic culture, its general characteristics, its relationships with other cultures, general principles of Islam in beliefs, worship, legislation and ethics.