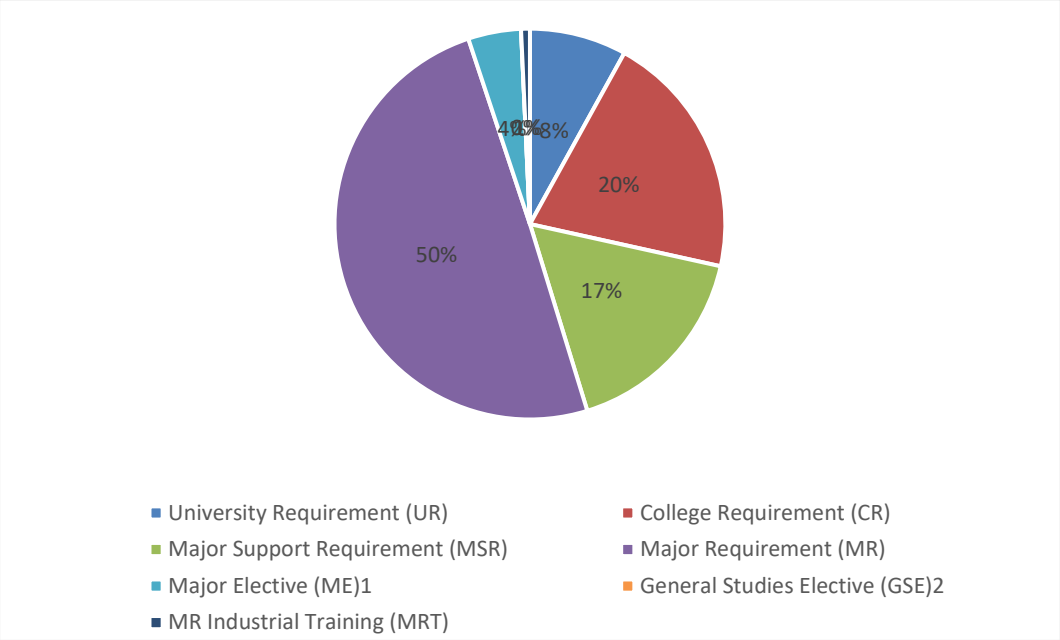
Bachelor of Science in Instrumentation and Control Engineering 2022

Program Components



University Requirement (UR)	**11**
College Requirement (CR)	**28**
Major Support Requirement (MSR)	**23**
Major Requirement (MR)	**68**
Major Elective (ME)[1]	**6**
General Studies Elective (GSE)[2]	
Training (Internship) **Yes**	**1**
Total Credit (CRD)	**137**

Detailed Study Plan

Year 1 - Semester 1

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

PHYCS 101	General Physics I	3	2	4	MSR	------	NO
Total		15	6	17			

Year 1 - Semester 2

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
EENG 100	Circuit Theory I	2	2	3	MSR	MATHS 101	NO
ENGL 242	Report Writing and Presentation	3	0	3	CR	ENGL 101	NO
HRLC 107	Human Rights	2	0	2	UR	------	NO
ICENG 111	Introduction to Instrumentation and Control Engineering	2	2	3	MR	MATHS 101 PHYCS 101	YES
MATHS 102	Calculus II	3	0	3	CR	MATHS 101	NO
PHYCS 102	General Physics II	3	2	4	MSR	PHYCS 101	NO
Total		15	6	18			

Year 2 - Semester 3

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
ICENG 202	Thermofluids	2	2	3	MR	PHYCS 101	YES
ICENG 221	Sensors and Transducers	3	1	3	MR	PHYCS 102 ICENG 111	YES
EENG 251	Digital Systems I	2	2	3	MR	EENG 100	YES
EENG 261	Electronic Devices and Circuits	2	2	3	MSR	EENG 100	NO
MATHS 205	Differential Equations	3	0	3	CR	MATHS 102	NO
PHYCS 209	Bulk Properties of Matter	3	2	3	MSR	PHYCS 101	NO
Total		15	9	18			

Year 2 - Semester 4

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
EENG 262	Analog Electronics	2	2	3	MSR	EENG 261	NO
EENG 271	Signals and Systems	3	0	3	MR	EENG 100 MATHS 102	YES
ICENG 203	Computer Applications for Instrumentation and Control Engineering	0	6	2	MR	MATHS 205 CSC 103	YES
ICENG 212	Data Communication Networks	3	2	3	MR	CSC 103	YES
MATHS 203	Calculus III	3	0	3	CR	MATHS 102	NO
STAT 276	Statistical Data Analysis	3	0	3	CR	MATHS 102	YES
Total		14	10	17			

Year 3 - Semester 5

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
ICENG 304	Linear Algebra and Numerical Methods	2	2	3	MR	MATHS 205	YES
ICENG 313	Microprocessors in Process Automation	3	2	3	MR	CSC 103 EENG 251	YES
ICENG 322	Measurement Systems I	3	2	4	MR	ICENG 221	YES
ICENG 331	System Identification	3	1	3	MR	STAT 276, ICENG 203 EENG 271	YES
ICENG 332	Process Dynamics and Simulation	2	2	3	MR	ICENG 203 EENG 271	YES
Total		13	9	16			

Year 3 - Semester 6

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
ARAB 110	Arabic Language Skills	3	0	3	UR	----------	NO
ICENG 323	Measurement Systems II	3	1	3	MR	ICENG 322	YES
ICENG 324	Signal Conditioning and Electronic Instruments	2	2	3	MR	ICENG 221 EENG 262	YES

ICENG 333	Process Control I	3	2	4	MR	ICENG 304, ICENG 331 ICENG 332	YES
ICENG 334	Programmable Logic Controller	2	2	3	MR	EENG 251 ICENG 313	YES
MENG 303	Engineering Economics	3	1	3	CR	Completion of 70 credits	NO
Total		16	8	19			

Training Requirement

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
ICENG 395	Industrial Training	0	3*	1	MR	Completion of 85 credits	YES

* 300 hours of supervised training.

Year 4 - Semester 7

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
HIST 122	Modern History of Bahrain and Citizenship	3	0	3	UR	----	NO
ICENG 425	Final Control Element and Drives	3	2	3	MR	EENG 262 EENG 271	YES
ICENG 435	Digital Control Systems	2	2	3	MR	ICENG 333 ICENG 313	YES
ICENG 436	Process Control II	2	2	3	MR	ICENG 333	YES
ICENG 495	Senior Project I	0	3	1	MR	Completion of 90 credits	YES
ICENG 4xx	Elective I	2	2	3	ME	Completion of 90 credits	YES
Total		12	11	16			

Year 4 - Semester 8

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
ICENG 437	DCS and Industrial Networks	3	2	3	MR	ICENG 334 ICENG 212	YES
ICENG 438	Instrumentation and Control Design Project	0	6	3	MR	ICENG 436 ICENG 425	YES
ICENG 496	Senior Project II	0	9	3	MR	ICENG 495	YES
ICENG 4xx	Elective II	2	2	3	ME	Completion of 90 credits	YES
ISLM 101	Islamic Culture	3	0	3	UR	----------	NO
Total		8	19	15			

Total Credits Hours required in the B.Sc. Program = 137 Credits

Major Elective Courses

Students must choose elective courses from the following list:

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
ICENG 441	Safety Instrumented Systems	2	2	3	ME	ICENG 322 ICENG 334	YES
ICENG 442	Virtual Instrumentation	2	2	3	ME	ICENG 322 ICENG 203	YES
ICENG 443	Digital Signal Processing	2	2	3	ME	EENG 271 ICENG 331	YES
ICENG 444	Biomedical Instrumentation Systems	2	2	3	ME	ICENG 323	YES
ICENG 445	Advanced Sensor Systems	2	2	3	ME	ICENG 322	YES
ICENG 451	Optimization Techniques	2	2	3	ME	ICENG 304	YES
ICENG 452	Model Predictive Control and Adaptive Control	2	2	3	ME	ICENG 333	YES
ICENG 453	Artificial Intelligence in Instrumentation and Control Systems	2	2	3	ME	ICENG 333	YES
ICENG 454	Embedded Control Systems	2	2	3	ME	ICENG 313 ICENG 333	YES
ICENG 461	Special Topics	2	2	3	ME	Completion of 90 credits	YES
ICENG 462	Big Data Analytics	2	2	3	ME	STAT 276 ICENG 304	YES
ICENG 463	Industrial Cyber Security	2	2	3	ME	ICENG 212	YES
ICENG 464	Wireless Sensor Technology	2	2	3	ME	ICENG 212 ICENG 322	YES
CHEN 477	Quality Assurance and Reliability Engineering	3	1	3	ME	Completion of 90 credits	YES

Course Description

Description of Major Courses

Course Code: ICENG 111 **Course Title:** Introduction to Instrumentation and Control Engineering
Concept of control systems through daily life examples. Basic terminology and symbols in control systems. Benefits of control systems: social, economic, environmental, and safety impacts. Basic components of an Instrumentation and Control System. Physical systems classification: mechanical, chemical, electrical, biomedical, etc. Units and standards. Signals classification: analog and digital. Sensing element classification. Signal conditioning. Final control element types. Controller: electronic and digital. Examples of modern control-systems applications. Hierarchy of instrumentation and control system activities. Tasks and responsibilities of control and instrumentation engineers, and career opportunities.

Course Code: ICENG 202 **Course Title:** Thermofluids
Basic concepts of thermodynamics. Energy, energy transfer, and general energy analysis, properties of pure substances. The first law of thermodynamics. Mass and Energy analysis of closed systems, mass and energy analysis of open systems. The second law of thermodynamics. Introduction and properties of fluids. Bernoulli and energy equations, momentum analysis of flow systems. Internal flow. Tools: spreadsheet software (e.g., Microsoft® Excel).

Course Code: ICENG 203 **Course Title:** Computer Applications for Instrumentation and Control Engineering
Classification of engineering software. MATLAB: programming environment, array and matrix operations, graphing, variables and text string manipulation, files and I/O statements, control flow and looping, functions, script files, symbolic processing. Simulink and MATLAB M-files, S-function. Selected toolboxes. Instrumentation and control applications using available software. Tools: programming environment for calculation and simulation (e.g., MATLAB®/Simulink).

Course Code: ICENG 212 **Course Title:** Data Communication Networks
Concepts and techniques of host-to-host computer networks and data communication. Topics include: the basics of network models, standards, and protocols, data communication systems and schemes implemented at physical and data link layers.

Course Code: ICENG 221 **Course Title:** Sensors and Transducers
Importance of measurement in process control and monitoring. Components of measurement systems. Static and dynamic characteristics of measurement systems. Error analysis and data representation. Sensors: resistive, inductive and capacitive sensors. Resistance strain gage, piezoelectric/piezoresistive sensors, and miscellaneous sensors. Calibration of measurement systems. Tools: spreadsheet software (e.g., Microsoft® Excel).

Course Code: ICENG 304 **Course Title:** Linear Algebra and Numerical Methods
Linear algebraic equations and selected matrix operations (e.g., Reduced row echelon form, Eigenvalues, etc.). Numerical methods and errors. Numerical solution of systems of linear equations: elimination and iterative methods. Numerical solution of nonlinear equations: bracketed and open methods. Open methods for simultaneous nonlinear equations. Interpolation and curve-fitting. Finite difference methods. Numerical differentiation and integration. Solution of ODEs - Initial Value Problems. Applications related to instrumentation and control engineering. Tools: spreadsheet software (e.g., Microsoft® Excel), programming and computing environment (e.g., MATLAB®).

Course Code: ICENG 313 **Course Title:** Microprocessors in Process Automation
Introduction to microcontroller architecture: CPU, RAM, ROM and flash memory. Microcontroller programming (Assembly and C languages). Interrupts, analog to digital conversion, digital to analog conversion. Universal asynchronous receiver transmitter. Term project: microcontroller applications in instrumentation and control.
Tools: programming environment for calculation and simulation (e.g., Assembly and C language).

Course Code: ICENG 322 **Course Title:** Measurements Systems I
Measurement of displacement, strain, force and torque. Pressure, level, temperature and flow rate measurement systems. Measurement of velocity and vibration. Physical property measurements: density, specific gravity, humidity, viscosity, thermal conductivity and refractive index. Smart sensors and transmitters. Related laboratory experiments.

Course Code: ICENG 323 **Course Title:** Measurement Systems II
Introduction to composition measurement and process analyzers. Spectroscopy: principles and specific types (e.g., ultra-violet/visible, infrared, X-ray mass and nuclear techniques). Chromatography: theory, data handling and calibration of gas, high performance liquid chromatography. Substance-specific methods: carbon, oxygen, nitrogen, etc. Electrochemical systems (e.g., principles and measurements, electrodes for pH and conductivity, ion-specific electrodes). Requirement for on-line analysis: sample handling and conditioning. Related laboratory experiments.

Course Code: ICENG 324 **Course Title:** Signal Conditioning and Electronic Instruments
Signal conditioning elements and schemes: amplifiers, AC/DC bridges, grounding, shielding, current loop, optoisolator, V/I, F/V converters, etc. Data acquisition and telemetry systems: multiplexing, telemetry signals, transmission modes, modulation, analog to digital and digital to analog converters. Electronic Instrument (e.g., voltmeter, ohmmeter, ammeter, power meter, frequency meter, etc.): principles of operation, applications, etc. Related laboratory experiments.

Course Code: ICENG 331 **Course Title:** System Identification
Introduction to system identification procedure, dynamical systems and models. Models of LTI Systems: identification of parametric models, transfer function models, state-space models, model structure selection, model Validation. Identification of non-parametric models: impulse response, step response models. Parameter estimation methods: minimizing prediction errors, linear regression and least-squares. Subspace identification method of state-space models: observability and controllability, Kalman filter. Closed-loop identification of multivariable systems. Recursive estimation methods. Tools: programming environment for system identification, modeling, and simulation (e.g., MATLAB®/Simulink and System Identification Toolbox).

Course Code: ICENG 332 **Course Title:** Process Dynamics and Simulation
Role of process dynamics and control. Development of dynamic models of several simple processes. Review of Laplace transforms. Linearization. Transfer function and state space models. Transient behavior of first- and second order systems. Dynamic behavior of more complicated processes: high-order, time delays, inverse response, lead-lag. Frequency response analysis. Multivariable process modelling. Simulation of the transient response. Related laboratory experiments.Tools: programming environment for process simulation and dynamic analysis (e.g., MATLAB®/Simulink and Control Station).

Course Code: ICENG 333 **Course Title:** Process Control I
Elements of a control loop, classification of control strategies. P&I Diagrams. Block diagrams. PID controllers and features. Transient behavior of closed-loop systems. Stability analysis. Root locus diagrams. Controller tuning. Design based on frequency response. Feedforward, cascade, inferential, override and selective control. Time delay compensation. Related laboratory experiments. Tools: programming environment for process control analysis and design (e.g., MATLAB®/Simulinke and Control Station).

Course Code: ICENG 334 **Course Title:** Programmable Logic Controller
Introduction to PLC- Relay Sequencer. PLCs architecture and components. PLC operation. PLC programming languages (LAD, FBD, Statement List, SFC-Grafcet, etc.). PLC Programming-bit logic operations, flid-flop, timers and counters, special instructions. Analog PLC operations and networking. PID Instructions. Developing Human Machine Interface (HMI) (alarm and tag management, display, etc.). Batch process control. PLCs selection, installation, troubleshooting, and maintenance. Term project. Related laboratory experiments. Tools: programming using PLC simulator software (e.g., Allen Bradley PLC simulator, Siemens PLC simulator, etc.).

Course Code: ICENG 395 **Course Title:** Industrial Training
All students in the program must participate in an approved training program in the relevant industry. At the completion of 300 hours of supervised training, each student must submit a formal report and conduct an oral presentation.

Course Code: ICENG 425 **Course Title:** Final Control Element and Drives
Final control element types (e.g., relay switches, electrical motors, valves, pumps, etc). Pneumatic control valves: types, selection, sizing, inherent/installed characteristics, dynamics, installation, and maintenance. Valve positioners. Control signal conversion systems: common industrial power electronic devices. Analysis and design of drive circuits.

I/P converters. Electrical actuators (e.g., servo DC/AC motor, stepper motor). Pneumatic actuator (e.g., diaphragm and pistons). Other common industrial valves: Proportional valves, safety valves, smart valves, etc. Related laboratory experiments.

Course Code: ICENG 435 **Course Title:** Digital Control Systems
Introduction to digital control schemes: DDC, DCS, DATA logging, etc. Sampling and reconstruction of signals. Aliasing effect and anti-aliasing filters. Modeling of the sampler, Z- Transformation. Block diagram analysis. Pulse transfer function and difference equations. Time response analysis. Stability analysis. Discrete form of PID controller and tuning. Digital control design using direct synthesis method, pole placement. Minimum Variance and General Minimum Variance Controllers. State Space Models. Conversion of difference equation to state space model. Controllability and observability. Control design based on state space model: pole placement, state feedback, and output feedback, observer design, combined control law and observer. Term project. Related laboratory experiments. Tools: programming environment for digital control system analysis and design (e.g., MATLAB®/Simulink).

Course Code: ICENG 436 **Course Title:** Process Control II
Multivariable control. Relative gain analysis. Singular value analysis, multiloop controller tuning. Decoupling control. Basic formulation of predictive control: state space models, constrained and unconstrained control problems. Step response and transfer function formulation. Dynamic Matrix Control. Term project. Related laboratory experiments. Tools: programming environment for MPC and MIMO control analysis and design (e.g., MATLAB®/Simulink/MPC system toolbox).

Course Code: ICENG 437 **Course Title:** DCS and Industrial Networks
Basic components. Redundancy concept. Hardware configuration (FCS, HIS, ENG), networking configuration, industrial communication protocols, OPC DCS programming (using different function blocks and faceplates), running and testing, and sequencing control. Configuring process trends and alarm messages and developing interactive graphics.
Emergency shutdown system. SCADA system. Related laboratory experiments.

Course Code: ICENG 438 **Course Title:** Instrumentation and Control Design Project
Design of control systems for real industrial applications, preferably from local industry. The students will perform the following: Define the design objectives and requirements, literature review, propose different instrumentation and/or control configurations, criteria of selection of best configuration, explanation for the reason of selecting the system configuration(s), specify the measurement systems and final control elements; criteria would include types of instruments (transmitters, controllers, sensors) and their prices (economical constraint), instrumentation and control standards, observability, controllability/operability issues, select and tune the process controllers, safety considerations, performance evaluation of the designed system. Written design reports and oral presentations are required.

Course Code: ICENG 495 **Course Title:** Senior Project I
In this 1st phase of the project, a preliminary study is carried out in teams under the supervision of a faculty member on an approved proposal of a research project relevant to the field. The research project may be of experimental or theoretical nature, where the application of engineering knowledge towards the development of the project is demonstrated. This phase involves a thorough literature review, development of a detailed implementation plan, as well as the conduction of any preliminary studies and preparation needed for the execution of the 2nd phase of the project in the subsequent course (Senior Project II). An end-of-term written report is required.

Course Code: ICENG 496 **Course Title:** Senior Project II
In this 2nd phase of the project, the development and implementation of the research project is continued by the same team under the supervision of the same faculty member. This phase involves accurate implementation and completion of the project tasks, deep analysis of the results, logical and evident-based reasoning of the outcomes and drawn conclusions. End-of-term written formal report, poster, and oral presentation are required.

Course Code: EENG 251 **Course Title:** Digital Systems I
Number systems; Basic logic gates; Boolean algebra; Simplification of logic functions: Karnaugh maps, QuineMcCluskey 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; FlipFlops; Design and analysis of counters and registers.

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.

Description of Major Electives

Course Code: ICENG 441 **Course Title:** Safety Instrumented Systems
Definition of functional safety and safety challenges in industry. Hazard and risk analysis and prevention. Standards for risk assessment and safety instrumented systems (safety instrumented functions). Failure analysis, safety reliability analysis, safety standards and regulations (IEC 61508 and IEC 61511), fault evaluation technique (fault tree analysis) and fault tolerance. Protection layer and explosion protection. Safety instrumented system required for low level buses, and safety integrity levels.

Course Code: ICENG 442 **Course Title:** Virtual Instrumentation
Virtual Instrumentation (VI). Block diagram and architecture of virtual instruments. Programming techniques: VIs and sub-VIs, loops and conditional statements, data display, arrays, case and sequence structures and clusters, string and file I/O. Data acquisition basics: ADC, DAC, DIO, counters and timers, interrupt, software and hardware installation. VI applications in measurement and control. Tools: graphical programming environment for virtual instrumentation design and data acquisition (e.g., LABVIEW).

Course Code: ICENG 443 **Course Title:** Digital Signal Processing
Time and frequency analysis of signals and systems Z-transform and its applications to the analysis of LTI systems, DFT, properties of the DFT, use of DFT in linear filtering, filtering of long data sequences, DFT as linear transformation, efficient computation of the DFT- FFT algorithms, Radix 2 DITFFT and DIFFFT. Design of IIR filters, butterworth, chebyshev, design of FIR filters, linear phase FIR Filters, implementation of discrete time systems: Structures for FIR, IIR systems, lattice ladder structures. Finite word length effects. Power spectrum estimation, parametric methods of PSD estimation. Tools: programming environment for designing, simulating, and analyzing signal processing systems (e.g., MATLAB®/Simulink/DSP system toolbox, SciPy, etc.)

Course Code: ICENG 444 **Course Title:** Biomedical Instrumentation Systems
Biomedical sensors classification and selection. Bioelectric potentials and electrodes. Heart system and Electrocardiogram (ECG). Blood pressure measurements. Blood flow measurements. Oximeters. Blood glucose measurement and artificial pancreas. Nervous system, synapse, EEG recording techniques, and wave types. Heart pacemakers and defibrillators, and Heart-lung machine. Hemodialysis and peritoneal dialysis, artificial respirator, nerve stimulator, diathermy. Bionic ear. Endoscopes, incubators, apnoea monitor, lithotripsy. Intensive Care Unit (ICU), bedside and central monitoring systems. Imaging: MRI, ultrasonography, X-ray instrumentation, CT.

Course Code: ICENG 445 **Course Title:** Advanced Sensor Systems
Review of sensor principles. Overview of advancing sensing techniques. Sensor classifications in advanced sensing techniques. MEMS. Micro-machined sensors, fiber optical sensors, laser sensors, ultrasonic sensors, acoustic sensors, Nuclear Magnetic Resonance (NMR) sensors, soft-sensing techniques, and Micro-Computed Tomography (CT) sensors, nano sensors, and biosensors. Examples of industrial applications of advanced sensors. Latest development and technology trends.

Course Code: ICENG 451 **Course Title:** Optimization Techniques
Formulation of the optimization problem. Linear optimization, interior-point methods, mixed integer programming, global optimization. Nonlinear constrained optimization problems. Genetic algorithm. Application to process design, planning, scheduling and advanced process control using available software tools. Tools: programming environment for modelling and solving optimization problems (e.g., GAMS).

Course Code: ICENG 452 **Course Title:** Model Predictive Control and Adaptive Control
Concept of model predictive control (MPC). MPC versus classical control systems. Predictions for single-input and single-output (SISO) models. Predictions for multi-input and multi-output (MIMO) models. Model predictive control calculations. Tuning MPC parameters. Online process identification techniques. Introduction to adaptive control. Model reference adaptive control. Self-tuning regulators. Adaptive MPC control system. MPC implementation. MPC control of selected unit operation models. Tools: programming environment for designing advanced control schemes (e.g., MATLAB®/Simulink/MPC system toolbox/Adaptive Control toolbox and blockset).

Course Code: ICENG 453 **Course Title:** Artificial Intelligence in Instrumentation and Control Systems
Introduction to intelligent systems and soft computing. Fundamentals of fuzzy logic systems. Fuzzy logic control. Fundamentals of artificial neural networks. Dynamic neural networks and their applications to control. Neuro-fuzzy systems. Applications of soft computing tools to Instrumentation and control systems. Term project. Tools: programming environment for simulation of intelligent control strategies (e.g., MATLAB®/Simulink and Fuzzy Logic and Neural Network Toolboxes).

Course Code: ICENG 454 **Course Title:** Embedded Control Systems
Basic Concepts of embedded systems. Main architecture of embedded control systems. Microcontrollers. Communication networks in embedded systems: features of a Controller Area Network (CAN) Communication, CAN message frames, Error detection and signaling, CAN controller modes. Multi-tasking embedded control systems. Embedded control system design: system identification, controllers design. Term project.

Course Code: ICENG 461 **Course Title:** Special Topics
Any important, relevant topic that is not covered in the given elective list. Topics may be varied subject to students' interest and availability of staff.

Course Code: ICENG 462 **Course Title:** Big Data Analytics
Data management tools and techniques. Modern relational DBMS and NoSQL environments. Data Mining and visualization. Artificial learning systems. Machine learning techniques: classification, clustering, SVM, neural networks, etc. Principles of high-performance computing. Distributed data processing. Overview of the cloud computing architecture. Term project related to Instrumentation and control.

Course Code: ICENG 463 **Course Title:** Industrial Cyber Security
The course covers the fundamentals of cyber security, cybercrime investigation, cyber-privacy, cyber operations, and cyber security applications. Topics include cyber security components, cyber security industries, cryptographic algorithms, cyber security architecture, security threat and risk assessment, e-services security, system cyber-security such as embedded systems, cloud computing security, and internet of things security.

Course Code: ICENG 464 **Course Title:** Wireless Sensor Technology
The course gives an overview of various topics related to wireless sensor networks. Topics include distributed signal progressing in large scale sensor networks, energy conservation approaches, node deployment and topology, communication in sensor networks, time synchronization, localization, data fusion and geographical energy aware routing.

Course Code: CHEN 477 **Course Title:** Quality Assurance and Reliability Engineering
Quality assurance, understanding, commitment, leadership, and organization. The role of quality system, planning, flow-charting. How to maintain plant quality and operation reliability. Causes and consequences of failure. Reliability of series, parallel, standby, and complex systems. Analytical methods including fault trees. Implementation methods, communication and training for quality. Guidelines for writing a quality manual.

Description of Major Support Requirement Courses

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: EENG 100 **Course Title:** Circuit Theory I
Basic quantities of electricity: Charge, Current, Voltage, Power, Energy and Resistance. Basic laws of electricity: Ohm's Law, Kirchhoff's Laws (KVL & KCL). Apply circuit theorems: mesh, nodal, superposition, Thevenin's, Norton's, and maximum power transfer. Capacitors and inductors in DC circuits. Phasors & complex numbers for AC circuits. Sinusoidal steady-state analysis. Power in AC circuits: Complex, Apparent, Real & Reactive Powers and Power Factor.

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 amplifies.

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: PHYCS 209 **Course Title:** Bulk Properties of Matter
Elasticity; fluid statics and dynamics; mechanical waves; vibrating bodies; acoustic phenomena; kinetic theory of gases; first and second law of thermodynamics; geometrical optics.

Description of College Requirement Courses

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

This course offers theoretical and practical experience in technical report writing. It also introduces the steps involved in writing a report and in presenting its findings. The emphasis throughout is upon practical tasks and assignments, the most important of which is the production of a full-length formal report.

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 303 **Course Title:** Engineering Economics

Fundamentals of engineering economy. Time value of money. Present worth analysis. Annual worth analysis. Rate of return analysis. Replacement and retention analysis. Capital rationing. Breakeven analysis. Payback period analysis. Cost estimation and indirect cost allocation. Depreciation methods.

Course Code: STAT 276 **Course Title:** Statistical Data Analysis

Introduction to statistical methods for data analysis and interpretation. Statistical inference, probability distributions, descriptive statistics and data visualization, significance tests, Analysis of Variance (ANOVA), linear and nonlinear regression analysis. Principles of design of experiments, statistical quality control. Tools: spreadsheet software (e.g., Microsoft® Excel) and programming environment (e.g., MATLAB®).

Description of University Requirement Courses

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.