# Bachelor of Science in Mechanical Engineering 2022

## Program Components
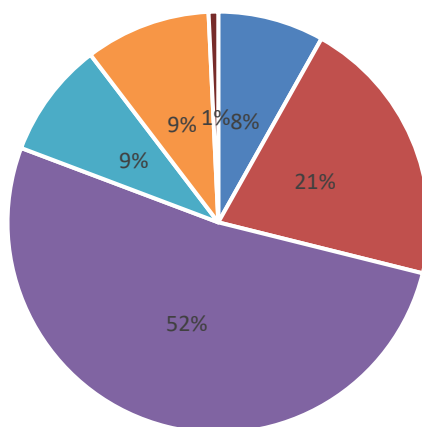


| Legend | |
|---|---|
| ■ University Requirement (UR) | ■ College Requirement (CR) |
| ■ General Studies Compulsory (GSCC) | ■ Major Requirement (MR) |
| ■ Major Elective (ME)1 | ■ Major Support Requirement (MSR) |
| ■ General Studies Elective (GSE) | ■ Training (Internship) Yes |

| | |
|---|---|
| **University Requirement (UR)** | **11** |
| **College Requirement (CR)** | **28** |
| **General Studies Compulsory (GSCC)** | **--** |
| **Major Requirement (MR)** | **70** |
| **Major Elective (ME)[1]** | **12** |
| **Major Support Requirement (MSR)** | **13** |
| **General Studies Elective (GSE)** | **--** |
| **Training** (Internship) **Yes** | **1** |
| **Total Credit (CRD)** | **135** |

[1] Student must select four (4XX) courses from Major Elective(ME) List.

# 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 | 3 | 4 | CR | ------ | No |
| ENGL 101 | Communication Skills I | 3 | 0 | 3 | CR | ------ | No |
| MATHS 101 | Calculus I | 3 | 0 | 3 | CR | ------ | No |
| PHYCS 111 | Fundamentals of Physics | 3 | 3 | 4 | MSR | ------ | No |
| ISLM 101 | Islamic Culture | 3 | 0 | 3 | UR | ------ | No |
| | Total | 15 | 6 | 17 | | | |

## Year 1 - Semester 2

| Course Code | Course Title | Course Hours | | | Course Type | Pre requisite | Major GPA |
|---|---|---|---|---|---|---|---|
| | | LEC | PRAC | CRD | | | |
| HRLC 107 | Human Rights | 2 | 0 | 2 | UR | ------ | No |
| ENGL 242 | Report Writing and Presentation | 3 | 0 | 3 | CR | ENGL 101 | No |
| MATHS 102 | Calculus II | 3 | 0 | 3 | CR | MATHS 101 | No |
| MENG 161 | Engineering Drawing | 1 | 6 | 3 | MR | MATHS 101 | YES |
| MENG 163 | Statics | 3 | 2 | 3 | MR | PHYCS 111 | YES |
| PHYCS 209 | Bulk Properties of Matter | 3 | 2 | 3 | MSR | PHYCS 111 | No |
| | Total | 15 | 10 | 17 | | | |

## Year 2 - Semester 3

| Course Code | Course Title | Course Hours | | | Course Type | Pre requisite | Major GPA |
|---|---|---|---|---|---|---|---|
| | | LEC | PRAC | CRD | | | |
| EENG 201 | Elements of Electrical Engineering | 3 | 2 | 3 | MSR | MATHS 102 | No |
| MATHS 211 | Linear Algebra | 3 | 0 | 3 | MSR | MATHS 101 | No |
| MATHS 205 | Differential Equations | 3 | 0 | 3 | CR | MATHS 102 | No |
| MENG 202 | Materials Science | 3 | 2 | 3 | MR | CHEMY 101 & ENGL 101 | Yes |
| MENG 232 | Thermofluids | 3 | 2 | 3 | MR | PHYCS 209 | Yes |
| MENG 263 | Dynamics | 3 | 2 | 3 | MR | MENG 163 | Yes |
| | Total | 18 | 8 | 18 | | | |

## Year 2 - Semester 4

| Course Code | Course Title | Course Hours | | | Course Type | Pre requisite | Major GPA |
|---|---|---|---|---|---|---|---|
| | | LEC | PRAC | CRD | | | |
| MENG 209 | Introduction to Engineering Profession | 2 | 3 | 3 | CR | ENGL 242 | Yes |
| MATHS 203 | Calculus III | 3 | 0 | 3 | CR | MATHS 102 | No |
| MENG 212 | Manufacturing Fundamentals | 2 | 3 | 3 | MR | MENG 202 | YES |
| MENG 236 | Applied Thermodynamics | 3 | 2 | 3 | MR | MENG 232 | YES |
| MENG 274 | Numerical Analysis | 2 | 3 | 3 | MR | MATHS 211 | YES |
| STAT 276 | Statistical Data Analysis for Engineering | 3 | 0 | 3 | CR | MATHS 101 | No |
| | Total | 15 | 11 | 18 | | | |

## Year 3 - Semester 5

| 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 |
| MENG 382 | Computer Programming and Application | 2 | 3 | 3 | MR | MENG 274 | YES |
| MENG 312 | Manufacturing Processes | 3 | 2 | 3 | MR | MENG 212 & MENG 209 | YES |
| MENG 333 | Fluid Mechanics | 3 | 2 | 3 | MR | MATHS 205 & MENG 236 | YES |
| MENG 371 | Mechanics of Materials | 3 | 2 | 3 | MR | MENG 202 | YES |
| MENG 373 | Kinematics and Dynamics of Machinery | 3 | 2 | 3 | MR | MENG 263 | YES |
| | Total | 14 | 11 | 18 | | | |

## 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 |
| MENG 303 | Engineering Economics | 3 | 1 | 3 | MR | Completion of 70 credits | YES |
| MENG 375 | Design of Mechanical Elements | 2 | 3 | 3 | MR | MENG 371 & MENG 312 | YES |
| MENG 384 | Vibration | 3 | 2 | 3 | MR | MENG 373 | YES |
| MENG 335 | Heat Transfer | 3 | 2 | 3 | MR | MENG 333 | YES |
| | Total | 14 | 8 | 15 | | | |

**Training Requirement**

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

**\* Does not need a time slot**

## Year 4 - Semester 7

| Course Code | Course Title | Course Hours | | | Course Type | Pre requisite | Major GPA |
|---|---|---|---|---|---|---|---|
| | | LEC | PRAC | CRD | | | |
| MENG 415 | Engineering Management | 3 | 1 | 3 | MR | STAT 275 & MENG 303 | YES |
| MENG 430 | Power Plant and Desalination | 3 | 2 | 3 | MR | MENG 335 | YES |
| MENG 475 | Design of Mechanical Systems | 2 | 3 | 3 | MR | MENG 375 | YES |
| MENG 495 | Senior Design Project I | 0 | 6* | 2 | MR | MENG 375 & Competition of 90 credits | YES |
| MENG 4xx | Major Elective I[1] | 3 | 2 | 3 | ME | As per ME list | YES |
| MENG 4xx | Major Elective II[1] | 3 | 2 | 3 | ME | As per ME list | YES |
| | Total | 14 | 16 | 17 | | | |

## Year 4 - Semester 8

| Course Code | Course Title | Course Hours | | | Course Type | Pre requisite | Major GPA |
|---|---|---|---|---|---|---|---|
| | | LEC | PRAC | CRD | | | |
| MENG 440 | Refrigeration and Air Conditioning | 3 | 2 | 3 | MR | MENG 335 | YES |
| MENG 485 | Systems and Control | 3 | 2 | 3 | MR | MENG 274 & MENG 384 | YES |
| MENG 4xx | Major Elective III[1] | 3 | 2 | 3 | ME | As per ME list | YES |
| MENG 4xx | Major Elective IV[1] | 3 | 2 | 3 | ME | As per ME list | YES |
| MENG 496 | Senior Design Project II | 0 | 6* | 2 | MR | MENG 495 | YES |
| | Total | 12 | 14 | 14 | | | |

**\* Does not need a time slot**

## Major Elective Courses

| Course Code | Course Title | Course Hours | | | Course Type | Pre requisite | Major GPA |
|---|---|---|---|---|---|---|---|
| | | LEC | PRAC | CRD | | | |
| MENG 441 | Energy Conversion and Management | 3 | 2 | 3 | ME | MENG 335 | Yes |
| MENG 442 | Fluid Machinery | 3 | 2 | 3 | ME | MENG 333 | Yes |
| MENG 444 | Internal Combustion Engines | 3 | 2 | 3 | ME | MENG 236 | Yes |
| MENG 446 | Design of Thermal Systems | 3 | 2 | 3 | ME | MENG 335 | Yes |
| MENG 447 | Computational Fluid Dynamics | 3 | 2 | 3 | ME | MENG 333 | Yes |
| MENG 448 | Aerodynamics | 3 | 2 | 3 | ME | MENG 333 | Yes |
| MENG 410 | Production and Processing of Aluminum | 3 | 2 | 3 | ME | MENG 312 | Yes |
| MENG 422 | Advanced Manufacturing | 3 | 2 | 3 | ME | MENG 312 | Yes |
| MENG 421 | Operations Research | 3 | 1 | 3 | ME | MENG 415 | Yes |
| MENG 426 | Quality Management | 3 | 1 | 3 | ME | MENG 415 | Yes |
| MENG 471 | Failure Analysis | 3 | 2 | 3 | ME | MENG 371 | Yes |
| MENG 455 | Special Topics | 3 | 2 | 3 | ME | Selected | Yes |
| MENG 473 | Tribology | 3 | 2 | 3 | ME | MENG 375 | Yes |
| MENG 476 | Control Systems Design | 3 | 2 | 3 | ME | MENG 485 | Yes |
| MENG 477 | Machine Health Monitoring | 3 | 2 | 3 | ME | MENG 384 | Yes |
| MENG 478 | Product Design and Development | 3 | 2 | 3 | ME | MENG 375 | Yes |
| MENG 479 | Introduction to Finite Element Methods | 3 | 2 | 3 | ME | MENG 375 | Yes |

# Course Description

**Course Code:** MENG 161    **Course Title:** Engineering Drawing
Freehand sketch. Isometric and oblique views, orthographic projection, sectional and auxiliary views, linear dimensioning, fundamentals of interpenetrations and developments of surfaces. Limits and fits: geometric tolerances, fasteners and fastenings, surface finish notations, welds and welding symbols and representations of standard elements. Applications with CAD; such as AutoCAD and Inventor.

**Course Code:** MENG 163    **Course Title:** Statics
Introduction to statics, forces in plane, forces in space, equilibrium of particles and rigid bodies in two and three dimensions, centroid and center of gravity, distributed forces, moment of inertia, analysis of trusses, frames and machines, forces in beams, friction in square-threaded screws and bolts.

**Course Code:** MENG 202    **Course Title:** Materials Science
Structure, process, and properties relationships of materials. Types of Bonding. Material classification and their distinguishing properties. Mechanical behavior of materials and introduction to failure analysis. Standards and standard methods of mechanical testing. Structure of materials. Microstructure visualization basic methods. Imperfections in solids and their effect on the mechanical behavior of materials. Phase diagrams and microstructure. Phase transformations. Material selection case studies.

**Course Code:** MENG 209    **Course Title:** Introduction to Engineering Profession
Engineering as a profession, Ethics, and technology: Ethics (including professional ethics), Interaction technology and society, Corporate Responsibility, Sustainability, Teamwork / Group Processes, Project work, Innovation / change expertise, Dissemination, project management.

**Course Code:** MENG 212    **Course Title:** Manufacturing Fundamentals
Workplace safety. Measurement tools. Layout tools and procedures. Hand tools and bench works. Metal casting processes: sand casting, die casting, and investment casting. Sheet metal processes: Piercing, coining, stamping, deep drawing, and stretch forming. Welding of metals. Material removal processes: turning, milling, drilling, and grinding. Non-traditional machining.

**Course Code:** MENG 232    **Course Title:** Thermofluids
Energy and the first law of thermodynamics: Energy balance for closed systems, energy analysis for cycles. Properties of pure substances. Control volume energy analysis. Second law of thermodynamics: statements of second law, Carnot cycle. Fluid Statics: Properties of fluids, Hydrostatic force on a plane and curved surface, Pressure measurements, Buoyancy, Stability of floating and submerged bodies. Rigid body motion, Internal viscous flows.

**Course Code:** MENG 236    **Course Title:** Applied Thermodynamics
Irreversibility, availability and second law efficiency. Exergy destruction, non-flow exergy and flow exergy. Vapor power cycles and exergy analysis: basic cycles; Rankine cycle, Otto cycle, Diesel cycle, Brayton cycle. Refrigeration: vapor-compression refrigeration, refrigerant properties, absorption refrigeration. Heat pump systems. Chemical Reactions; balancing the combustion equation, adiabatic flame temperature.

**Course Code:** MENG 263    **Course Title:** Dynamics
Rectilinear and curvilinear motion of the particles, kinetics of particles, linear and angular momentum, work, energy and power, principle of impulse and momentum, impact: kinematics of rigid bodies, kinetics of rigid bodies, introduction to three-dimensional dynamics of rigid bodies. Computer applications are employed throughout the course.

**Course Code:** MENG 274    **Course Title:** Numerical Analysis
Taylor series, Matrix algebra: Gauess-Jordan elimination, EVP. Interpolating polynomials, least square method, integration rules: trapezoidal, Simpson's, improper integrals. Finite difference formulation; differentiation schemes, roots of equations. Initial and boundary value problems of ODE: Euler and Runge-kutta methods. Finite Element: shape functions, elemental matrices, global coordinates, elements assembly. Applications using commercial packages.

**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:**     MENG 312       **Course Title:** Manufacturing Processes

Production of iron and steel. Production of aluminum. Bulk deformation processes: hot and cold working, forging, rolling, extrusion and drawing. Metal cutting: theory of metal cutting, multi-point cutting, machinability and economics of metal cutting. Grinding and abrasive processes. Introduction to CNC machining. Metrology: Surface texture and geometrical feature measurement. Polymer processing. Introduction to advanced manufacturing systems.

**Course Code:**     MENG 333       **Course Title:** Fluid Mechanics

Fluid kinematics, energy, and Bernoulli's equation. Dimensional analysis and similitude. Momentum and energy equations (Integral Relations), Differential relations in two and three dimensions: velocity and acceleration, Navier Stokes relations, energy relation, introduction to stream and potential functions, introduction to boundary layer theory with applications to flat plates, cylinders. Compressible flow, normal shock waves.

**Course Code:**     MENG 335       **Course Title:** Heat Transfer

Basic modes of heat transfer. Thermal circuits, surface energy balance. Steady one-dimensional heat conduction, conduction across flat plate, cylindrical and spherical shells. Fins. Convection fundamentals and correlations, external flow, internal flow, tube banks, impinging jets, packed beds. Types of heat exchangers, overall heat transfer coefficient, design of heat exchanger. Radiation, black body and gray radiation, view factor, radiation exchange between surfaces.

**Course Code:**     MENG 371       **Course Title:** Mechanics of Materials

The concept of stress and strain, types of stresses, types of loading: axial loads, pure bending symmetric and unsymmetrical bending, torsion. Deflection of beams, statically indeterminate beams, curved beams, buckling of columns, shear center, thin and thick-walled pressure vessels. Analysis of interference fit applications, fatigue strength, marine factors, introduction to fatigue failure theories, finite element applications, introduction to the theory of elasticity and plasticity.

**Course Code:**     MENG 373       **Course Title:** Kinematics and Dynamics of Machinery

Basic concepts of mechanisms and machines, analysis of displacement, velocity and acceleration of mechanisms, static and dynamics force analysis, cam design, spur, helical, bevel and warm gears, ordinary and epicycle gear trains, balancing of rotating and reciprocating machinery, and flywheels. Computer applications are employed throughout the course.

**Course Code:**     MENG 375       **Course Title:** Design of Mechanical Elements

Design consideration; Assembly loading analysis, stresses and strain analysis for static and fatigue loading. The design, selection, analysis, and synthesis of springs, joining and fastening methods, shafts, and other elements. Design project using computer facilities.

**Course Code:**     MENG 382       **Course Title:** Computer Programming and Application

Introduction to modern programming languages. MATLAB®: creating vector and matrices, if statements, while and for loops, script and function files, matrix operations, MATLAB® built-in functions, plot commands. Solving systems of linear and nonlinear equations. Data manipulation, application of linear and nonlinear algebraic and differential equations in mechanical engineering systems, numerical solution of optimization problem.

**Course Code:**     MENG 384       **Course Title:** Vibration

A review of simple harmonic motion and Fourier series, undamped and damped free vibration of SDFS, Coulomb damping, torsional vibration, forced vibration of SDFS: equivalent viscous damping, vibration isolation and control, transient vibration to arbitrary excitation, multi-degree of freedom systems, modal analysis, dynamic absorber, forced vibration of lumped mass system. Lagrange's equation, applications using computer facilities.

**Course Code:** MENG 395 **Course Title:** Industrial Training

In this industrial training course, 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:** MENG 410 **Course Title:** Production and Processing of Aluminum

Flow diagrams and process description of various sections of aluminum plant including raw materials preparation, carbon plant, anode and cathode preparation, pot-house and finished product, and furnace operation. Principles of electrolysis and current efficiency. Melt contamination. Production of aluminum alloys by mixing. Cast Aluminum Alloys.

**Course Code:** MENG 415 **Course Title:** Engineering Management

Introduction to engineering management. Types and characteristics of production systems. Product design. Process and service design. Capacity planning. Project planning. Supply chain management. Forecasting methods and techniques. Inventory management. Quality management. Material requirements planning (MRP). Production scheduling.

**Course Code:** MENG 421 **Course Title:** Operations Research

Linear Programming: formulation of Linear Programming models, graphical solution, and simplex method. Duality theory and sensitivity analysis. Transportation problem, assignment model, and transshipment model. Introduction to Dynamic, Integer and Goal Programming.

**Course Code:** MENG 422 **Course Title:** Advanced Manufacturing

Introduction to advanced manufacturing as an innovative technology to improve products or processes. Overview and components of manufacturing systems: types and performance of manufacturing system. Manufacturing automation systems; group technology (GT), cellular manufacturing, FMS, CIM, and robotics. Advanced manufacturing practices: lean, agile, networking, and cyber manufacturing. Enterprise integration. Digital manufacturing. Smart manufacturing systems. Introduction to resource planning systems.

**Course Code:** MENG 426 **Course Title:** Quality Management

Quality philosophies and management strategies. Quality Dimensions. Process Improvement Technique: PDCA cycle and the seven basic quality control tools. Quality systems: TQM and ISO. Performance measurement systems: Six Sigma and Balanced Scorecard. Quality improvement tools: QFD and FMEA. Statistical process control. Quality control charts for variables and attributes. Quality and liability costs.

**Course Code:** MENG 430 **Course Title:** Power Plant and Desalination

Power stations classifications, steam power plant, feed water heaters, performance. Steam generators, fuels and combustion processes, turbine, water systems. Gas power stations and diesel power plant, characteristics and performance. Combined power cycles. Co-generation concepts and systems. Power generation and environmental impact. Water desalination, reverse osmosis, multiple flash evaporator.

**Course Code:** MENG 440 **Course Title:** Refrigeration and Air Conditioning

Applications of Refrigeration and Air Conditioning: Major uses. Air-conditioning processes and cycles. Refrigerant and refrigeration cycles. Outdoor design conditions and indoor design criteria. Load calculation. Refrigeration components and evaporative coolers. Air system basics: fan and duct systems, fan combinations in air-handling units and packaged units. Absorption systems: the absorption cycle. Air conditioning systems and selection.

**Course Code:** MENG 441 **Course Title:** Energy Conversion and Management

Solar energy and applications: solar radiation, solar water heating, photovoltaic generation. Power from wind: turbine types and terms, characteristics of wind. Energy storage and distribution. Fuel cells and hydrogen applications. Nuclear, tidal, and geothermal energy. Analysis methods and energy saving potentials, energy audit in domestic, transport and industry, economic evaluation of energy conservation opportunities.

**Course Code:** MENG 442 **Course Title:** Fluid Machinery
Classifications of fluid machinery. Momentum and energy transfer between fluid and rotor. Principles and practice of scaling laws. Performance characteristics of centrifugal and axial flow fans, compressors, and pumps. Positive displacement pumps. Cavitation and water-hammer problems. Valves, types, and characteristics. Performance characteristics of axial and radial flow turbines. Fluid machinery noise.

**Course Code:** MENG 444 **Course Title:** Internal Combustion Engines
Basic engine operation, introduction to engine cycles. Air standard cycles, fuel-air and actual cycles, volumetric efficiency. Performance and the effects of operating variables on it. Two stroke engine air capacity and scavenging. Ideal combustion of S.I engines, real combustion of S.I engines, abnormal combustion of S.I engines, diesel combustion. Emission sources, exhaust after treatment, emission reduction systems and diesel emissions.

**Course Code:** MENG 446 **Course Title:** Design of Thermal Systems
Piping systems, Friction factor, pipe roughness, pressure losses, series and parallel piping systems, Optimization process, economic pipe diameter, and equivalent length of fittings, Types of pumps, Pump testing methods, cavitation, net positive suction head, dimensional analysis of pumps, specific speed, Shell and tube heat exchangers, analysis of shell and tube heat exchangers, Effectiveness-NTU analysis, design considerations.

**Course Code:** MENG 447 **Course Title:** Computation Fluids Dynamics (CFD)
The Navier-Stokes; direct and iterative methods for linear systems; finite differences for elliptic, parabolic and hyperbolic equations; Fourier decomposition, error analysis and stability; high-order and compact finite-differences; finite volume methods; time marching methods; Navier-Stokes solvers; grid generation; finite volumes on complex geometries; finite element methods; spectral methods; boundary element and panel methods; turbulent flows; boundary layers; and Lagrangian coherent structures (LCSs).

**Course Code:** MENG 448 **Course Title:** Aerodynamics
Aerodynamic forces and moments, Dimensional analysis: Buckingham Pi Theorem, types of fluid flow: continuum, inviscid/viscous, incompressible, subsonic, transonic, supersonic, hypersonic flows. Concept of boundary layer theory, introduction to a method for dealing with friction, continuity, momentum, and energy equations. Stream and potential functions, circulation, angular velocity, vorticity and strain. Inviscid incompressible flow in a duct with applications. Gas dynamics, inviscid compressible flow with applications to ducts of various geometry and airfoils. CFD applications to various geometries (Ducts, Airfoils).

**Course Code:** MENG 455 **Course Title:** Special Topics
Any important, relevant and possibly hot topic in the field that is not covered in the approved elective list. Topics may vary based on students' interest and availability of staff.

**Course Code:** MENG 471 **Course Title:** Failure Analysis
Course goals, materials selection, material processing, aesthetics, and environmental considerations. Macroscopic and microscopic fracture analysis, Principles of fracture mechanics and failure analysis, tribological failure, types of complete failure: distortion, buckling, yielding, plastic instability, creep, fatigue, cumulative failure, and crack propagation. Fail-safe design analysis, diagnostics methods and control of mechanical failures, case studies of failure analysis.

**Course Code:** MENG 473 **Course Title:** Tribology
Surface properties and surface contact stress; Friction, measurement of friction, theories of friction, thermal effects in sliding friction; Types of wear, wear of lubricated surfaces. Tribological properties of solid materials, solid lubricants, polymers, and composites, the pv factor, lubricant properties, fluid lubricated thrust bearings. Fluid-lubricated journal bearings, oil supply grooves, wear failure analysis, and industrial preventive maintenance: case studies.

**Course Code:** MENG 475 **Course Title:** Design of Mechanical Systems
Design and analysis of mechanical systems based on critical studies of high-performance machinery. Applications of design fundamentals to mechanical components, and integration of components to form systems. Advanced techniques such as optimization and finite element analysis, design case studies using the computer facilities (at least 2 case studies).

**Course Code:** MENG 476      **Course Title:** Control Systems Design
Introduction, concept of optimal designs, gain adjustment design methods, closed loop tracking performance, cascade & feedback compensation, root locus compensation, frequency response design, PID Controls, state-space design methods, industrial controllers, actuators, introduction to advanced design methods (QFT, LQG, H2 & H∞), case studies.

**Course Code:** MENG 477      **Course Title:** Machine Health Monitoring
Machine maintenance; run to failure, preventive maintenance and predictive maintenance, costs, planning and benefits, role of vibration, bearing temperature, lubricant oil and acoustics in predictive maintenance, vibration analysis, overall vibration, time waveform, FFT spectrum analysis, vibration diagnostic charts. Software and hardware requirements: sensor, data collectors, and analyzers. Real world case studies.

**Course Code:** MENG 478      **Course Title:** Product Design and Development
Introduction to product design and development, methods used for opportunity identification, product planning based on customer needs, product specifications and concept generation, concept selection process and techniques, Product design and modelling, prototyping and robust designing, the intellectual property rights and product development economics.

**Course Code:** MENG 479      **Course Title:** Introduction to Finite Element Methods
Basics of Finite Element Method, Stiffness (Displacement) Method, Truss Equations, Weighted Residual (Galerkin's Residual Method), Beam Equations, Plane Stress and Plane Strain Stiffness Equations, Plane stress and Plane Strain Concepts, Constant Strain Triangular Element (CST), Linear Strain Triangular Element (LST), Isoparametric Formulation, Review Numerical Integration (Gaussian & Newton-Cotes Quadrature), 3D Stress Analysis, Heat Transfer, Basic Differential Equations, One Dimensional Elements, Two Dimensional Elements, Fluid Flow, Basic Differential Equations, One Dimensional Elements, Two Dimensional Elements, Application of FEM to structural dynamics. Applications using commercial packages. Application of ANSYS (student version is available for free download) package to solid mechanics, fluid mechanics, heat transfer problems and dynamic structural problems.

**Course Code:** MENG 485      **Course Title:** Systems and Control
Concept of systems, concept of open and closed loop systems, modeling of systems, state variable models, systems performance and characteristics, stability and sensitivity analysis, basic control actions, root-locus analysis & design, frequency response analysis & design, introduction to modern control, applications.

**Course Code**: MENG 495      **Course Title:** Senior Design Project I
The first is a two-part course sequence applying an integrated system design approach on a team-based project, open-ended problem with realistic constraints. Team effort and both oral and written presentations are a part of the experience. Important topics are discussed in the meeting with the project supervisor including the design process, design tools, engineering communication, engineering ethics, and intellectual property. In the end of semester, the project supervisor submit grade passed on a progress report.

**Course Code**: MENG 496      **Course Title:** Senior Design Project II
Completion of the team designed functional working model, submission of final written report of the design project are essential requirements for the completion of the course then conduct oral presentation in front of examination committee for grade evaluation.

# University Requirements Courses Descriptions

**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 Principles
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.

# College Requirement Courses Descriptions

**Course Code:** CHEMY 101    **Course Title:** General Chemistry I
Significant figures, chemical formulas and equations; mass relations, limiting reactants and theoretical yield; Physical behaviour of gases; electronic structure, periodic table, covalent bonding; Lewis structures, Molecular structures, hybridization; molecular orbitals, solutions; colligative properties. Related practical work.

**Course Code:** ENGL101    **Course Title:** Communication Skills
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:** 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:** ENGL242    **Course Title:** Report Writing and Presentation
This course offers theoretical and practical experience in technical report writing and presentation. It presents the steps involved in writing a report in detail and in presenting its findings. Presentation skills are also introduced. The emphasis throughout is upon tasks and assignments, the most important of which is the production of a full-length report and formally present it using power point.

**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 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:** 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:** STAT 276    **Course Title:** Statistical Data Analysis for Engineering
Introduction to statistical methods for data analysis and interpretation, descriptive statistics and data visualization, statistical inference, probability distributions, significance tests, Analysis of Variance (ANOVA), linear and nonlinear regression analysis. Principles of design of experiments, statistical quality control. Tools: spreadsheet software and programming environment.

# Major Support Requirement Courses Descriptions

**Course Code:**    PHYCS 111        **Course Title:** Fundamentals of Physics

Vectors and scalars; straight line and projectile motion; Newton's laws of motion; work, energy and power, momentum and impulse; rotational motion; periodic motion; the electric field; Gauss's law; electric potential; capacitance and dielectrics; magnetic fields and magnetic forces.

**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.

**Course Code:**    EENG 201        **Course Title:** Elements of Electrical Engineering

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:**    MATHS 211        **Course Title:** Linear Algebra

Fields. Vector spaces. Linear dependence and independence. Bases. Dimensions. Subspaces. Quotient spaces. Linear transformations. Connection with matrices. Change of bases (PAQ and PAP). Eigen-values. Characteristic polynomial. Minimal polynomial. Canonical forms in simple cases. Real and complex inner-product spaces. Orthonormal bases. Orthogonal and complex unitary matrices and their eigen-values. Orthogonal and unitary reduction of real symmetric and complex Hermitian matrices.