MQF Level 6

Bachelor of Engineering (Honours) in Mechanical Engineering (Plant)

ME6-03-21

Course Description

This degree course in Mechanical Engineering is relevant to a range of industries, since it covers the key mechanical engineering principles and subject areas for the plant engineer. The course is therefore wide-ranging and it will develop the candidates' ability to apply these principles to solve engineering problems in a variety of work environments and business concerns. Additional managerial modules further enhance this programme so that graduates may add real value to the organisation that employs them.

Programme Learning Outcomes

At the end of the programme the learner will be able to:

1. *Analyse a variety of mechanical engineering issues using mathematical and scientific knowledge;*
2. *Comprehend the operations and rectify failures of a large variety of equipment;*
3. *Take structured and responsible decisions that will lead to effective and efficient solutions;*
4. *Understand complex electronically controlled systems.*

Entry Requirements

MCAST Advanced Diploma in Operations and Maintenance

or

MCAST Undergraduate Diploma in Foundations of Engineering

or

2 A-Level passes and 2 I-Level Compulsory A-Levels: Physics, Mathematics (Pure or Applied) Applicants need to obtain an average Grade C or better across their A-Levels in Mathematics and Physics (such as Grades C, C; Grades B, D; Grades A, E),

or

a related MCAST Advanced Diploma (with an overall mark of 60% or higher).

Current Approved Programme Structure

Unit Code	Unit Title	ECTS	Year
ETMTH-606-1809	Mathematics for Engineers 1	6	1
ETMEC-606-1805	Thermodynamics 1	6	1
ETMEC-606-1806	Fluid Mechanics 1	6	1
ETMEC-606-1807	Mechanics for Machines 1-Dynamics and Kinematics	6	1
ETDSN-606-1801	Engineering Design & CAD	6	1
ETMEC-606-1804	Applications of Pneumatics and Hydaraulics	6	1
ETE&E-606-1802	Fundamentals of Electrical and Electronics Power	6	1
ETMTS-606-1801	Strength of Materials 1	6	1
ETMEC-606-1808	Workshop Practice	6	1
ETWBL-603-1802	Work Based Learning Internship Part 1	3	1
CDKSK-603-2111	English 1	3	1
ETMTH-606-1811	Mathematics for Engineers 2	6	2
ETMEC-606-1811	Thermodynamics 2	6	2
ETMEC-606-1812	Fluid Mechanics 2	6	2
ETMEC-606-1813	Mechanics of Machines 2	6	2
ETMTS-606-1802	Engineering Materials	6	2
ETPLN-606-1801	Condition Monitoring and Fault Diagnosis	6	2
ETELX-606-1822	Programmable Logic Controllers	6	2
ETENG-603-1804	Environmental Engineering	3	2
ETENG-606-1805	Energy Management	6	2
ETMTS-606-1803	Strength of Materials 2	6	2
ETWBL-603-1803	Work Based Learning Internship Part 2	3	2
ETMTH-606-1812	Mathematics for Engineers 3	6	3
ETMEC-606-1522	Vibrations	6	3
ETELE-606-1815	Electrical Power Systems	6	3
ETMTS-606-1508	Materials for Plant Engineers	6	3
ETPLN-606-1802	Plant Operations a & Performance	6	3
ETENG-606-1505	Control Engineering	6	3
ETPLN-606-1504	Plant Design	6	3
ETMTS-606-1509	Material Loss, Prevention & Protection	6	3
ETMEC-606-1814	Problem Based Learning	6	3
CDKSK-604-1909	Entrepreneurship	4	3
CDKSK-602-2105	Community Social Responsibility	2	3
ETMTH-606-1813	Mathematics for Engineers 4	6	4
ETMGT-606-1804	Management for Engineers	6	4
ETELX-606-1823	Power Electronics, Devices and Circuits	6	4
ETPWR-606-1501	Alternative & Traditional Power Generation	6	4
ETHVA-606-1510	HVAC	6	4
ETPLN-606-1505	Plant Typology	6	4
ETPLN-606-1506	Diagnostics and Control	6	4
ETPLN-606-1803	Engineering Plant Technology	6	4

ETRSH-600-1502	Research Methods	0	4
ETDIS-612-1501	Dissertation	12	4
	Total ECTS	**240**	/

Unit: ETMTH-606-1809 - Mathematics for Engineers 1

Unit level (MQF): 6

Credits: 6

Unit Description

This unit aims to provide underpinning knowledge essential for an engineer to develop skills, not only in solving mathematical and scientific problems but also in applying these skills to analyse, model and predict behaviours of engineering systems.

The unit is split into five learning outcomes, addressing important areas of mathematics, namely: Algebra, graphical techniques, matrices, vectors, calculus, differential equations and statistics. In all the learning outcomes, mathematical skills in order to reach a solution to straightforward problems are first developed. This will be followed by the application of these skills to various, more complex, engineering situations.

The first outcome covers various algebraic methods in solving engineering problems, as well as limits and functions. Graphical techniques including curve sketching, loci, transformations of graphs and their inverses, as well as the polar coordinate system are covered in the second outcome.

The third outcome covers matrices and vectors. 2x2 and 3x3 matrices, including the inverse and transpose of matrices, will be discussed. This will then lead to solving simultaneous equations using matrices. In vectors, the basics of vector addition, subtraction and resolution of forces is first seen to. This will then be followed by more complex problems involving vectors, namely vector geometry.

In the fourth outcome, students will revise the basics of differentiation and integration in calculus. Various other integration techniques will then be introduced. Students will develop skills to apply this knowledge to analyse and model a variety of engineering situations especially by using differential equations.

The statistics part is covered through learning outcome 5. The emphasis here is on developing higher level skills of synthesis and evaluation and hence the context is production, manufacturing and testing, where students will use correlation and regression techniques as well as appropriate probability models.

It is assumed that students undertaking this unit would have appropriate prior basic knowledge of the above mentioned topics.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Use algebraic methods to solve engineering problems;*
2. *Sketch and transform graphs of basic functions;*
3. *Present solution to engineering problems using matrices and vectors;*
4. *Analyse and model engineering situations and solve differential equations and problems using calculus;*
5. *Apply statistical techniques to solve engineering problems.*

Unit: ETMEC-606-1805 - Thermodynamics 1

Unit level (MQF): 6

Credits: 6

Unit Description

This unit is designed to present an application-oriented delivery of engineering thermodynamic, and enables students to develop the knowledge required to apply thermodynamic principles to heat engines. Students will be able to understand how these principles are relevant in engineering.

The Unit will also provide the student with a base from which future advance work in engineering may be undertaken. Knowledge of the subject will enable the learner to understand the parameters used to explain the characteristics of thermodynamic systems. The learner will be able to evaluate the performance of plant and machinery.

Knowledge of engineering thermodynamics is essential to understand the operating principles of plant and machinery. The energy for conventional prime movers and electrical power generation is derived from the use of engines and turbines, which convert the chemical energy released by fuel combustion into mechanical energy. The efficiency of this energy conversion is based on certain thermodynamic principles.

Equipment such as nozzles, which convert gas pressure into velocity, and compressors which convert work into pressure, also operate based on ideal thermodynamic principles. This unit discusses the laws applicable to gases and vapours during the processes of expansion and compression in engines and turbines. A sound knowledge of engineering thermodynamics will enable the learner to design and operate the above machinery at optimum efficiency.

The unit progresses from a theoretical approach to the practical aspects of thermodynamics in power plant. Based on the principles taught earlier in the unit, the layout, operation and performance of power plant components are discussed.

It would be an advantage if candidates had a knowledge and understanding of physics, mathematics and engineering systems to the desired level.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain the First Law of Thermodynamics and compare reversible and irreversible processes;*
2. *Apply The Second Law of Thermodynamics to heat engines, and illustrate Entropy and, T-s diagrams of Heat Engine Cycles;*
3. *Carry out study of combustion of fuels, analysis of the products of combustion and explain the calorific properties of fuels;*
4. *Evaluate Gas and Steam Cycle plant and how to improve the efficiency.*

Unit: ETMEC-606-1806 - Fluid Mechanics 1

Unit level (MQF): 6

Credits: 6

Unit Description

Fluids are a vital part of people's lives and a crucial part of engineering and technology. Knowledge of fluids is of paramount importance to an engineer. The understanding of their behaviour and phenomena is part of the formation of an engineer. This knowledge will provide the skills and tools for an engineer to practice the engineer's profession. In this unit the basic fundamental behavioural properties of fluids are delivered to the engineering students. The knowledge to be acquired in this unit, such as Bernoulli's theory, have to become second nature to the engineer.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Solve engineering problems using basic properties and behaviour of fluids;*
2. *Apply the Bernoulli Equation to assess and determine fluid flow parameters;*
3. *Apply Similarity and Dimensional Analysis to derive and understand Dimensionless Groups and their importance in engineering;*
4. *Assess and solve engineering problems involving Boundary Layers, Flow in Pipelines and incompressible Drag on bodies.*

Unit: ETMEC-606-1807 - Mechanics of Machines 1 - Dynamics and Kinematics

Unit level (MQF): 6

Credits: 6

Unit Description

This unit will provide the learner with the knowledge of the movement characterization and the movement analysis of particles and rigid bodies. Furthermore, it provides opportunities for learners to develop integrated skills necessary to apply relevant kinematics and kinetics energy and momentum methods in various problem solving processes. Learners will analyse the kinematics and kinetics problems in rectangular, cylindrical and curvilinear coordinate systems; in two and three dimensional systems.

The learner will be able to distinguish between scalar and vector quantities. The student is introduced to vector quantities in order to determine the position vector of an object or particle. By using the vector notation, the students will be able to solve practical examples and determine the displacement, velocity and acceleration of particle or rigid body. Different types of coordinates are introduced such as Cartesian, path, polar and cylindrical coordinate system. The learner will be able to solve problems related to Kinematic of rigid body, in both translational and rotational motion. This unit will also cover the principles of impulse and momentum, work and energy, analytical dynamics and conservation of forces.

In the last learning outcome, the learner is introduced to the fundamentals of vibrations and simple harmonic motion. The learner will be able to identify the difference between transient and simple harmonic vibration. This will definitely help the learner to understand other units in the following years.

Case studies of engineering applications will be also covered. Furthermore, this unit will enable the students to apply learnt methods to real world applications. For each topic covered through the course, illustrative numerical examples are provided. For a better understanding of the course, some mathematical background in differentiation and integration is desirable.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Apply fundamental principles and methods of Kinematics and Kinetics;*
2. *Analyse the motion of particles in a rectangular, cylindrical and curvilinear coordinate system and the motion of rigid bodies in two and three dimensional systems;*
3. *Determine the inertia descriptions of a rigid body relative to reference coordinate systems;*
4. *Define and solve problems in kinematics and dynamics and make appropriate assumptions for the problems of kinematics and dynamics;*
5. *Carry out the mathematical formulations for the kinematics and dynamics.*

Unit: ETDSN-606-1801 - Engineering Design and CAD

Unit level (MQF): 6

Credits: 6

Unit Description

We make use of and interact with a variety of man-made products on a daily basis – this can be a bus, car, smartphone, toothbrush, alarm clock, laptop, just to mention but a few. Despite the differences in the intended function and complexity, which exist amongst these artefacts, they have something in common – they were designed.

The scope of this unit is to equip learners with understanding of and knowledge on the process involved to design man-made products. Aspects such as customer requirements, design parameters and design information will be covered. Furthermore, this unit will provide learners with knowledge on how to systematically approach and solve a design problem via the use of tools in different stages of the engineering design process.

Besides products that are utilized in everyday life, there are other complex technical systems which are designed and employed specifically in product development. Examples of such technical systems include tooling, automation lines and entire factories. Although the focus of this unit is placed on the engineering design of artefacts, the underlying principle of the various design tools covered can also be employed to design the aforesaid technical systems.

Customers are expecting more and more functions from a product, making it increasingly complex. This in turn is putting additional pressure on designers and other product development stakeholders, to develop products in a shorter period of time and put them on the market with a competitive price. In such a product development scenario, computer-based technology is becoming part and parcel of engineering design. This unit will look into this aspect too.

By end of this unit, learners should be able to understand the progression of the engineering design process. By making use of the right tools, learners should also be able to identify the customer requirements and generate a product design specification. In addition, learners should have gained sufficient knowledge to develop new concepts, analyse and evaluate them. Finally, learners should demonstrate understanding on how computer-based technology is employed in engineering design.

This is a learning-by-doing type of module, where students will be given the opportunity to apply the knowledge gained to solve engineering design problems.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe the engineering design process;*
2. *Identify the customer and design requirements and generate a product design specification;*
3. *Synthesise, analyse and evaluate design solutions using the correct tools;*
4. *Demonstrate the use of computer-based technology in engineering design.*

Unit: ETMEC-606-1804 - Applications of Pneumatics and Hydraulics

Unit level (MQF): 6

Credits: 6

Unit Description

The unit aims to develop understanding of fluid power systems in terms of their working and representation using recognized standards. The unit also develops skills to produce variety of designs. The unit provides opportunities to the students to evaluate the use of fluid power technology for various industrial applications and to make an informed decision in selecting the appropriate ones.

The unit is split into four learning outcomes. The first learning outcome deals with introduction of fluid power symbols using international standards or national standards. Students will read, interpret and explain the diagrams made using these symbols for pneumatic and hydraulic systems.

In Learning Outcome 2, students will study the construction, operation and function of given pieces of equipment. They will analyse and compare the performance characteristics of pneumatic and hydraulic equipment. These characteristics relate to operational, volumetric and isothermal efficiency as well as compression ratios and losses.

Learning outcome 3 primarily is about design of various pneumatic and hydraulic systems involving directional control, sequential operations and dealing with multi-actuators, regenerative and counterbalance circuits. Electro-pneumatic and electro-hydraulic circuits as well as fail-safe circuits are also included.

Students are given the opportunities to evaluate a given industrial application and to select an appropriate pneumatic and hydraulic system for the given application in learning outcome 4. Students will thoroughly investigate technical aspects such as procedures for installing and commissioning. Students will also evaluate commercial aspects such as initial costs, operational and maintenance costs and adaptability of the system for any future changes Health and safety regulations will be investigated and examined.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Interpret fluid power diagrams;*
2. *Explain the performance characteristics of pneumatic and hydraulic equipment;*
3. *Design pneumatic and hydraulic circuits;*
4. *Select appropriate industrial applications.*

Unit: ETE&E-606-1802 - Fundamentals of Electrical and Electronics Technology

Unit level (MQF): 6

Credits: 6

Unit Description

This unit provides the learner with the fundamental building blocks of electrical and electronics technology which would enable him to understand the design and operation of basic electrical and electronics systems.

The unit is basically split in two main sections. The first section which consists of two learning outcomes, starts by looking at concepts of Analogue electronics. Though there is a substantial shift towards digital technology and processes, analogue electronics retains a fundamental role in circuit design. This course provides the underpinning theory of semiconductor devices, starting with the pn junction and progressing to the operation of the Bipolar Junction Transistor (BJT). The characteristics and modelling of the BJT are discussed together with different biasing techniques.

The second learning outcome then deals with concepts of digital electronics. Digital technology forms the backbone of our technological society. Digital technology presents in the form of microprocessors and ASIC technology is found everywhere. An engineering student needs a solid introduction to the formal logic underpinning digital electronics especially as digital design is becoming more abstract.

In the final two learning outcomes this unit develops further to cover the basic principles of dc and ac circuit theory. The learner is introduced to D.C theory, and electrical principles and taught how to adopt the relevant circuit laws to series and parallel circuits and networks. The unit then introduces single-phase a.c. circuit theory and its application to series and parallel RLC circuits. Circuit and Transformation theorems such as Norton's, Thevenin's and Superposition analysis are also applied to d.c. and a.c. networks.

As part of the learning experience, learners will be given the possibility to try out typical laboratory tests and practical exercises. The selection of such tests will be at the institute's discretion however it is important that the practical work fully complements the theoretical knowledge.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain the basic principles of analogue and digital electronics;*
2. *Explain and analyse basic analogue electronic circuits;*
3. *Explain the principles of DC electrical theory and be able to analyse and design complex DC circuits and networks;*
4. *Explain the principles of AC electrical theory and be able to conduct complex single phase AC calculations.*

Unit: ETMTS-606-1801 - Strength of Materials 1

Unit level (MQF): 6

Credits: 6

Unit Description

This unit will provide the learner with the knowledge required to analyse direct stress and shear stress, compound stress and strain, shearing force and bending moments and bending stress. This unit is part of the basis of any engineering course and designed in a comprehensive way where the learner is introduced gradually to interrelated topics until the learner comprehends the final learning objective.

The learner will be able to use the elastic material properties to find the required information. Furthermore, the learners will be able to analyse the behaviour of different materials under different loads and temperatures and determine operational factor of safety.

In the second learning outcome, the learner is introduced to the theory of elastic failure in two dimensional and three dimensional systems. On completion of the learning outcome, the learner will be able to analyse various structures and materials widely used in engineering.

The third learning outcome provides the learner with the underpinning knowledge required to analyse shearing forces and bending moments. Furthermore, learners will investigate the theoretical behaviour of structural members under load and will verify the characteristics by experimental testing. The learner will be able to distinguish between concentrated loads, uniformly distributed loads, combined loads and varying distributed loads.

In the last outcome, the learner is introduced to bending stress and moment of inertia. The learner will be able to identify combined bending and direct stress on different structures such as composite beams and reinforced concrete beams.

For each topic covered through the course, illustrative numerical examples are provided. For a better understanding of the course, some mathematical background in differentiation and integration is desirable.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Investigate the stresses and strains in static engineering components;*
2. *Determine the principal stresses, principal strains and volumetric strains of two and three dimensional stress systems;*
3. *Analyse the bending moment of different structures and loads;*
4. *Calculate the stress concentrations in bending.*

Unit: ETMEC-606-1808 - Workshop Practice

Unit level (MQF): 6

Credits: 6

Unit Description

This unit shall provide standard workshop safety regulations and procedures which are essential for the learner to work in a safe environment. This will provide the learner with safety procedures that will need to abide to when performing workshop practices for one's own safety, the safety of the other adjacent operators, as well as the safety of the work itself.

Through this unit the learner shall be made knowledgeable of the basic workshop tools as well as their proper usage. Such tools would include general hand-tools as well as pneumatic and/or electric tools. The learner shall be made aware of the different practices that can be applied using the basic tools and machinery available in a workshop.

An important part of the workshop practise is the methodology of measuring and marking. The learner shall understand the different skills of measuring and marking for the different materials that the learner shall be using.

This unit will provide the opportunity for the learner to obtain a hands-on experience of using a number of basic workshop practices to perform a specific component. The learner shall have to interpret a drawing of the respective component, choose the correct tools and practices respectively, as well as maintaining a safe working environment.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the properties of engineering materials;*
2. *Understand common machining methods;*
3. *Describe common engineering joining processes;*
4. *Carry out basic workshop practices by following safe working procedures;*
5. *Identify workshop tools and their correct usage;*
6. *Apply different methods of measuring and marking to produce accurate drawings;*
7. *Implement the general workshop practices through hands on training.*

Unit: ETWBL-603-1802 - Work Based Learning Internship – Part 1

Unit level (MQF): 6

Credits: 3

Unit Description

The main objective of this unit is to give the B.Eng. learners a first-hand opportunity to experience real life situations within the different areas of the engineering sector. In this Work based Learning Internship, the learners are presented with engineering issues, from different industries which are accompanied with tight deadlines that the learners must respect when conducting a given task by a superior.

This unit has been purposely designed to be carried out at the end of the first year to serve as an introduction to the Problem Based Learning Unit (6 credits) which will be delivered during the third year of the programme.

Learners are expected to work as autonomously as possible. Tutors are only expected to supervise their work and provide them with minimal guidance. Hence, learners are expected to work on their own initiative. This unit will also offer learners the opportunity to establish work relations with local industry and to network within the engineering community.

Unit: ETMTH-606-1811 - Mathematics for Engineers 2

Unit level (MQF): 6

Credits: 6

Unit Description

The principal aim of this unit is to provide students with mathematical knowledge and skills that are necessary to support their concurrent studies as well as possible subsequent studies. This unit will allow students to create a link between mathematics and real world engineering problems.

In this unit, learners are required to analyse and make use of the necessary analytical skills in order to model and solve practical engineering problems. Being an advanced topic, it is important that students following this unit would have obtained Mathematics for Engineers 1 previously and would have a strong mathematical background, with a particular sound knowledge in calculus and differential equations.

The unit is significant to learners aiming to further extend their knowledge of mathematics as a tool to provide solutions to a wide range of engineering problems, varying from mechanical to electrical fields. On completion of such unit, learners will understand how to solve ordinary differential equations using a variety of power series and Laplace methods, analyse mechanical and electrical systems in terms of stability, analyse complex waves using Fourier series as well as solve partial differential equations and rates of change problems involving stationary values.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Apply ordinary differential equations, both series and numerical methods to analyse, model and solve engineering problems;*
2. *Use Laplace transforms to analyse, model and solve engineering problems;*
3. *Use Fourier series to analyse, model and solve engineering problems;*
4. *Apply Partial Differential Equations to analyse, model and solve engineering problems.*

Unit: ETMEC-606-1811 - Thermodynamics 2

Unit level (MQF): 6

Credits: 6

Unit Description

This unit first focuses on the mechanisms of heat transfer. It is important for the learner to understand the differences in the methods of how heat behaves in materials and objects. The basic theories of heat by conduction through solid and composite materials are the basis of understanding heat flow. Further to these, types of convection and the radiation behaviours of heat must also be known. These are then amalgamated in to the combined heat transfer which is more realistic. Applications of these theories are investigated.

In the second part, the unit focuses on practical aspect of common engines and machinery.

Study of the 4-stroke and 2-stroke internal combustion engines vis-à-vis their performance and emissions. Parameters which affect their performance and the exhaust emissions are of paramount importance in today's world. The unit ends with consideration to compressors, both reciprocating and rotary.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Solve engineering problems on the different forms of heat transfer mechanisms;*
2. *Analyse problems related to convection in external/internal flow or mixed;*
3. *Evaluate the performance of internal combustion engines and jet propulsion;*
4. *Understand reciprocating and rotodynamic machinery.*

Unit: ETMEC-606-1812 - Fluid Mechanics 2

Unit level (MQF): 6

Credits: 6

Unit Description

This unit must only be attempted by the learner if Fluids 1 has been successfully completed. The unit is focused more on hydrodynamics and the behaviour of fluid in fluid machines. Theory is considered with the practical aspect in mind. The students are to operate fluid machines such as centrifugal pumps, positive displacement pumps, and water turbines. This equipment is available. The students should be made to measure the parameters during the operation. Then using the data collected, apply the theory to deduce and calculate the performance of these machines. In such a way, the limitations and possibilities of real equipment will become aware to the students.

In this unit, the current Global Warming issues are addressed in the form of a brief study of Alternative and Renewable Energy technologies. Once again a practical approach is taken in choice, sizing and application of wind turbines. Ocean technologies are examined. Students will gain a realistic view of the possibilities of these new technologies.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Explain the operation and application of Renewable Energy Machines and their impact on the environment;*
2. *Solve engineering problems on Pressure Transient and Surge Control;*
3. *Apply the Theory of Rotodynamic Machines;*
4. *Describe the performance of Positive Displacement Machines.*

Unit: ETMEC-606-1813 – Mechanics of Machines 2

Unit level (MQF): 6

Credits: 6

Unit Description

Mechanical engineering is the field of engineering engaged in the design, development, fabrication and operation of the power plants and auxiliary systems on various industrial and transport structures. Therefore, this unit will provide the learner the basic knowledge of different mechanisms, their method of working, forces involved and consequent vibration. Having basic knowledge in kinematics and dynamics of machines as well as the basic concepts of gears, gear trains, the mechanics of rigid bodies, and graphical and analytical kinematic analyses of planar mechanisms, learner will be able to understand and solve large number of engineering problems in practice.

Mechanics of Machines is designed for graduate courses in kinematics and dynamics of machines. It covers the basic concepts of gears, gear trains, the mechanics of rigid bodies, and graphical and analytical kinematic analyses of planar mechanisms. In addition, the lecturer will describe a procedure for designing disc cam mechanisms, discuss graphical and analytical force analyses and balancing of planar mechanisms, and illustrates common methods for the synthesis of mechanisms.

Case studies of engineering applications will be also covered. Furthermore, this unit will enable the students to apply learnt methods to real world applications. For each topic covered through the course, illustrative numerical examples are provided. For a better understanding of the course, some mathematical background in differentiation and integration is desirable.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Apply knowledge of kinematics and dynamics of machines;*
2. *Understand concepts of gears, gear trains and the mechanics of rigid bodies;*
3. *Use graphical and analytical kinematic analyses of planar mechanisms;*
4. *Understand theoretical and practical knowledge of friction, gearing and cams, balancing and vibration in different machines and systems.*

Unit: ETMTS-606-1802 - Engineering Materials

Unit level (MQF): 6

Credits: 6

Unit Description

The aim of the unit is to provide underpinning knowledge about the essential properties of engineering materials, how these properties are tested including interpretation of test results and then compare the results with the published data. The basic atomic arrangements and structures of the most common engineering materials will be analysed.

In understanding and developing the above, the learner will apply the principles of chemistry and physics to understand how the properties of materials depend on chemical bonding, atomic and molecular arrangements, crystal structures and microstructures.

Essential engineering materials are alloys. Students will be introduced to the concept of a material and derivation of its alloys by adopting variations in chemical composition and structure. In view of this, special emphasis will be made on steel. Learners will be introduced to the iron-carbon phase diagram for the development of various steel compositions. The effect of carbon content, as well as content of other alloying elements on steel properties will be explained thoroughly.

Engineering material properties may be developed through tailor made heat treatments and may vary depending on the method of processing, for instance whether the manufacturing process is carried out in the liquid or in the solid state. Heat treatments ranging from basic quenching to more advanced treatments such as annealing and normalizing will be covered. Liquid and solid processing will also be discussed in some detail. The resulting variation in engineering material properties associated with heat treatments and/or processing method will be analysed in depth.

All of the aforementioned knowledge will help future engineers choose materials suitable for given products and/or applications in the engineering industry. For instance, students will investigate a treatment performed on a specific steel and apply the knowledge gained to select a processing method suitable for a given product and its service conditions. In this manner, the learner is capable of performing a material selection exercise by controlling the properties required from an engineering material while recognizing that costs and environmental factors are also crucial.

Important engineering materials are also ceramics, polymers and composites. The use of these materials in engineering will be covered in some detail. With respect to ceramics, carbides and nitrides, used especially in engineering tools will be given the necessary importance. Students will analyse how the combination of two different materials results in a material with unique characteristics that can never be achieved from one material family – a composite material.

The final section of the unit will be focused on an in depth understanding of degradation and failure mechanisms for metals and their alloys, ceramics, polymers and composites. Learners will be made aware that failure could occur earlier than expected if the service conditions are changed drastically or if the product is not maintained correctly. Failure mechanisms such as fatigue, creep, corrosion and combined mechanisms will be investigated thoroughly to be able to recommend remedial and preventative measures to avoid or retard failure.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Distinguish between engineering materials through analysis of their properties and understand the relationship between atomic bonding, structure and properties;*
2. *Understand the principles of the heat treatment and processing of various materials and the resulting influence on essential properties;*
3. *Examine failure mechanisms of engineering materials and recommend remedial and preventive measures to avoid failure.*

Unit: ETPLN-606-1801 – Condition Monitoring and Fault Diagnosis

Unit level (MQF): 6

Credits: 6

Unit Description

The main aims of the unit are; to provide an understanding of condition monitoring techniques and its importance in engineering system. That will enable the learners to analytically diagnose and locate the faults with suitable techniques.

In order to run the industrial processes, power generation plants and many other engineering systems consistently and for reasonably long periods of time, engineers have to ensure that the condition monitoring is in a place. This is an essential element of preventive maintenance and it can be of great assistance and can indicate the signal(s) for intervention to avoid expensive failures and system shutdown. The condition monitoring provides the data which can be used to assist in the planning and adjustment of a preventative maintenance programme.

This unit observes the overall concepts of condition monitoring which includes the causes of failure, methods of monitoring and the data analysis. A range of condition monitoring techniques which are used to detect leaks, corrosion and cracking in engineering systems and plant will be studied by learners at later stage.

In order to diagnose, locate and identify system faults learners will apply a range or check, tests, and other techniques. Finally, investigation will take place by learners on the more common causes and effects of failure and, using a range of techniques, learners will analyse the cause and effect of such failure(s) on system performance.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe the importance of condition monitoring in engineering system;*
2. *Identify and describe the affecting factors on condition monitoring techniques in engineering system;*
3. *Diagnose, Identify and locate the faults in the system;*
4. *Analyse and evaluate the importance of fault diagnosis techniques in engineering systems.*

Unit: ETELX-606-1822 – Programmable logic Controllers

Unit level (MQF): 6

Credits: 6

Unit Description

This unit is designed to introduce students of the mechanical engineering discipline to the makeup, working principles and applications of Programmable Logic Controllers (PLC). The unit has an emphasis on enabling students, with no programming or electrical engineering background, to appreciate and understand the operation and applications of PLC employed to monitor, automate and control real life systems.

Outcome 1 introduces learners to the fundamentals of electricity and electronic devices such as logic gates' operation. Examples of mechanical systems and their resemblance with electronic and electromechanical ones are used to facilitate better understanding of the logic behind these systems. The outcome also familiarises learners with binary number system and binary logic which stand at the heart of any computer-based system.

The examination of control systems' fundamentals and the employment of new technologies driving modern control systems, such as computer-controlled ones, are addressed in outcome 2. Exposure to analogue and digital sensors and actuators as input and output devices are explored to familiarise learners with modern sensors and actuators' technologies and their uses.

The working principles and basic architecture of a typical microprocessor-based control system such as PLC are examined in outcome 3. The generic model of data processing is used to demonstrate how analogue or digital inputs are processed by programmes to produce desired outputs driving varieties of output devices. Intelligent sensors are introduced to highlight how high technologies can improve systems' performance and effectiveness. Programming concepts are introduced through the use of structured programming, pseudo code or flow chart techniques as a way to develop learners' logical programming skills. It also introduces learners to low level programming and visual programming used in PLCs.

Outcome 4 provides the learner with the opportunity to investigate and examine varieties of PLC's applications including modern intelligent applications. Integrating PLC's applications to allow effective communication among controllers is explored.

Hierarchical system such as SCADA is explored as new development in the automation of large scale control systems.

Learning Outcomes

On completion of this unit the student will be able to

1. *Examine logic circuits and their operations;*
2. *Examine the principles of control systems;*
3. *Describe PLC's working principles, architecture and programming concepts;*
4. *Investigate PLC applications.*

Unit: ETENG-603-1804 – Environmental Engineering

Unit level (MQF): 6

Credits: 3

Unit Description

The unit is designed to familiarize the student with the concept of Environmental Engineering within the context of Sustainable Development. The development of human activity and the impact on the environment and climate will be discussed in the light of the methodologies and technologies available to mitigate and were possible eliminate the negative effects of population and economic growth.

The Unit will describe the concept of Sustainable Development and outline the principle treaties and international agreements which have shaped the commitment towards mitigating the effect of human activity. Particular note will be made of Malta's obligations in this respect under the overall EU agreements.

The Unit will expose the student to the methodologies and technologies being developed to address environmental issues in the areas of –

- The generation and elimination of Waste –through the 3 Rs, with a focus on recycling;
- Efficient use, harvesting and extraction of water;
- Waste water recovery and re-use;
- Sources of and controlling emissions from power generation, transportation and industry;
- Control and reduction of industrial effluent;
- Building efficiency and intelligent control of building services to reduce consumption of utilities.

The above will be described within the concept of designing for Sustainable Dwellings, Industrial Buildings and Plants, Hospitality and Commercial complexes. The role of Environmental Engineering in relation with other disciplines will be described.

The principle of Corporate Social Responsibility as a means of contribution by Industry towards supporting local communities with environmental activities will be discussed within the general concept of Environmental Ethics.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Learn about the Principles of Sustainable Development as described in successive International Treaties starting from the Kyoto Protocol. Understand Malta's obligations through the EU directives;*
2. *Develop an appreciation of the different perspectives of environmental issues, the effect on communities and the importance of environmental ethics;*
3. *Learn about the methodologies and technologies available to mitigate or eliminate the environmental impact of human and industrial activity;*
4. *Explain the role of the Environmental Engineer within society and the contribution made towards addressing Environmental Issues in conjunction with other professional disciplines.*

Unit: ETENG-606-1805 - Energy Management

Unit level (MQF): 6

Credits: 6

Unit Description

The Unit is designed to offer learners a perspective on the principles of Energy Management in the light of the current emphasis being made in efficient utilisation of energy and resources backed by appropriate legislation and the drive by industry to attain cost-effectiveness.

The need to address Energy Management is driving new technologies which, when correctly implemented, lead to better efficiency, cost-reduction and minimise impact of the operation on the environment without affecting the quality of the product or service being delivered. Recent legislation such as LN196:2014 implements the EU directives which impose proper Energy Management on large Industry and promote similar voluntary measures on smaller entities. As awareness of the impact of industrial activities on the environment increases, there is a proportionate cultural increase in awareness which aids in the implementation of Energy Management.

The basis of any Energy Management system is to first understand how energy is being used and this is best achieved by appropriate Energy Audits led by accredited expert Engineers. This unit is designed to familiarise learners with appropriate environmental and audit standards with an emphasis on criteria developed in ISO 50001 and ISO 50002. The unit will explain how to implement monitoring activities which assist in keeping energy use under control and provide data for continuous improvement programs.

The unit will also discuss activities designed to engage all stakeholders within an enterprise towards implementing a culture of eliminating energy waste.

The Unit will provide a description of control system such as BEMS and REMS used within different industries which enable better energy management.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the principles of Energy Management;*
2. *Evaluate and understand Protocols, Directives and Legislation obliging or encouraging Energy Management;*
3. *Plan and execute Energy Audits based upon ISO 50002;*
4. *Plan monitoring and control systems designed to optimise energy efficiency and enable continuous improvement.*

Unit: ETMTS-606-1803 – Strength of Materials 2

Unit level (MQF): 6

Credits: 6

Unit Description

This unit will provide the learner with the knowledge required to analyse stress and deflection of beams, torsion, springs and struts, thick/thin cylinders and spheres. This unit is part of the second year engineering course and designed in a comprehensive way where the learner is introduced gradually to interrelated topics until the learner comprehends the final learning objective.

The learner will be able to use the elastic material properties and different cross sectional areas to find the required information. Furthermore, the learners will be able to analyse the behaviour of different cross sectional beams under different loads. Thus determine the deflection of a beam and the students will verify the results by experimental testing. The learner will be able to distinguish between concentrated loads, uniformly distributed loads, combined loads and varying distributed loads.

In the second learning outcome, the learner is introduced to torsion in different cross sectional areas such as thin tubular and thin cellular sections. On completion of the learning outcome, the learner will be able to analyse various structures and materials widely used in engineering.

The third learning outcome provides the learner with the underpinning knowledge required to analyse different springs such as close and open coiled helical springs, leaf and flat spiral springs. Furthermore, learners will investigate the theoretical behaviour of structural members such as struts and ties under axial and eccentric loads. Different connections will be considered such as pin ended, fixed from both sides and partially fixed.

In the last outcome, the learner is introduced to stress and strain in thick/thin cylinders and spheres under internal pressures. The learner will be able to identify combined loading and determine volumetric strains of cylindrical and spherical shells.

For each topic covered through the course, illustrative numerical examples are provided. For a better understanding of the course, some mathematical background in differentiation and integration is desirable.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Investigate the stress and deflection of beams;*
2. *Determine torsion in different cross sections;*
3. *Analyse springs and struts;*
4. *Calculate the stress and strain in thick/thin cylinders and spheres.*

Unit: ETWBL-603-1803 - Work Based Learning Internship - Part 2

Unit level (MQF): 6

Credits: 3

Unit Description

Work-based Learning in engineering aims to equip learners with the skills that can improve their technical and social abilities and therefore their employability. It aims to ease the transition from the College to the place of work. “Internship” is a form of work based learning where the learner carries out work-related tasks and activities with a degree of autonomy and under the direction of a knowledgeable work place mentor.

The main objective of this unit is to give the B.Eng. learners an opportunity to experience real life situations and apply problem solving skills to address every day issues within the different areas of the engineering sector. In this Work based Learning Internship, the learners are presented with engineering issues, from different industries which are accompanied with tight deadlines that the learners must respect when conducting a given task by a superior.

This unit has been purposely designed to build upon their first industry experiences and to consolidate their preparation for the Problem Based Learning Unit (6 ECTS) which will be delivered during the third year of the programme.

Learners are expected to work as autonomously as possible. Tutors are only expected to supervise their work and provide them with minimal guidance. Hence, learners are expected to work on their own initiative. This unit will also offer learners the opportunity to establish work relations with local industry and to network within the engineering community.

Unit: ETMTH-606-1812 - Mathematics for Engineers 3

Unit level (MQF): 6

Credits: 6

Unit Description

The aim of this unit is to investigate the analysis of vectors, which is an essential part of an engineer's scientific background.

The topics covered in this unit include the algebra, the differential and the integral calculus of vectors together with Stokes' theorem, Green's theorem and the divergence theorem and applications from various fields. Also included are the curvilinear coordinates which prove extremely useful in the solution of problems in advanced engineering, physics and mathematics.

In order to be able to follow this unit, students are required to have previously followed and achieved Mathematics for Engineers 1 and Mathematics for Engineers 2.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Determine Eigen Values and Eigen Vectors and analyse transformations of coordinate systems;*
2. *Use multiple integration to solve volume and surface integrals;*
3. *Use vector differential and integral calculus to analyze and solve field problems;*
4. *Apply integral theorems to solve integrals of scalar and vector fields.*

Unit: ETMEC-606-1522 - Vibrations

Unit level (MQF): 6

Credits: 6

Unit Description

Understanding mechanical vibrations is of fundamental importance when dealing with structures and machines that are exposed to mechanical vibrations, or generate mechanical vibrations during the operation. Typical examples of such structures include rotating machinery, motor vehicles, aircraft, machine tools, vibration transporters, civil structures (buildings, bridges, etc.), sensitive measurement or laboratory equipment that operates in vibrating environment, and so on.

Vibration assessment is crucial when designing such structures in order to avoid excessive vibration levels that may lead to degraded performance, or even loss of mechanical integrity and failure in more severe cases.

Vibration control, commonly classified into passive control (e.g. by use of dampers, vibration isolators, etc.), semi-active (by use of controllable passive devices such as magneto-rheological damper) and active control via sensors, actuators and controllers, has also gained significant importance due to high demands in modern machine performance, safety, passenger comfort, etc.

Other important vibration-related issues include noise, which is usually coupled with mechanical vibrations, vibration measurement and data analysis, occupational health and safety. All of these areas require understanding of fundamental vibration principles, as well as some advanced topics in vibration theory, systems and control theory and occupational health. This course provides a thorough treatment of vibration theory fundamentals, as well as some more advanced topics, which are relevant for most modern vibration engineering applications.

This course covers fundamental theory of vibrations, as well as some more advanced topics. A general overview of mechanical systems vibrations is provided, addressing issues such as vibration systems modelling, analysis, vibration control, etc. Vibration theory of discrete vibration systems is covered in detail. This includes topics on kinematics of periodic motion, natural (resonant) frequencies for single degree of freedom systems, forced vibrations (both steady-state and impulse response), and introduces damping (viscous damping, critical damping, over- and under-damping, etc.), harmonic excitation, support excitation, and so on. Vibration isolation fundamentals are discussed in some detail, as well as vibration measurement instruments principles. Furthermore, these results are generalized to multi degree of freedom systems and relevant matrix analysis methods are introduced. Such methods include modal analysis and several methods applicable for analysis of forced vibrations of multi degree of freedom systems.

As a special topic, vibrations of continuous media and transverse vibrations of beams are covered as well. For each topic covered thorough the course, illustrative numerical examples are provided. For a better understanding of the course, some mathematical background in ordinary differential equations and matrix analysis is desirable (although not necessary).

Learning Outcomes

On completion of this unit the student will be able to:

1. *Construct mathematical models of single degree of freedom vibration systems, understand basic properties of these systems and provide time domain solutions;*
2. *Understand vibration propagation and isolation, as well as vibration measurement principles;*
3. *Construct mathematical models of multi degree of freedom vibration systems;*
4. *Demonstrate basic knowledge of vibrations of continuous media, and software and mathematical tools for dealing with such systems (e.g. finite element method).*

Unit: ETELE-606-1815 - Electrical Power Systems

Unit level (MQF): 6

Credits: 6

Unit Description

This unit focuses on introducing 3-phase systems to other engineering disciplines to develop an understanding of their fundamentals.

In outcome 1 the learners will have the opportunity to develop the necessary skills to analyse 3-phase circuits. Starting with recap on the fundamental concepts of single phase AC circuits analysis, and moving on to develop the required understanding of: how 3-phase supply is generated, the relationship between line and phase voltages and currents of Y and Δ connected balanced and unbalanced load, and concepts related to electrical power system economics.

In outcome 2 the unit provides the concepts of how power is calculated in 3-phase Y and Δ connected balanced and unbalanced load, and how to calculate the power as a complex quantity (apparent power) of active and reactive components. Learners will learn the required technique for measuring power using one, two and three watts' meter methods and when to use these methods.

In outcome 3 the unit provides the necessary knowledge to enable learners to describe electrical power system's stages and elements from the generation to transmission to distribution to industrial and domestic premises. It also introduces the learner to methods employed for protection of the system.

Outcome 4 is designed to provide the learners with the necessary fundamental knowledge of electromagnetism and magnetic circuits. This should develop an understanding of the structure and the working principles of 3-phase machines such as 3-phase induction motor, synchronous machines, and transformers.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Analyse electrical systems to determine electrical parameters;*
2. *Measure and calculate power of 3-phase system;*
3. *Describe electrical power systems;*
4. *Describe structure and working principles of 3-phase Electrical power machines.*

Unit: ETMTS-606-1508 – Materials for Plant Engineers

Unit level (MQF): 6

Credits: 6

Unit Description

The unit Materials for Plant Engineers covers scientific and engineering principles of different technical materials and joining processes of materials used for plants. In developing these principles, learners use chemistry and physics to understand how properties of materials depend on chemical bonding, atomic and molecular arrangements, crystal structures and microstructures.

This unit gives the learner a broad foundation in all classes of materials, including steels, copper and copper alloys, aluminium and its alloys, titanium and its alloys, polymers, but also in joining processes used in the manufacturing of different parts. Learners also learn how to use variations in composition and structure and different methods of processing to control properties of materials, recognizing that costs and environmental factors are also important.

This unit will introduce the learner to the science of solid materials used in plants. The unit content covers the most common materials for specific applications such as steels, cooper and copper alloys, aluminium and its alloys, but also more specific materials like titanium, polymers and ceramics. Lectures will cover properties of these materials from atomic and macroscopic points of view, typical fields of application, but also the problems which could appear during their life time in exploitation, their protection and prevention, maintenance and repair works. The mechanism of alloying and alloying systems for copper and aluminium alloys will be described. By use of iron-carbon phase diagram, the effect of carbon content, as well as the effect of other alloying elements on the properties of steel will be explained. Specification systems and standards (EN, DIN, AISI) for all materials for plants will be presented. Special attention will be given to joining processes for these materials. The basics of welding, soldering and brazing will be presented together with the most important parameters of each process.

This unit aims to provide the learner with fundamentals of materials for plant as well as joining processes used in plant engineering. The emphasis is on metal materials such as steel, aluminium and copper but also on titanium and special types of polymers. It will provide the learner with hands-on experience on material properties and selection for specific applications, their advantages, limitations with typical capital and running costs. It will provide the learner with the fundamental concepts of welding, soldering and brazing joining processes together with their descriptions and typical places of application.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the underlying principles of the interrelationships among structure, properties and processing;*
2. *Distinguish between the major types of materials for plants and how their properties can be calculated or determined experimentally;*
3. *Select and apply material for plant engineering systems;*
4. *Describe metal forming and joining processes of all classes of materials.*

Unit: ETPLN-606-1802 – Plant Operations and Performance

Unit level (MQF): 6

Credits: 6

Unit Description

This unit is designed to provide an in-depth understanding on the design, layout, installation, commissioning and efficient operation of an Engineering Plant Room.

The unit will cover the major elements in a typical industrial plant room namely, Space Heating Equipment, Space Cooling Equipment, Water Heating and Cooling, Ventilation, Water Supply for First and Second Class Systems, Water Production and Recovery, Chillers and Boilers including utilising different fuels, Compressed Air, Fuel Storage, Fire Fighting Systems and integrated control via Building Energy Management Systems.

The Unit will discuss the concept of equipment redundancy for security of service.

The Unit is designed to serve as a basis for understanding correct installation and efficient operation of a service plant room. On Achieving the Unit, the learner will be able to correctly design and evaluate the implementation of specific services through the commissioning phase. The learner will be able to establish the correct parameters for Key Performance Indicators with which to evaluate the efficient operation of the plant equipment and the controls necessary to achieve this.

The Unit will also cover the critical elements of Legislative obligations in operating plant equipment including the Legal Requirements related to Lifting Equipment which may be installed in Plant rooms.

The content is designed to serve as the foundation for further specialisation in the field of Building Services Engineering.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Comprehend clearly the requirements of the Plant room and designate the correctly specified equipment and layout of the installation;*
2. *Establish Commissioning Criteria to evaluate the correct performance of the installation to the design specification;*
3. *Establish the Key Performance Indicators and a monitoring System to correctly assess the efficient operational performance of the equipment;*
4. *Comprehend the Legal Requirements in Operating and Maintaining Plant Equipment and the basic Criteria of Health & Safety Obligations.*

Unit: ETENG-606-1505 - Control Engineering

Unit level (MQF): 6

Credits: 6

Unit Description

The objective of this unit is to introduce the learner to the integration of control systems within multi-disciplinary dynamic engineering fields such as mechanical, electrical, thermal, flow, environmental, biomedical, energy, etc., which seek to have their systems and sub-systems automatically regulated.

Today's mechatronic devices, manufacturing and heavy plant industries are being faced with an increase in demand, better quality, lesser impact on the environment and above all, operate at a much lower competitive cost. These contradictive requirements are very difficult to attain unless the systems and sub-systems embedded within the various applications and structures are constantly being observed and intelligently controlled. This unit allows the learner to grow in understanding what it entails to design, operate and monitor such systems unmanned whilst adhering to optimal and stringent performance specifications. Representative cases of such systems and sub-systems are endless starting off from smart sensors and actuators, smart home applications, biomedical applications, automotive technology, intelligent material handling, advanced manufacturing and automation, fabrication, HVAC systems, reverse osmosis, power plants, water treatment facilities, aircraft and space technology, marine applications, the list is endless. Control engineering is significant in reaching out to the next industrial goal - Industry 4.0.

Control system engineering essentially addresses the study of these multidisciplinary fields through mathematical modelling whilst investigating and validating the response of such models by means of appropriate control systems simulation software packages. These analytical evaluations and simulations aim at developing integrated hardware and intelligent controllers that will force such systems to behave in the most appropriate methodology. Such simulation packages will not only address the response of the systems under specific operating conditions but even evaluate the validity and robustness of the controller design when such systems are presented with influential performance factors such as disturbances and noise. Better still, such simulation packages in this way even provide system and/or controller prototyping and verification prior to the actual physical development. The fact that the cost of microprocessors and microcontrollers has drastically reduced over the years, it has made it more attractive for controllers to be electronically driven. This fact highlights the need for mechanical and manufacturing engineering learners to become aware of such technologies and learn how to integrate microcontrollers with existing multidisciplinary fields.

In light of the above, this unit seeks to introduce the learner to the basics of control systems engineering by reviewing arguments, both in favour and against, the need of implementing controls systems procedures in the development of today's goods and services. Given that feedback is an important asset of control systems, an understanding of the closed-loop architecture and its functional requirements is necessary. Systems and subsystems are then represented using appropriate control systems techniques such as block diagram reduction, signal flow analysis, Mason's theorem; with the latter two techniques being predominantly focused on SISO systems. In view that today's systems are mainly MIMO type, modern control systems theory is addressed through state-space analysis. The block diagram representation carried out is then amalgamated with representing the physical systems analysed mathematically through differential equations and subsequently converted into Laplace transformation rules. This approach is particularly helpful when utilsing software simulation packages such as MATLAB/Simulink to code/describe, in block diagram format, the systems and sub-systems under consideration; thus attaining the resulting behaviour in relation to the time-domain characteristics. The dynamic and steady-state responses acquired can be subsequently evaluated when such systems are subjected to standard test input signals. Both software simulation packages as well as analytical tools are addressed to help the learner understand how to evaluate the systems' open-loop/closed-loop stability. In this way appropriate three-term industrial controllers or compensators can be designed. Lastly, this unit gives an opportunity to learners in integrating areas from the above work within a practical engineering scenario through the development of a basic closed loop control system via a suitable microcontroller.

In conclusion, this unit is suitable for mechanical and manufacturing engineering learners who wish to acquire the necessary fundamental knowledge and concepts within control systems technology to optimise and/or develop better, intelligent and sustainable system solutions for our future.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Review classical and modern control theories as applied in engineering systems;*
2. *Examine mathematical models for control systems and subsystems;*
3. *Study the stability of control systems;*
4. *Analyse the use of microcontrollers in closed-loop control systems.*

Unit: ETPLN-606-1504 - Plant Design

Unit level (MQF): 6

Credits: 6

Unit Description

Changes in the market and the rapid development of computer technology have resulted in re-industrialization of the existing industries. Production of standard products for the warehouse is replaced by the individual production according to customer requirements, which requires the design of complex products with many variants by performing the simultaneous application of new materials and new technologies. Increasing complexity of the product causes an extension of time to develop new products, which is in contradiction with the demand for shorter delivery times of products. Hence the need to design both products and production systems simultaneously.

These conditions put increasing demands on the designer of plant design.

The aim of this course is to introduce students with the methodology of designing a production system, which can help designers to achieve solutions that meet technical and economic criteria. Lectures follow current design of the production system of defining the product range and develop the technological processes by general and detailed design of production systems. In addition to the above definition of manufacturing equipment, there are basic guidelines for the design of transport and warehouse systems.

The introduction shows the factory as a system, and provides the basics of designing plant design. In order to understand the factory as a system, it briefly explains the theory of its classification, hierarchy, structure, modelling, and these elements of the production system. It defines objectives, features, basic principles and types of tasks in the plant design to be met with plant design (designing a new plant, reconstruction of the existing production system to the extension area, rearrangement of individual departments/machines, and introduction of smaller rationalization of production process).

Learning Outcomes

On completion of this unit the student will be able to:

1. *Discuss the basics of the organisation of production systems, especially lean management (Value Stream Management);*
2. *Produce a feasibility study: from defining production program and plant location, over capacity determination (number of machines, personal, areas, infrastructure) to budget cost-effectiveness;*
3. *Understand the concept of material flow analysis and design of transport systems and warehouses;*
4. *Understand basic types of layout and use of methods for layout planning and use of simulation as means for optimisation of production system.*

Unit: ETMTS-606-1509 – Material Loss, Prevention and Protection

Unit level (MQF): 6

Credits: 6

Unit Description

The aim of this course is to provide the fundamental knowledge of material loss, as well as methods for prevention and protection, required for an engineering degree. This course covers a broad approach to the phenomenon of materials loss, including corrosion and wear, and various procedures and techniques for prevention and protection of material.

The first part of the course covers the theoretical aspects of electrochemistry through the chapters: Electrochemical systems, Electrolysis, Electrochemical cells, Oxidation-reduction (redox) reactions, Electron transfer reactions, Electrolyte solutions (ion-ion and ion-dipole interaction), Electrochemical potential and Electrode potential.

The second part Corrosion of Metals, refers to the different types of corrosion (chemical corrosion, galvanic corrosion, pitting, cavitation, crevice, fretting, intergranular corrosion, leaching, selective leaching, dezincification, erosion, etc.) and susceptibility of different metals/alloys to different corrosion mechanisms.

The third part of the course refers to the theoretical basis of the types and mechanism of the material wear. Wear mechanism combine effects of various physical and chemical processes proceeding during the friction between two counteracting materials: micro-cutting, micro-ploughing, plastic deformation, cracking, fracture, welding, melting and chemical interaction. Types of wear mechanisms are: adhesive wear, fatigue wear, corrosive wear and erosive wear.

The last part considers corrosion and wear prevention and protection. Corrosion protection involves applying of protective coatings with an emphasis on paints, material selection and design, cathodic protection, stress relieving, insulation, alloying, etc.

Wear prevention and protection includes processes of heat treatment and surface engineering. These are processes of bulk heat treatments (annealing, normalizing, quenching, tempering and precipitation hardening) and other hardening mechanism such as age hardening, cold working, and surface modification processes such as carburizing, nitriding, carbonitriding, ion implantation, PVD coatings CVD coatings, electroplating and spray coatings.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand and apply fundamental principles of electrochemistry: redox reactions electrolysis, electrode potential, etc.;*
2. *Identify different forms of material loss explaining the mechanisms of corrosion;*
3. *Explain the mechanics of metal/alloys in rubbing or rolling contact and distinguish between the different form of wear;*
4. *Evaluate electrochemical techniques as well as the use of other processes, to protect real systems from corrosion;*
5. *Recommend process, such as heat treatments or surface modification treatments, used in wear protection to extend lifetime of low carbon steel machines parts.*

Unit: ETMEC-606-1814 - Problem Based Learning

Unit level (MQF): 6

Credits: 6

Unit Description

The main objective of this exercise is to give the B.Eng. students the opportunity to experience real life situations where they are presented with real life engineering issues, from industries and with tight deadlines.

To this end, students are assigned a particular task by our partners in the industry and it is the students' responsibility to carry out the task. Such tasks should take the form of industrial problems which perhaps the industry partner could not solve or did not have the time or resources to solve itself.

Students are expected to work as autonomously as possible. Tutors are expected to supervise their work and provide them with minimal guidance. Students are expected to work on their own initiative. This module will also offer students the opportunity to establish work relations with local industry and to network with the engineering community.

Unit: ETMTH-606-1813 - Mathematics for Engineers 4

Unit level (MQF): 6

Credits: 6

Unit Description

This mathematics unit provides an introduction to the finite element method in relation to engineering, rather than a purely mathematical point of view. However, the mathematical foundations of the method are presented along with their physical interpretations. The basic theory and several applications of the finite element method are presented.

For problems involving complicated geometries, loadings and different material properties, it is generally not possible to obtain analytical mathematical solutions. Hence we need to rely on numerical methods, such as the finite element method, for acceptable solutions.

To date, the Finite Element Method (FEM), sometimes referred to as Finite Element Analysis (FEA), is the most widely used numerical method for solving a variety of problems governed by partial differential equations in both static and dynamic areas of engineering.

This unit is designed to give learners a comprehensive introduction to the mathematics involved in the finite element method, a powerful numerical method for structural analysis, heat transfer problems, fluid flow, mass transport analysis, and electromagnetic potential solutions.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the basic ideas of the finite element method and how it is applied;*
2. *Understand the definition of truss, beam, membrane, plate, and continuum elements;*
3. *Formulate planar one-dimensional elements;*
4. *Analyse the formulation of plane stress/strain two-dimensional elements and identify the difference between these and planar one dimensional elements;*
5. *Apply the finite element method to model and analyse real-life engineering problems.*

Unit: ETMGT-606-1804 - Management for Engineers

Unit level (MQF): 6

Credits: 6

Unit Description

The aim of this unit is to provide the fundamental knowledge and the basic concepts in the field of organizational management, based on scientific approach. This course covers fundamental principles of what is management. The principles of what is Project Management will be introduced during the second part of this unit. During this section, the learner will have a general view of what it entails being a Project Manager. Finally, the concept of Scientific Management will be introduced during the last part of the unit.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the meaning of Management;*
2. *Understand the role of a Project Manager;*
3. *Understand and apply Fundamentals of Optimisation problems.*

Unit: ETELX-606-1823 - Power Electronics, Devices and Circuits

Unit level (MQF): 6

Credits: 6

Unit Description

This unit presents the devices and basic circuits fundamental to power electronics. A review of basic semiconductor devices used for switching is presented along with practical examples for driver circuits required for saturation/cut-off transitions. The operation, derivation of transfer functions and practical implementation of AC-DC and DC-DC conversion circuits is also studied. The unit is aimed at students developing strong design, practical implementation and analytical skills at both component and circuit level. Further power electronic circuits are studied in the module Power Engineering: Advanced Power Converters.

This unit requires as a prerequisite, Physics for Engineers, Analogue Electronics 1 and Electrical and Electronics Principles.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Evaluate the operation of power electronic switching and protection devices;*
2. *Investigate the operation of Rectifier Circuits;*
3. *Investigate the operation of DC-DC Converters;*
4. *Design and Testing of Practical Power Electronic Circuits.*

Unit: ETPWR-606-1501 – Alternative and Traditional Power Generation

Unit level (MQF): 6

Credits: 6

Unit Description

Energy is a driving force for modern civilization development, i.e. energy production and consumption are some of the most important activities of human life. Energy is at the very heart of sustainable development; it fuels economic growth and social development, at the same time, its production and use can also lead to environmental degradation, increase in local and regional pollution, and climate change.

Electricity (power) is one of the most useful forms of energy; it is equivalent to work to which is easily converted (and vice versa), it is clean and easily transported over long distances; and it could be said that the electricity is the most critical strategic infrastructure in our society today and its importance will increase in the future. Direct importance of electricity in reliably delivering energy to point of use enables every other major technological infrastructure in our society.

The power engineer builds and operates machines and plants in order to convert traditional and novel energy sources into useful forms. The role of the power engineer has changed over the past few decades by considering influences of the power generation (and use) on environment and climate change. The main task of sustainable power generation is a reduction of fossil fuel usage (energy efficiency of energy production) and an increase of energy use produced from renewable energy sources. This area requires from mechanical engineering learners that they should learn the matter not only in depth but also in width.

This course is designed to give participants a comprehensive introduction to basics of power generation methods including wide scope of different traditional and alternative technologies of power production.

In short, the objectives of this unit are: introduction to basics of power generation in accordance with sustainable development; deeper insight into the power plants and their components, cross-section of essential engineering concepts/principles from the domain of thermodynamics, heat transfer and hydro-(aero-) dynamics needed to understand a functioning of modern power plant, and an overview of the broad field of energy technology. Providing in-depth proficiency in a broad array of power generation technologies (and their technical, economic and environmental characteristics): traditional (based on fossil and nuclear fuels) and novel/alternative *(wind, hydro, solar, biomass/waste, fuel cells/hydrogen, geothermal, and ocean/tidal)*.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the principles of different power generation methods;*
2. *Describe all main components in a power plant (especially their prime movers), whether based of novel (alternative) or traditional technology;*
3. *Distinguish and compare different technical, economic and environmental aspects of power generation systems;*
4. *Get a future perspective of power generation technologies and understand main features of the future power generation methods.*

Unit: ETHVA-606-1510 – HVAC Systems

Unit level (MQF): 6

Credits: 6

Unit Description

The HVAC unit provides attendants a fundamental knowledge of the HVAC systems theory as well as a better insight into practical problems encountered in this area.

The Heating Ventilation and Air-conditioning (HVAC) unit incorporates the study of thermal and/or industrial comfort, designing, and installation methods of air-handling units in order to prepare technologists to fill the wide technological gap between HVAC service, HVAC technicians and HVAC engineers. This unit addresses challenges abound in manufacturing, contracting, building operations and in the engineering of commercial, institutional and industrial building systems.

Heating, Ventilating, and Air Conditioning (HVAC systems) include a range from the simplest hand-stoked stove, used for comfort heating, to the extremely reliable total air-conditioning systems found in submarines and space shuttles. Cooling equipment varies from the small domestic unit to huge refrigeration machines which are used in industrial processes. Depending on the complexity of the requirements, the HVAC designer must consider many more issues than simply keeping temperatures comfortable. This course will introduce fundamental concepts that are used by designers to make decisions about system design, operation, and maintenance.

This unit is mainly bisected into 4 main parts. The first part of HVAC covers the seven main processes (i.e. the processes and/or methods involved to control and maintain: (i) Heating, (ii) Cooling, (iii) Humidifying, (iv) Dehumidifying, (v) Cleaning, (vi) Ventilating, and (vii) Air Movement. The second part of HVAC is related to the design of ventilation systems for thermal comfort purposes according to the ASHRAE Standard 55. So, in this section, the objective is to provide and maintain internal air conditions at a predetermined state, regardless of the time of the year, the season and the external atmospheric environment. The third section focuses on the different modes of refrigeration cycles, mainly covering vapour compression and vapour-absorption cycles. While the fourth section focuses on the latest HVAC and refrigeration technologies, such as the variable refrigerant flow and/or volume (VRV’s / VRF’s), and the controls involved in dedicated HVAC building management systems (BMS).

In all four sections, the unit focuses on the technology involved in equipment used to provide the necessary in every process and/or cycle. Thus, AC compressors, heat exchangers, expansion devices, pumps, absorbers (water-ammonia) and (water-lithium-bromide), generators, controllers and instrumentational devices (devices used to measure temperature, air speed and humidity) are all reviewed.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Understand the main features and concepts of operation of HVAC systems, indoor air-quality (IAQ) and air distribution systems;*
2. *Understand factors influencing thermal comfort and describe methods how to use the psychometric chart and steam tables to design thermal comfort conditions and air-conditioning for industrial processes for both summer and winter periods;*
3. *Study the principles of refrigeration and cooling equipment for vapour-compression, vapour-absorption refrigeration systems, and heat pumps;*
4. *Assess standard practices related to the installation of air-handling units and the benefits offered by VRVs in combination to the control of HVAC systems via dedicated HVAC building management systems (BMS's).*

Unit: ETPLN-606-1505 - Plant Typology

Unit level (MQF): 6

Credits: 6

Unit Description

Plant engineers are faced with technical requirements of different plants. It is important that they understand their concepts, layouts and design characteristics. This unit is designed to provide students with a comprehensive introduction to different plant types as well as common needs of various plants such as technical logistics and supply with working fluids, first and foremost water, air/gases and steam. Equipment related to different plants will be considered according to designed capacity and production features. Bearing in mind that the majority of processes/operations in plant engineering require pressures different from the atmospheric pressure, an introduction to pressurised equipment will be presented.

The course will start with plant classification and public-oriented plants consideration. The majority of this unit consists of plant typology of industrial facilities, which means: production and assembly plants - including high-technology plants, process plants, chemical and pharmaceutical plants, and food/beverage plants, as well as water treatment – purification plants, waste and sewage recycling plants and at the end power plants. Numerous examples of industrial plants will be analysed.

In view that the industry demands also skilled professionals in maintenance, inspection and safety assurance, these topics will also be covered.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe concepts and provide an understanding of the common aspects of various plants;*
2. *Identify and understand the specific characteristics of different engineering plants;*
3. *Distinguish inspection and maintenance methods and understand their application at various plants.*

Unit: ETPLN-606-1506 - Diagnostics and Control

Unit level (MQF): 6

Credits: 6

Unit Description

Early industrial process controllers aimed at addressing simple basic low-level decision-making functions to perform routine task previously carried out by human operators. However, over the past few years, process control has made a tremendous leap with the introduction of advanced microprocessor based intelligent regulators to the extent that evolved model predictive control strategies are implemented at various industrial sectors such as, but not limited to, power generation, desalination, waste-water treatment, chemical plants, manufacturing industries and many others.

Designing cost-effective, artificially intelligent and diagnostic procedures for complex control systems to aid in running supervisory decisions and fault identification routines, is an on-going challenge that the process industry faces. Such systems not only perform continuous parameter monitoring but aim at enhancing the inbuilt process control procedures to take over specific scenarios such as abnormal situations, start up or power down. This has to be carried out whilst ensuring that such decisions will have no ill-effect on the product/service quality and avoiding crucial circumstances such as irreversible damage and other consequences which may be imparted also to the environment and to society. In this regard, to avoid undesirable repercussions, environment, safety standards and regulations are becoming more stringent.

The objective of this unit is to introduce the learner to diagnostic methods and techniques integrated within typical industrial process control plants. In *learning outcome 1* the student addresses the functional benefits of having systems monitored and regulated by process controllers. The topic is further evolved into understanding control system hierarchy, making reference to typical industrial case-studies. The next step is to guide the learner into tackling appropriate and systematic diagnostic procedures and be able to evaluate the outcome through mathematical analysis. *Learning outcome 2* focuses on the process control loop elements starting off from signal flow and the manipulation of such signals to generate and extract useful information for the process controller. The next element would be measurement system whereby the student is guided into appropriate selection and evaluation of such components vis-à-vis specific design criteria to accommodate for the system's measurement requirements. Actuation technologies are subsequently addressed, whereby within this section the student needs to understand the selection and performance criteria of a range of actuators and drives. This is carried out in the light of necessary mathematical analysis and performance evaluation using an appropriate software package/s. This learning outcome is concluded by addressing intelligent devices and industrial network protocols which aid to achieve complete peripheral communication. *Learning outcome 3* focuses on the heart of the process control system, that is, the controller. Throughout this section the student is guided in selecting typical industrial controllers, appreciate the standard interfacing peripheral equipment along with acquiring advanced programming skills in developing codes to operate and/or diagnose typical industrial process control systems. Learning outcome 4, which is the final outcome, seeks to present to the learner structured maintenance procedures through specific case studies, addressing different process plant equipment. This learning outcome further explores the methods and use of remote diagnostic techniques, hence consolidating all the previous learning outcomes in evolving an intelligent SCADA system. The student is guided into developing appropriate risk assessment evaluation making reference to industrial process control standards.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Examine process control systems and related diagnostics methodologies;*
2. *Analyse the process control loop elements;*
3. *Evaluate industrial controllers, programming methods and applicable interfacing equipment;*
4. *Investigate maintenance procedures and industrial process control safety systems.*

Unit: ETPLN-606-1803 - Engineering Plant Technology

Unit level (MQF): 6

Credits: 6

Unit Description

This unit aim is to provide learners with the knowledge of the principles and laws of thermodynamics and applications in engineering plants and processes. Most modern industrial plants may have to shut down if the processing systems and methods were not maintained effectively. The engineer has a vital role to play when involved in design, installation, operation and maintenance of systems. The unit starts by considering the basic principles in terms of thermodynamic system, parameters and application. The systems definition covers the laws both 1st and 2nd of thermodynamics, measurement of engine performance, heat engine cycles and layouts and performance of various power plants and supply equipment. Importance can be placed on the thermodynamic principles and systems as applied to engineering plants. Consideration is given to the application of continuity of mass, conservation of energy, and the internal energy enthalpy. It also carefully looks at the opportunities to give greater knowledge in some depth of the various power supply equipment and the procedures that are required to operate and test plant equipment safely. This unit allows learners to consider and develop knowledge and understand the principles and application of the thermodynamic systems and applications.

Learning Outcomes

On completion of this unit the student will be able to:

1. *Describe and apply the Thermodynamic Principles to Plant Engineering and Processes;*
2. *Identify and apply the Steady Flow Energy Equation (SFEE) to equipment and plant;*
3. *Demonstrate an understanding of methods used to examine and make recommendations on the performance of the various Power Supply Equipment (PSE);*
4. *Demonstrate understanding of the operating and testing of plant safely.*