MCAST

MQF Level 6

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

ME6-02-21

Course Description

This Mechanical Engineering degree provides you with a solid understanding of relevant engineering fundamentals and prepares you for a broad range of career options in the manufacturing field.

The programme is structured around studies which will develop in students a firm understanding of principles and disciplines which are needed in the modelling, measuring, analysis and design of mechanical components and systems.

On completing the course, graduates are expected to demonstrate that they have assimilated the professional skills necessary for formulating and executing design projects, for teamwork, and for effective communication.

Programme Learning Outcomes

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

1. *Take decisions based on pertinent information related to the manufacturing processes;*
2. *Manage the operational function of a manufacturing organisation;*
3. *Source, validate and apply information to find solutions to engineering related issues;*
4. *Design products, the manufacturing systems and facilities required for the production of products.*

Entry Requirements

MCAST Advanced Diploma in Manufacturing

or

MCAST Advanced Diploma for Polymer Process Technicians

or

MCAST Undergraduate Diploma in Foundations of Engineering

or

2 A-Level passes and 2 I-Level passes 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
ETDSN-606-1801	Engineering Design and CAD	6	1
ETMEC-606-1805	Thermodynamics 1	6	1
ETE&E-606-1802	Fundamentals of Electrical and Electronics Technology	6	1
ETMTS-606-1801	Strength of Materials for Mechanical Engineers 1	6	1
ETMEC-606-1806	Fluid Mechanics 1	6	1
ETMEC-606-1807	Mechanics for Machines 1 - Dynamics and Kinematics	6	1
ETMEC-606-1808	Workshop Practice	6	1
ETMEC-606-1804	Applications of Pneumatics and Hydraulics	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
ETDSN-606-1802	Engineering Design 2	6	2
ETMTS-606-1802	Engineering Materials	6	2
ETMFG-606-1801	Advanced Manufacturing Technologies Jig and Tool Design	6	2
ETENG-606-1805	Energy Management	6	2
ETMEC-603-1817	Metrology	3	2
ETMFG-606-1802	Component Manufacture	6	2
ETENG-606-1507	Dynamics and Kinematics	6	2
ETMEC-606-1815	Mechatronics	6	2
ETWBL-603-1803	Work Based Learning Internship - Part 2	3	2
ETMFG-606-1803	Quality, Lean Manufacturing	6	2
ETMTH-606-1812	Mathematics for Engineers 3	6	3
ETMEC-606-1814	Problem Based Learning	6	3
ETENG-606-1505	Control Engineering	6	3
ETELE-606-1815	Electrical Power Systems	6	3
ETMEC-606-1816	Simulation of Advanced Management Systems in Manufacturing Engineering	6	3
ETMTS-606-1507	Materials and Manufacturing Processes	6	3
ETMEC-606-1517	Mechanics of Machines	6	3
ETDSN-606-1803	Engineering Design 3	6	3
ETMEC-606-1522	Vibrations	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
ETPRD-606-1501	Production Technology	6	4
ETPRD-606-1502	Product Design	6	4
ETMGT-606-1804	Management for Engineers	6	4
ETPMR-606-1503	Polymers and Their Manufacture	6	4
ETPRD-606-1503	Production Planning and Control	6	4

ETMEC-606-1520	Mechatronics for Manufacturing Cells	6	4
ETQLS-606-1501	Quality Assurance	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 analyze 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: 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-606-1805 - 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 vapors 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: 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 for Mechanical Engineers 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-606-1806 - 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: 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: 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: 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: ETDSN-606-1802 - Engineering Design 2

Unit level (MQF): 6

Credits: 6

Unit Description

Computer technology has nowadays facilitated a lot of tasks executed in product development. Such technology is a must-have for relevant companies to be a t a competitive edge in a globalised economy. Computer-Aided Design (CAD) and Computer-Aided Manufacture (CAM) technology meet a wide range of roles include two-dimensional (2D) and three-dimensional (3D) geometric modelling, plastic melt flow analysis in an injection mould, virtual / physical prototyping and the automatic generation of part-programming required to machine complex part geometries. Due its considerable capabilities, CAD / CAM technology ensures that a product is designed and manufactured to the required standards, at a low cost and in the shortest possible time-to-market. Learning outcome 1 focuses on the roles of CAD / CAM in product development. Typical software and hardware requirements to run efficiently CAD / CAM technology are also treated in the first learning outcome.

The advent of ICT made it possible that a product is developed at different places around the globe. For instance, a part can be articulated by a designer in Germany and the required mould is designed and fabricated in Malta. It is frequent the case that product development stakeholders working in such environments, use different commercially available CAD / CAM systems. In such cases, it is of paramount importance that any CAD / CAM information is shared and exchanged irrespective of the system by which it was generated. To this end, learning outcome 2 treats neutral file formats. The procedure required to convert a 3D virtual geometric model in CAD, in a format, which can be read by CAM, is also explained.

As mentioned previously, one of the roles of CAD / CAM lies in the generation of part-programming. Given the wide range of applications of part-programming in the local manufacturing industry (e.g. milling, spark erosion, water-jet cutting), this unit focuses on this particular aspect. For this reason, the scope of learning outcome 3 is to get the learners familiar with Computer Numerical Control (CNC) part-programming. CNS is used to numerically control a machine via computer technology. By end of this unit, learners should be able to manually generate the CNS part-program to fabricate simple geometric forms using one particular manufacturing process, namely vertical milling. In this respect, CNC codes (e.g. G-codes for preparatory functions and M-codes for miscellaneous functions) will be covered. Practical examples of CNS part-programs will be provided. Given its relevance to the local manufacturing industry, the u se of computer-aided part-programming (CAPP) will be also covered. The advantages that CAPP offers, compared to manually-generated CNC part-programming, will be highlighted. A commercial Computer-Aided Manufacturing (CAM) software package shall be used in this unit, so that learners get familiar with the steps one needs to take to generate a CNC part-program via CAM.

This is a learning-by-doing type of unit and it will provide learners with the opportunity to apply the knowledge they have learnt to design and fabricate case-study components using CAD / CAM technology.

Learning Outcomes

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

1. *Describe the roles and software / hardware requirements of CAD / CAM technology;*
2. *Describe how CAD / CAM information is exchanged and shared;*
3. *Generate manually Computer-Numerical Control (CNC) part-programming;*
4. *Generate computer-aided CNC part-program using CAM software.*

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: ETMFG-606-1801 - Advanced Manufacturing Technologies Jig and Tool Design

Unit level (MQF): 6

Credits: 6

Unit Description

Due to global competition there is increasing pressure to develop products of high quality and competitive prices and to deliver them to market in a short period of time. In addition, owing to the modern lifestyle, customers are expecting more and more functions from a product, making it increasingly complex. Such a dynamic product development scenario brings with it a lot of challenges, in particular from the manufacturing point of view. Manufacturing strategies, which can rapidly adapt and hence accommodate changes in production volumes and handle the components/products variety, must be developed. To this end, flexible manufacturing systems are commonly installed in companies across a wide range of sectors, such as automotive and consumer products. The ability to quickly react to changes in product configurations, is equally important to a company as maintaining product quality and costs low. This study unit looks into such manufacturing strategies and the elements characterising them. Given the complexity of Advanced Manufacturing Technology (AMT) installations, characterising such flexible manufacturing strategies, health and safety requirements are of paramount importance to safeguard the operators working in these manufacturing environments. Learning outcome 1 focuses specifically on this aspect.

Learning outcome 2 is concerned with the function and purpose of AMT installations. Typical production volumes and manufacturing processes/strategies suitable to achieving such volumes are first introduced. An overview of manufacturing strategies in general, such as one-off, batch, mass and continuous production follows. The focus will then be placed on group technology, single machine cells, flexible manufacturing cell and flexible manufacturing systems. Typical elements of AMT installations are described, more specifically, workstations (e.g. CNC machining centres), material handling systems (e.g. automatic guided vehicles) and storage retrieval systems, including tooling storage and handling. Aspects related to jigs and fixtures will also be treated. The focus in learning outcome 3 is placed upon the benefits and drawbacks to design and implement flexibility into a manufacturing process. Issues such as economics of using AMTs, types of costs involved such as training and machine software/hardware upgrades, are described.

The underlying principle of a number of advanced manufacturing processes is the main subject of the fourth learning outcome. Examples of such processes include electro discharge machining, water jet cutting and additive manufacturing. The benefits of combining different types of such technologies and their applications in the local manufacturing industry will also be discussed.

Learning Outcomes

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

1. *Recall health and safety requirements in the manufacturing workplace;*
2. *Describe the function and purpose of advanced manufacturing technology (AMT) installations;*
3. *Analyse the benefits and drawbacks in designing and implementing an AMT;*
4. *Describe the underlying principle of advanced manufacturing processes and recall their applications in the local industry.*

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: ETMEC-603-1817 - Metrology

Unit level (MQF): 6

Credits: 3

Unit Description

Throughout this unit the learner shall become familiar with the importance of standardization and the standards that are applicable in the science of measurements. Throughout the unit the learner shall have the opportunity to evaluate measurements of various sizes and shapes by comparing the unknown measurement to known standardised/calibrated measurements. Some dimensions can be measured with a number of different methods which may differ in precision depending on the level of accuracy provided by the equipment used. The different methodologies covered within this unit shall fall under the following categories; mechanical, optical, pneumatic, and electrical. This unit shall also cover practical and theoretical concepts of errors including; systematic errors, random errors, sources of errors, etc.

The learner shall also become knowledgeable of the different materials that are used when it comes to manufacturing of precision gauges. This unit shall also cover information regarding measurement limits and allowances.

This unit shall provide the learner with a number of examples of how to perform precision measurements of unknown magnitudes through a combination of usage of precision gauges as well as equations and calculations. Topics that will be covered include; dovetails, bores, flatness, alignment, gears and threads amongst others.

Throughout this unit the learner will be able to perform precision measurements, interpret the measurements taken and evaluate the respective dimensions together with their corresponding accuracy levels. The learner shall be able to check the tolerances within the results obtained according to the respective case study, as well as review the practical and theoretical concepts of errors.

The unit shall also provide familiarization with modern emerging trends in metrology including; micro and Nano metrology, 3D digitizing, and laser scanning, amongst others.

Learning Outcomes

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

1. *Explain the basis and importance of metrology including its various applications;*
2. *Identify the different procedures and equipment used to perform precision measurement;*
3. *Perform a number of precision measurements;*
4. *Interpret obtained results, including the evaluation of limits and tolerances.*

Unit: ETMFG-606-1802 - Component Manufacture

Unit level (MQF): 6

Credits: 6

Unit Description

This unit will provide the learner with theoretical knowledge of component manufacturing. This would allow learners to understand and get familiar with some of the basic manufacturing processes and fabrication techniques that are used for different materials.

Therefore, this unit is relevant to those wishing to understand the different techniques used to manufacture particular components. An overview of how these materials are shaped or formed will be given, including the casting, deformation and machining processes used for metals and polymers. As a component may consist of a number of smaller components, different methods of joining two or more components together will be taught, together with any troubleshooting or problems which may result from this. An insight of the machinery and tools needed will also be given so the learner will acquire the necessary skills to evaluate which processing technique is best for which component.

At the end of the unit, learners are taught how to test a component to be sure that the component and its manufacturing process meet the required specifications. An overview of the various standard test methods and the way they are carried out is given.

Learning Outcomes

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

1. *Select suitable metal forming processes;*
2. *Select suitable polymer forming processes;*
3. *Describe manufacturing processes for composite materials;*
4. *Assemble, prototype and test engineering components.*

Unit: ETENG-606-1507 - Dynamics and Kinematics

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.

This unit will develop learners' understanding of both the typical and complex problems of material points and rigid body movements. This unit provides opportunities for learners to develop integrated skills necessary to apply relevant kinematics and kinetics energy and momentum methods in various problem solving processes.

This unit is designed to gradually develop the learners' ability to select and apply appropriate principles and methods of kinematics and dynamics for various types of material points and rigid bodies' movements. Learners will analyze the kinematics and kinetics problems in rectangular, cylindrical and curvilinear coordinate systems, in two and three dimensions.

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. *Demonstrate basic knowledge of Kinematics and Kinetics of a body;*
2. *Understand the motion of particles by using different coordinate systems considering two and three dimensions;*
3. *Determine the inertia of a rigid body relative to reference coordinate system;*
4. *Evaluate and solve practical problems in kinematics and dynamics.*

Unit: ETMEC-606-1815 - Mechatronics

Unit level (MQF): 6

Credits: 6

Unit Description

Within our fast changing modern world and through the demand of more and highly sophisticated intelligent consumer products, *mechatronics* has coined the rapid transformations in many multi-disciplinary areas including *manufacturing* and *automated process control*. In essence, *mechatronics* provides the integration that the manufacturing sector requires by amalgamating a wide variety of engineering fields and sub-fields, namely *mechanical*, *electrical*, *control systems*, *communications* and *computer engineering*.

This unit aims at granting learners following the mechanical engineering course, the possibility to review basic mechatronic elements and their embedded technologies, whilst enhancing their evaluation skills when reviewing from micro/mini individual intelligent components up to fully integrated complex manufacturing systems on a much larger scale. The learners will identify and comprehend the basis of a variety of sensors and actuators which, when integrated with appropriate controllers, can be used to form a dedicated control strategy to automate, regulate and/or monitor real life systems. Through this introductory approach to mechatronics, the learner will also have the possibility to appreciate and evaluate a range of applications, especially in the manufacturing engineering sector, where typical industrial *programmable logic controllers (PLCs)* as well as *industrial robots* are incorporated. Learners will be guided to develop their understanding and knowledge in key elements which constitute the two aforementioned industrial components. With no prerequisites for programming background compulsory, the learner will be introduced to acquiring the necessary practical skills in programming *PLCs* and *industrial robots*. Furthermore, the learner will be presented with a systematic approach as to how s/he ought to handle basic diagnosis and troubleshooting of typical electrical faults and code debugging addressed in practical case-studies integrating PLCs and Industrial Robots.

In light of *mechatronics*, *PLCs* and *industrial robots*, finally the learner will be able to review all the above addressed content with reference to important evaluation factors such as the practical advantages and limitations of such equipment. Special reference shall be made to health & safety regulations and legislation, ethical code, standard working practices and procedures, along EU norms and legislation pertaining to the integration of PLCs and industrial robots within the manufacturing automation world.

Learning Outcomes

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

1. *Understand the architecture of mechatronic systems;*
2. *Understand the principles and programming concepts of Programmable Logic Controllers;*
3. *Prepare programmes concepts for Industrial Robots;*
4. *Demonstrate the integration of Programmable Logic Controllers and Industrial Robotics within Mechatronic systems.*

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: ETMFG-606-1803 - Quality, Lean Manufacturing

Unit level (MQF): 6

Credits: 6

Unit Description

This unit covers the compelling case for the use of Quality and Lean principles within a manufacturing setting. It firstly clarifies the specific meanings of both concepts before showing how, when used professionally; they can support the achievement of superior organisational results.

The key areas of focus are, identifying and eliminating waste in all its forms, the important role of people, processes, design for manufacture, flexibility, reliability, profitability, reducing inventory as well as batch size and set up time reduction.

The basic lean principles are covered as are the concepts of value, value stream, process flow, customer pull processes, continuous improvement, skills and competences.

The unit also covers the most popular of Lean Tools and methods and shows how these can be put to practical use in the manufacturing environment e.g. process flow analysis, production levelling, Kanban (Just in Time), Total Productive Maintenance and Autonomous Maintenance.

Some of the terminology used in Lean has its origins in Japan due to the work and success achieved there. This unit however uses the English version of the key concepts and only uses Japanese terms where these are in common use in the English language. There are many information sources available for those wishing to become familiar with the Japanese terms.

Learning Outcomes

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

1. *Explain the fundamental concepts of Quality and Lean;*
2. *Apply Quality and Lean working methods in the manufacturing environment;*
3. *Implement Total Productive Maintenance in the manufacturing environment;*
4. *Explain how Quality and Lean can help deliver meaningful improvement in the manufacturing environment.*

Unit: ETMTH-606-1812 - Mathematics for Engineers 4

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-606-1814 - 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: 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 utilising 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: 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: ETMEC-606-1816 - Simulation of Advanced Management Systems in Manufacturing Engineering

Unit level (MQF): 6

Credits: 6

Unit Description

Since last few years the technology is moving with the bullet speed and it has become the key driver of our economy and competitiveness. The innovation technology is a major part of our economic growths since last few years which includes products, services, systems, etc. The engineers are developing the technology in the research laboratories and adopting by entrepreneurs to make available for the end users. In these days the economy is technology-based and the process of technology development and implementation is managed by the engineers who are using their knowledge and skills to transform this knowledge from research laboratories to dynamic markets. This transformation has become a key competitive edge of the engineering profession in industrial organizations. In order to gain the economic return, without a successful execution of a well-developed technology cannot be possible. Therefore, technology growth and its applications must be studied as an integrated subject between technology and market trends. The unit is a highly interdisciplinary one which contains advanced engineering and business studies curriculums.

Conventionally, engineering students have a more technical (development) view point to look at the process as they are trained to look from the technological development side, while business students are asked to learn the management (adoption) side of the same process. This separated “development-vs.-adoption” training approach and the separation of field knowledge make it more difficult for students to achieve a complete/inclusive understanding of this interdisciplinary subject in order to lead this important process effectively in their professional careers.

This unit attempts to overcome the above deficiency by offering students a holistic, interdisciplinary and integrated view of the inclusive technology development and application process, ranging from laboratory to market considerations. In order to achieve a high level of focus, the unit will highlight principles and practices relate to simulation of advanced management systems in modern industrial setting.

Learning Outcomes

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

1. *Describe engineering and technology enterprise management system;*
2. *Identify and analyse the product development strategies and computer aided engineering techniques;*
3. *Justify the importance of simulation of advanced management system;*
4. *Distinguish and evaluate recent and future management system in manufacturing engineering.*

Unit: ETMTS-606-1507 - Materials and Manufacturing Processes

Unit level (MQF): 6

Credits: 6

Unit Description

This unit covers scientific and engineering principles of different technical materials designated to a wide range of manufacturing processes. It gives the learners a broad foundation in all classes of materials, including cast iron, different types of steels, copper and copper alloys, aluminium and its alloys, ceramics Learners will then understand how knowledge of these materials influences product manufacture. To get a better insight in relationship between properties of materials and application, learners will cover the basics of the most important metal shaping processes, such as casting, plastic deformation, cold working etc.

The main purpose of this unit is that the learner will have basic knowledge of common structural materials used in manufacturing processes, their properties and use as well as some general industrial shaping processes. The unit covers the scientific fundamentals of material, adaptation of material properties, various types of steel, cast iron and basics of surface engineering. Light alloys, powder metallurgy materials, ceramics and composite materials will also be covered in addition to production methods which are mainly casting, plastic deformation, cold working and plastic moulding.

Learners will cover properties of materials from atomic and macroscopic points of view, typical fields of application, as well as see the problems which could appear during their life time in exploitation, their protection and prevention, maintenance and repair works. Learners will become familiar with the use of iron-carbon phase diagram and its effect of carbon content, as well as have the content of other alloying elements on steel properties explained.

In addition, learners will become aware of the importance of heat treatment of steels and use of TTT diagrams, hardenability curves, continuous cooling curves, and how heat treatment influences steel chemistry and properties. Also learners will understand the mechanism of alloying and alloying systems for copper and aluminium alloys as well as understand the specification systems and norms (EN, DIN, AISI) for all plant materials.

Learning Outcomes

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

1. *Understand the basic common structural materials, their properties and use and their application in general industrial manufacturing processes;*
2. *Explain the connection between properties and use of common structural materials;*
3. *Identify the correct material and manufacturing process for a specific product;*
4. *Describe some common shaping processes by explaining the context in which such processes are used, giving possibilities and limitations.*

Unit: ETMEC-606-1517 - Mechanics of Machines

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, basic knowledge of different mechanisms, their method of working, forces involved and consequent vibration during working is necessary to any mechanical engineering learner. 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 lectures 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. Each chapter concludes with a selection of problems of varying length and difficulty. SI Units and US Customary Units are employed.

Learning Outcomes

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

1. *Apply basic knowledge of kinematics and dynamics of machines;*
2. *Understand basic 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: ETDSN-606-1803 - Engineering Design 3

Unit level (MQF): 6

Credits: 6

Unit Description

A manufacturer's competitive advantage in a global economy is directly connected to its capacity to introduce new products in the market in less time and with lower costs. To achieve these goals, product development must be based on strong and interdisciplinary engineering knowledge supported by leading CAD/CAM/CAE systems. CAD/CAM/CAE systems are based on the CAD Model, which is applied in today's engineering world. Engineering software requires specific methodology established on virtual engineering approaches and data integration.

This course will introduce the students to the process of product development using Computer Aided Design and related tools. The aim is to prepare them for an entry level career in any engineering discipline. Students will utilize state-of-the-art computer software program CATIA V5, to solve real-life mechanical engineering problems in a 3-D environment. These problems involve a high degree of creative thinking, analysis and problem-solving technique. Using projects and tutorials, students are motivated to develop and implement these skills during the course.

CATIA software is a product of Dassault Systemes and specialises on product development cycle from the initial stages of design. It is renowned in the Aviation, Shipbuilding and Manufacturing industries.

The course will start by introducing the concept of integrated engineering, information as an intellectual property, customer-driven vs engineering-driven product development, integration and globalization methods and means of concurrent computer aided engineering.

The basic CAD skills will be initiated through learning about the art of engineering product design. The students will learn about basic, as well as advanced engineering knowledge for designing mechanical systems. The students will take the knowledge learned and apply it using one of the most advanced CAD software in industry. Using CATIA software the students will be able to complete a 3D model and a working set of 2D drawings of an assembly of their own design, solving an engineering problem as their final project.

Learning Outcomes

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

1. *Understand the principles of product design using CAD technology;*
2. *Apply geometric modelling techniques and model structure organization to engineering design;*
3. *Use the CAD software to design and simulate complex products, assemblies and mechanisms;*
4. *Design mechanical systems using state-of-the-art engineering software both in 2D and 3D.*

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 modeling, 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: ETMTH-606-1813 - Mathematics for Engineers 3

Unit level (MQF): 6

Credits: 6

Unit description

This mathematics unit provides an introduction to the finite element method with 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.

Mechanical engineering is among the most diversified of the traditional engineering disciplines. The mechanical engineer builds machines to extend our physical and mental capabilities and to convert traditional and novel energy sources into useful forms.

The role of the mechanical engineer has changed dramatically over the past few decades with the extensive use of high-performance computers. This new area offers mechanical engineering learners special opportunities for creativity, demanding that they learn not only in depth but also in breadth.

For problems involving complicated geometries, loadings and 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) is the most widely used numerical method for solving a variety of problems governed by partial differential equations in all areas of engineering.

This unit is designed to give learners a comprehensive introduction to the finite element method, a powerful numerical method for solving problems of engineering, typical areas being structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential.

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: ETPRD-606-1501 - Production Technology

Unit level (MQF): 6

Credits: 6

Unit Description

As a field of study in the modem context, production or manufacturing (the words manufacturing and production are often used interchangeably) can be defined two ways, one technologic, and the other economic. Technologically, manufacturing is the application of physical and chemical processes to alter the geometry, properties, and/or appearance of a given starting material to make parts or products; manufacturing also includes assembly of multiple parts to make products. The processes to accomplish manufacturing involve a combination of machinery, tools, power, and manual labour. Economically, manufacturing is the transformation of materials into items of greater value by means of one or more processing and/or assembly operations. A manufacturer's competitive advantage in a global economy is directly connected to its capacity to introduce new products in the market in less time and with lower costs.

This unit will introduce the learners to the traditional and non-traditional techniques in manufacturing industry. Therefore, it is designed to provide a basic understanding of present-day manufacturing processes. The unit will start by giving an introduction to manufacturing. Through lectures, demonstrations, and practical applications, the learners will be introduced to various manufacturing processes.

Further on learners will learn basic metal removal processes: turning, milling, boring and grinding. With special attention given to CNC machines. Material removal calculations will also be introduced for each conventional process including, metal removal rate, depth of cut, cutting forces, spindle and cutting speeds. The most common non-traditional techniques will also be considered in detail. Using projects and tutorials, learners are motivated to develop and implement process planning skills during the unit.

Learning Outcomes

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

1. *Select the most suitable manufacturing process to produce and join different shapes of product;*
2. *Identify the processes likely to be used for producing a particular product and joints using a specific material or class of material;*
3. *Describe the advantages and disadvantages of the different classes of manufacturing and joining processes;*
4. *Demonstrate good team and interpersonal skills to enhance both oral and written communication with colleagues, management and other professionals within the manufacturing industry.*

Unit: ETPRD-606-1502 - Product Design

Unit level (MQF): 6

Credits: 6

Unit Description

The main task of design engineers is to apply their knowledge to solve technical problems within different technological, economic, environmental and human-related requirements. The engineering product design process has to provide a description of an artefact which will be produced afterwards. In mechanical engineering, artefacts can have a different level of complexity (machine, assembly/subassembly, element, etc.). Through the product design process, they have to be specified down to the most detailed dimensions, used materials, type of surface treatment, etc.

This course aims at providing learners with continuation on the topic of Engineering Design in a holistic manner resulting in the engineering product design in different industries. It sums up different aspects of design, from the planning phase to the detail design phase. Various requirements which directly influence the design process will be covered. These requirements are related to exploitation, manufacture, safety, reliability, recycling, etc., which will be explained through theoretical considerations, examples and case studies.

Several design process models and design tools will also be explained and applied. Special attention will be given to the role of modelling and simulation techniques in product design. The use of these tools will be accompanied by a detailed overview of engineering calculations such as loading or stress analysis in design. The role of materials selection, joining for different products and other manufacturing considerations will be elaborated in the Product Design. Design and selection of machine parts will be covered with several detailed case studies from different industries. Basics of project management in the framework of the product design will also be included in this course. The role of standards and legislation governing an Engineering Designer and his product will also be elaborated.

Learning Outcomes

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

1. *Analyse the product engineering design phases and their requirements;*
2. *Identify and apply product engineering design tools and support;*
3. *Appraise the application of engineering knowledge in the design phase;*
4. *Assess the influence of material selection, product manufacture and assembly on its design.*

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: ETPMR-606-1503 - Polymers and Their Manufacture

Unit level (MQF): 6

Credits: 6

Unit Description

The course covers structure, physical & mechanical properties, design considerations and manufacturing methods for polymer-based materials. The properties of the polymers not only determine their use but how they are manufactured. Their final structure influences characteristics such as flexibility, impact strength, transparency and resistance to abrasion, heat, oils and solvents.

There are two broad groups of polymeric materials Thermo-softening polymers or thermoplastics, and thermosetting polymers. Thermo-softening polymers generally have a 'long chain' molecular structure formed by the 'addition polymerisation'. Thermosetting polymers have a network structure and are formed by the 'condensation polymerisation' process which produces water as a by-product of the chemical reaction occurring during setting. These structures are extremely important as they determine the method by which components will be manufactured from the polymer.

In terms of properties the thermo-softening group of polymers tend to be flexible to some degree, show reasonable impact resistance and are usually able to be re-heated and re-shaped, assuming the 'new' shape upon cooling. From an environmental point of view, these properties make thermo-softening polymers ideal for recycling.

In comparison, thermosetting polymers are rigid, often brittle and cannot be re-heated for the purpose of re-shaping. They tend to degrade or burn when heated significantly.

The most common industrial manufacturing processes for polymers include: Extrusion, Injection Moulding, Blow Moulding, Thermoforming, Rotational Moulding, Casting Processes, Foam Processes, Compression and Transfer Moulding.

This course is designed to provide a basic understanding of present-day polymer materials and associated manufacturing processes. The course will start by introduction to plastics and their structure. Further on through lectures, demonstrations, and practical applications, the student will be introduced to various manufacturing processes for production of plastic parts.

Learning Outcomes

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

1. *Understand the behaviour and properties of plastic materials;*
2. *Understand the design of plastic products and the equipment, tooling, and environment necessary for their manufacture;*
3. *Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, manufacturability, and sustainability;*
4. *Identify, formulate, and solve manufacturing-engineering problems related to plastics.*

Unit: ETPRD-606-1503 - Production Planning and Control

Unit level (MQF): 6

Credits: 6

Unit Description

This course provides the learner with profound insights into how to coordinate the supply, production and distribution functions. It also educates the learners how to balance conflicting objectives to minimise the total of all the costs involved and maximise customer service.

Production planning is one part of production planning and control dealing with basic concepts of what to produce, when to produce, how much to produce, etc. It involves taking a long-term view at the overall production planning.

Therefore, objectives of production planning are as follows:

- To ensure right quantity and quality of raw material, equipment, etc. are available during times of production;
- To ensure capacity utilisation is in tune with forecast demand at all the time.

A well thought production planning ensures that overall production process is streamlined providing following benefits:

- Organisation can deliver a product in a timely and regular manner;
- Suppliers are informed will in advance for the requirement of raw materials;
- It reduces investment in inventory;
- It reduces overall production cost by driving in efficiency.

Production planning and control involves generally the organisation and planning of the manufacturing process. Specifically, it consists of the planning of the routing, scheduling, dispatching and inspection, co-ordination and the control of materials, methods, machines, tooling and operating times. Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Production control ensures that production team can achieve required production target, optimum utilisation of resources, quality management and cost savings. An effective production planning and control **system** helps to maintain inventory at proper level, hence minimises wastage. It helps to have better control over raw material inventory, which contributes to effective purchasing. Having in place a sound system of production planning & control, everything in relate to production is planned well in advance of operation. Therefore, it helps in minimising capital investment in equipment and inventories. To get the most value out of our resources we must design production processes that make products most efficiently. Managing the operation means planning for and controlling the resources used in the process.

For efficient, effective and economical operation in a manufacturing unit of an organisation, it is essential to integrate the production planning and control system. Production planning and subsequent production control follow adaption of product design and finalisation of a production process. Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Production control ensures that production team can achieve required production target, optimum utilisation of resources, quality management and cost savings.

Learning Outcomes

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

1. *Understand and describe production strategy and application of strategic capacity planning methods for products and services;*
2. *Understand, select and determine feasible process and facility layouts, location planning and analysis for good production planning and control;*
3. *Know and determine the best production quality, management and control methods in a production/process facility;*
4. *Understand and describe the components of supply chain management;*
5. *Comprehend the use and benefits of materials requirements planning (MRP), enterprise resources planning (ERP) and the work systems.*

Unit: ETMEC-606-1520 - Mechatronics for Manufacturing Cells

Unit level (MQF): 6

Credits: 6

Unit Description

Mechatronics is considered to be a multidisciplinary field amalgamating many different areas within engineering capped under *Mecha*nisms and Elec*tronics*, hence the term *mechatronics*. The pillars of this concept are mechanical, electrical, IT, computer, and control engineering and through the synergistic interlinking of these fields and sub-fields, products, manufacturing operations and complex control procedures are nowadays both developed as well as in optimised in real time. Through the years, technological advancements we have progressed considerably; so has automation as a result. Studies addressing manufacturing engineering are nowadays focusing on addressing mechatronics for the simple reason that at this day and age the majority of manufacturing operations and equipment all involve the integration of mechanisms with electronics, at various degrees; starting off from simple closed-loop control to high intelligent and sophisticated autonomous systems. A key factor which is shaping the modern manufacturing world is the cost effective yet precise and elaborate production design specifications that the industry is being faced with. Not to mention the need to optimise production quality, saving time, increase output, lessen wastes and protect our environment. Another aspect is improvement in the quality of life; operators' tasks are now shifted from physically challenging, unsafe and unhealthy operations through the extensive use of industrial robots, automated machines, AGVs, ASRS, etc. All these changes are reshaping the manufacturing automation and processes; hence mechatronics is an asset for the industry of the 21st century.

This unit is a continuation of the unit ETMEC-606-1815 entitled *Introduction to Mechatronics*. It aims at exploiting in depth the key components of any control system, i.e. the measurement system, actuation technologies and the controller. In learning outcome 1 the student is exposed to advanced mechatronic design philosophies which aid in developing more advanced manufacturing automation strategies. Learning outcome 2 focuses on the core elements of the control system through an analytical evaluation as well as software tools which help designing and sizing appropriate electro-mechanical systems. Learning outcome 3 addresses the heart of all control systems, i.e. the industrial controller. Students are guided through advanced controller coding techniques as well as interfacing of additional special function units that modern controllers make use of. Learning outcome 4 focuses on industrial manipulators, which are nowadays integrated in the majority of manufacturing systems. Students are guided to understand other forms of control strategies and the design of optimised manipulator characteristics such as dynamic control of forces, velocities, etc. as well as path planning.

Learning Outcomes

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

1. *Assess the integration of mechatronics in the manufacturing industry;*
2. *Analyse the mechatronic control loop elements;*
3. *Evaluate advanced programming concepts of PLCs and applicable interfacing equipment;*
4. *Appraise industrial manipulators and autonomous mechanisms.*

Unit: ETQLS-606-1501 - Quality Assurance

Unit level (MQF): 6

Credits: 6

Unit Description

Strategic quality requires that quality is defined as more than simply the absence of defects or the reduction of variation. This system of knowledge and applied technologies include, but is not limited to, development and operation of quality control systems, application and analysis of testing and inspection procedures. It also includes the ability to use metrology and statistical methods to diagnose and correct improper quality control practices, as well as an understanding of human factors and motivation, facility with quality cost concepts and techniques, and the knowledge and ability to develop and administer management information systems and finally to audit quality systems for deficiency identification and correction. In other words, quality is a comparison between one's product and those offered by others, a comparison made by people outside of one's firm. Without a set of principles, achieving a common understanding, the field of quality management would be impossible.

In supply products or services there are three fundamental parameters that determine their saleability – price, quality and delivery. The quality management system is the means by which the organization achieves its objectives and therefore no function or activity should be exist outside the system. Therefore, this unit will provide learners with the fundamental knowledge and the basic concepts in the field of quality. This unit covers fundamental principles of contemporary quality control, the quality improvement programs, introduces concept of ISO systems, and provides a broad spectrum of Measurement System Analysis.

Learning Outcomes

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

1. *Apply fundamental principles of contemporary quality control methods to own products and organisations;*
2. *Apply Six sigma quality and Kaizen improvement own supply and services;*
3. *Apply Quality Management System ISO system to own organization;*
4. *Perform measurement system analysis for continuous data;*
5. *Apply statistical methods to quality control.*