MQF Level 6

ME6-01-21p

Pre-Warrant Qualification Course (Mechanical)

Course Specification

Course Description

The main objective of the PWQ course is that of offering further professional development to graduate engineers to help them complement their professional experience with specific analytic methods. The course will cover six units that are considered an essential foundation for professional engineering practice. This will be delivered over a period of approximately one year and pegged at level 6 of the MQF.

Participants for this programme shall be restricted to successful graduates from the full MCAST B.Eng. 240 ECTS programmes.

The six chosen units are Mathematics, Fluid Mechanics, Thermodynamics, Mechanics of Machines, Engineering Materials and finally the Engineering Project unit. If successful, the students will be awarded a postgraduate certificate of 35 ECTS at level 6.

Programme Learning Outcomes

At the end of the programme the student is able to:

1. *Analyse case studies involving thermodynamic and fluid dynamic processes.*
2. *Investigate and recommend materials for a range of applications together with treatments that alter their properties.*
3. *Use mathematical techniques to support engineering decisions.*
4. *Recommend Mechanisms that satisfy both static and dynamic applications in engineering.*

Entry Requirements

Eligibility for this course requires a 240 credit MCAST Bachelor of Engineering degree.

Current Approved Programme Structure

Unit Code	Unit Title	ECTS	Year
ETMTH-605-2100	Mathematics	5	1
ETMEC-605-2100	Mechanics of Machines	5	1
ETMEC-605-2101	Fluid Mechanics	5	1
ETMEC-605-2102	Thermodynamics	5	1
ETMEC-605-2103	Engineering Materials	5	1
ETPRJ-610-2100	Engineering Project	10	1
	Total ECTS	35	

ETMTH-605-2100 Mathematics

Unit Type: ☒ Theory ☐ Practice ☐ Theory and Practice ☐ Placement

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

This unit prepares the learners to further develop an in depth theoretical mathematical basis while also further develop knowledge and skills required to solve engineering problems.

The aim of this unit is to investigate problems using vector analysis, which is an essential part of an engineer's scientific background. In Linear Algebra, the solutions of Linear Systems of equations are basic concepts that build the basis for other subjects in vector analysis such as differential and integral calculus.

The topics covered in this unit include the properties and solution of linear systems of equations, 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.

LEARNING OUTCOMES

Upon completing the unit, learners should be able to:

1. *Analyse and solve linear systems of equations using Matrices and Vectors.*
2. *Analyse and appraise solution of problems using Vector Differential Calculus.*
3. *Apply and appraise solution of problems using Vector Integral Calculus and Integration Theorems.*
4. *Solve linear algebra problems using numerical methods.*

Unit: ETMEC-605-2100 Mechanics of Machines

Unit Type: ☒ Theory ☐ Practice ☐ Theory and Practice ☐ Placement

Level: 6

Credits: 5 ECTS

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

Upon completing the unit, learners should 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.*

ETMEC-605-2101 Fluid Mechanics

Unit Type: ☒ Theory ☐ Practice ☐ Theory and Practice ☐ Placement

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

Fluid mechanics is the branch of physics concerned with the mechanics of fluids (liquids and gases) and the forces on them. The term 'fluid mechanics' constitutes of fluid statics - the study of the fluids at rest, and fluid dynamics - the study of the effect of forces on the fluid motion.

This unit provides an extended knowledge of fluid mechanics principles and phenomena to engineers who have already gained a firm understanding of the basic fluid mechanics principles – theory of engineering topics previously taught during the delivery of several units of the 'old' MCAST B.Eng. (Hons) Degree in Mechanical Engineering (Plant).

More specifically, this unit focuses onto two main areas in fluid mechanics. The first area of study comprises the understanding of the fundamentals of compressible fluid dynamics. The fundamentals then serve as a basis to analyse and characterise extensively the compressible aerodynamics round various fluid systems. The second area relates to the hydrodynamics of fluid flow behaviour of both single-phase flow (pure liquids or gases) and multi-phase (gas-liquid) flows. This theoretical description and mathematical explanation of phenomena related to movement of fluid particles is presented by applicable techniques for analysing fluid motion. Mathematical methods include the Eulerian and the Lagrangian frame of reference.

The selected study topics provides the student with the necessarily theoretical background to analyse and provide answers to challenges attributed to the behaviour of fluids flow phenomena within a variety of different industrial processes. This include typical fluid flow challenges, such as cavitation, choking and phenomena related to the formation of pressure surges and intermittent flow behaviour. These are the most commonly faced process challenges within the fluid processing industry, particularly within the oil and gas industry (flow assurance and metering issues), petroleum industry (issues related to both storing and pumping of petroleum products), food and beverage industries (issues related to the processing, handling and storing of viscous and nonconventional fluid mixtures) and water processing facilities such, as water treatment plants and sewage plants (difficulties encountered to meet or maintain pre-set product outflow specifications and regulations).

LEARNING OUTCOMES

Upon completing the unit, learners should be able to:

1. *Understand the fundamentals of compressible fluid dynamics e.g. speed of sound, definition of subsonic, sonic, supersonic flow and other critical conditions of a single-phase gaseous fluid.*
2. *Understand the methods and applicability of differential relations for computing complex 1-D, 2-D and 3-D fluid flow problems.*
3. *Distinguish between the types of gas-liquid flow regimes and their related hydrodynamic characteristics and pressure drop in conduits and pipeline systems.*
4. *Understand the difference between steady state and transient fluid flow conditions of industrial process systems.*

ETMEC-605-2102 Thermodynamics

Unit Type: ☒ Theory ☐ Practice ☐ Theory and Practice ☐ Placement

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

Thermodynamics is a branch of physics which deals with the energy and work of a system. It was born in the 19th century as scientists were first discovering how to build and operate steam engines. Thermodynamics deals only with the large scale, macroscopic response of a system which we can observe and measure in experiments.

This unit provides an extended knowledge of thermodynamic principles and phenomena to engineers who have already gained a firm understanding of the basic thermodynamics theory – theoretical content of several engineering topics which previously taught during the delivery of several units of the 'old' MCAST B.Eng. (Hons) Degree in Mechanical Engineering (Plant).

This unit offers an advanced learning in the field of thermodynamics systems, particularly related to the study of energy exchange mechanics between thermodynamic systems by thermal interaction. More specifically, this unit focuses on the design characteristics of industrial heat exchanger units, configurations of heat exchanger network design based on the pinch analysis, the design of boilers and boiler trial theory, and the design and working principles of impulse and reaction steam turbines.

The understanding of the fundamentals of the heat transfer / energy exchange phenomena of the mentioned devices, equipment, and technologies, is significantly important to several engineers within various industries. Having a good understanding of such fundamental principles is nowadays considered as the foundation tools that engineers use to turn theory into practice and provide feasible answers to the day-to-day engineering challenges and gain the expertise to design complex heat engines.

In summary, the focus of this unit is twofold. The first objective is to provide the basic concepts of thermodynamics and applies them to a wide range of technologies, and lay the groundwork for subsequent studies in such fields as fluid mechanics, and heat transfer, and the second objective is to prepare the student to effectively use thermodynamics in the practice of engineering.

Learning Outcomes

Upon completing the unit, learners should be able to:

1. *Understand the design characteristics of industrial heat exchanger units.*
2. *Understand the configuration of heat exchanger network design and the significance and applicability of the pinch analysis.*
3. *Understand the design of boilers and boiler trial theory.*
4. *Distinguish between impulse and reaction steam turbines and solve design problems.*

ETMEC-605-2103 Engineering Materials

Unit Type: ☒ Theory ☐ Practice ☐ Theory and Practice ☐ Placement

Level: 6

Credits: 5 ECTS

Unit description

The unit aims to provide underpinning knowledge about essential properties of engineering materials, how these properties are tested, including test result interpretation as well as the comparison of such results with published data. Basic atomic arrangements and structures of the most common engineering materials will be reviewed.

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

Alloys are essential engineering materials. Students will analyze the effect of variations in chemical composition of a mixture on the final properties of an alloy. The development of the structure of an alloy shall be understood through the study of phase diagrams. In view of this, emphasis will be made on steel. Several examples illustrating the use of the Iron Carbon phase diagram shall be carried out. This will make the learner understand the concept of an alloy such as steel with diverse properties owing to a variation in composition with respect to Carbon content and alloying elements present in the mixture.

Engineering material properties may be developed and adjusted through tailor made heat treatments and may vary depending on the method of processing. An example is whether the material manufacturing process is carried out in the liquid (cast) or solid (ex: rolled) state. A wide range of treatment processes will be explained, starting from basic quenching to more advanced treatments such as annealing and normalizing. Learners will be made knowledgeable on the variations of the most common liquid and solid processing methods. A deeper analysis of these treatments will enable the learner to choose a specific heat treatment with the relative correct parameters for steel with the desired characteristics. This would be possible following the understanding of the resulting microstructures that will be produced by different treatments/parameters.

The aforementioned topics will assist engineers in industry to choose a suitable material or materials for given products, tools and/or other applications. An example is that learners investigate a specific heat treatment with defined parameters applied to a particular steel and by applying the knowledge gained, decide for which application this steel would be an ideal candidate. Another example would be the choice of a specific heat treatment to produce a tool with the required properties. In this manner, students are capable of performing a materials selection exercise by controlling the properties required from an engineering material while recognizing the importance of raw material, availability and cost, form of supply, corrosion/degradation resistance and environmental impact among others.

Ceramics, Polymers and Composites are equally important materials in the engineering industry and as such, their use and applicability will also be covered in some detail. Examples include carbides and nitrides with respect to ceramics, rubbers when discussing polymers and more. Learners will analyze how the combination of two or more different material classes gives rise to a material engineered with unique characteristics, namely, a composite.

In the concluding section of the unit, an in depth understanding of degradation and failure mechanisms for metals, ceramics, polymers and composites will be covered. Learners will be made aware that failure could occur earlier than expected especially if the service conditions are changed drastically or if the product is not maintained correctly. Failure mechanisms such as Fatigue, Creep, Corrosion, Scission of intermolecular chains and combined mechanisms will be investigated together with the modes of testing for such failure. Students will be capable of analyzing these issues for a given engineering situation/product/service condition and recommend remedial and preventive measures to avoid or retard failure.

Learning Outcomes

Upon completing the unit, learners should 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.*

ETPRJ-610-2100 Engineering Project

Unit Type: ☒ Theory ☐ Practice ☐ Theory and Practice ☐ Placement

Level: 6

Credits: 10 ECTS

Unit description

The basic principles underpinning an engineering project involves conducting and concluding specific tasks, whether as part of an overall strategy or as individuals. Project management tools will give learners the ability to split a substantial project into manageable tasks and create a suitable strategy for the completion of the project deliverables.

The project for the scientific engineering research will be contextualized, that is, either the assignment is conducted in conjunction with industry or the project would have a scientific background and conducted within the college's facilities. The student will carry out the project from initiation to completion, thus enriching his or her experience within project management. The task, which would also involve considerable research, will provide the student with a broader sense of individuality, achievement, purpose and objective decision making. Suitable strategies for project delivery will be created while encompassing customer's requirements, specifications, expectations, time-frames and/or required problem solutions.

The worthiness of a scientific academic research relies on its reliability, the research process itself, dissemination of results, and honesty of researchers. Sustaining and following the required standards at every step will surely protect the reputation of the researcher and research institution. Furthermore, applying appropriate communication research skills to diverse audiences will not only be useful for scientific research but also vital throughout one's career. Additionally, addressing research questions and finding meaningful data structures requires researchers to master different strategies so to get the most out of their data. Every research has quantitative components that require data analysis.

This module will also enable learners to cover research methods, communication of research work and other different aspects of approaches to research and evaluation. One will develop a background for a critical approach to data analysis and interpretation related to an engineering or scientific project. To meet the requirements of this course students will also demonstrate their ability to produce either a scientific project or an engineering design project in conjunction with the industry.

Learning Outcomes

On completion of this unit the student will be able to

1. *Prepare a statement of intent for a given project title and analyse the requirements. The engineering task should be in conjunction with Industry or a scientific project conducted within the appropriate facilities.*
2. *Build the project according to the devised criteria, analyse results and evaluate the project deliverables.*
3. *Effectively communicate the project outcomes or research endeavour and analysis to an audience.*
4. *Describe the aims of an engineering project, limitations, and conclusions.*