MQF Level 6

EE6-01-21p

Pre-Warrant Qualification Course (Electrical/Electronics)

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, Optimization and Mathematical Modeling, Programming and Reasoning Skills, Electromagnetics, Electronic Physics and Semiconductor Principles and Devices 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 electromagnetics and semiconductor devices.*
2. *Investigate and recommend algorithms for a range of design optimisation applications.*
3. *Use mathematical techniques to support engineering decisions.*
4. *Build code that satisfies the specifications of an engineering task involving algorithmic thinking.*

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
ETELE-605-2100	Electromagnetics	5	1
ETPRG-605-2100	Programming and Reasoning Skills	5	1
ETMTH-605-2101	Optimisation and Mathematical Modelling	5	1
ETPHY-605-2100	Electronic Physics/Semiconductor Principles/Devices	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.*

ETELE-605-2100 Electromagnetics

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

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

Electromagnetics forms a basic part of all Electrical systems. The electronics engineer needs to have a good grasp of what is happening at field level in order to take the appropriate decisions. The scope of this module is to provide an introduction to this subject and its related applications.

This module uses the traditional transmission line approach to introduce the student to the subject. Field theory using electrostatics and magnetostatics is covered afterwards together Maxwell's equations for time varying fields. The relationship between the fundamental fields and electrical components. Finally, the interaction between the fields in terms of plane wave propagation is discussed.

LEARNING OUTCOMES

Upon completing the unit, learners should be able to:

1. *Analyze transmission lines.*
2. *Investigate the principles of Electrostatics.*
3. *Investigate the principles of Magnetism.*
4. *Apply Maxwell's equations for time varying fields and plane waves.*

ETPRG-605-2100 Programming and Reasoning Skills

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

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

The development of algorithms is an art or a skill, which can be mastered using a specific methods or techniques. Algorithmic strategies are a general approach by which many problems belonging to various areas of computing applications can be solved algorithmically. Examples of such algorithmic techniques include Brute force, Divide-and-conquer, Dynamic programming, Greedy technique and Backtracking. Therefore, the design process of algorithms is an important step. Such step requires the need to understand a problem statement completely.

In programming it is further required to represent complex data structures so to describe various objects. Using computational reasoning such data structures can be optimised or even help developers to come up with different solutions. After implementing the requirements, one needs to check whether the program works as expected. As stated by computer scientist Edsger Dijkstra, “Testing shows the presence, not the absence of bugs”.

The use of logics, and mathematical tools can be used to give meaning to computer programs. Translating the logics of a program into formal semantics and mathematical notation can be useful to check that a program satisfies certain requirements. Mathematics is all about reasoning. This unit shall provide learners the opportunity to apply some mathematical tools such as probabilities to design and implement specific programming algorithms. Additionally, it will strengthen the learners’ skills in tackling abstract problems. The first two learning outcomes mainly focus on the implementation of probabilistic knowledge and randomised algorithms for AI case studies, mainly focusing on the Bayesian approach to solve real problems in the engineering world.

Furthermore, this unit will provide the learner with an insight into concurrent programming as well as a strong foundation through which the learner can implement solution to various engineering problems.

Learning Outcomes

Upon completing the unit, learners should be able to:

1. *Apply probability reasoning for a specific AI application.*
2. *Demonstrate an understanding of Probability analysis and randomized algorithms.*
3. *Implement solutions based on concurrent programming.*
4. *Design and implement efficient solutions through data structures and algorithms.*

ETMTH-605-2101 Optimization and Mathematical Modelling

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

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

The first part of this module is designed to give the student the foundations such that with the skills acquired one could direct his efforts towards any practical optimisation challenge. Optimisation algorithms deal with finding the minimum or maximum value of a function. The student is first exposed to different optimisation scenarios. For each scenario a low level algorithm implementation and the mathematics behind such an algorithm is presented. This will give the student the insight required to make informed decisions when higher level libraries are introduced and made use of. The use of optimisation algorithms as the-behind-the-scenes for data science, machine learning and AI shall also be introduced.

In the second part mathematical modelling of systems that consist of different engineering domains involving mechanical, fluids, thermodynamics and electrical are presented. Differential equation models are presented as an introduction. Solution of the differential equation models are discussed, by using transforms or time domain approaches. Limitations of such different approaches are presented especially when dealing with nonlinear systems. Finally, state space models are introduced together with bond graph models.

Comparison of the different modelling approaches are presented with case studies on real physical systems.

LEARNING OUTCOMES

Upon completing the unit, learners should be able to:

1. *Adopt the correct optimisation algorithm that best fits the nature of a problem.*
2. *Use the design of experiment methodology for process or design optimisation.*
3. *Develop models using state space representation and simulation diagrams.*
4. *Understand Bond Graph components and representation.*

ETPHY-605-2100 Electronic Physics/Semiconductor Principles/Devices

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

Level: 6

Credits: 5 ECTS

UNIT DESCRIPTION

Electrical Engineers need to have a good grasp of the fundamental physics involved in semiconductors. Thus building from these basic principles learners have a deep understanding of the how discrete semiconductors work.

This unit present the fundamental Electron physics and then applied to semiconductor devices, starting from the pn diode junction and the two main families of discrete devices, the Bipolar Junction Transistor and the Field Effect Transistor. Their operation and equivalent models are discussed and several discrete designs described. Circuits involving both technologies are presented in order to gain the advantage of both.

Semiconductor testing is a specialized area within circuit design but it is critical as a quality assurance process. The learner is introduced to the role of the test engineer and the equipment used. An introductory suite of tests that is performed on an Integrated circuit is presented.

LEARNING OUTCOMES

Upon completing the unit, learners should be able to:

1. *Understand the properties of Electrons.*
2. *Discuss the fundamental properties of semiconductor devices.*
3. *Discuss semiconductor models.*
4. *Investigate Methods to test Integrated Circuits.*

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.*