MCAST

Malta College of Arts, Science & Technology

MQF Level 6

EE6-A1-20

Bachelor of Science (Honours) in Biomedical Engineering

Course Specification

Course Description

The objective of this programme is that of developing professionals who have strong practical competences backed by solid underpinning knowledge related to the biomedical engineering sector. The exciting advances being made in artificial body parts and organs and other prosthetic implants all fall in the realm of biomedical engineering.

The course gives candidates a basic understanding of the functioning of the human body, a sound knowledge of biomechanics and the various interfaces that allow prosthetics to become an extension of the human body. The various engineering fields involved are also studied to provide a seamless product to the client.

To enhance this qualification, learners will have the opportunity to carry out apprenticeship experiences in their chosen field in the first 2 years of their programme. Learners will work as apprentices during the summer after they conclude the first year and second year. However, during the scholastic year of their second year they will be going on apprenticeship once a week.

Programme Learning Outcomes

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

1. *Appraise the interaction of medical equipment and the human body;*
2. *Analyse and design electronic and control circuits for biomedical applications;*
3. *Manage projects involving the specification, installation and maintenance of biomedical equipment;*
4. *Contribute in the development of research projects in the field of biomedical engineering.*

Entry Requirements

MCAST-BTEC or MCAST MQF Level 4 qualification in the field of Electrical and Electronics Engineering

Or

2 A-Level passes and 2 I-Level passes

Compulsory A-Levels: Physics and Mathematics (Pure or Applied)

Current Approved Programme Structure

Unit Code	Unit Title	ECTS	Year
ETELX-506-1519	Analogue Electronics 1	6	1
ETMGT-504-2003	Business Management Systems	4	1
ETELX-506-1520	Digital Electronics 1	6	1
ETELE-505-2000	Electrical and Electronic Principles	5	1
ETMTH-506-1509	Engineering Mathematics 1	6	1
ETMTH-506-1510	Engineering Mathematics 2	6	1
ETMEC-505-2001	Mechanical and Thermo-Fluid Principles	5	1
ETSYS-505-2000	Microprocessor Systems	5	1
ETELE-505-2000	Programming Techniques	5	1
CDWBL-506-1901	Work based Learning – Part 1	6	1
CDKSK-503-1907	English 1	3	1
CDKSK-503-1908	English 2	3	1
ETELX-506-1522	Analogue Electronics 2	6	2
ETELX-506-1523	Automation and Control	6	2
ETELX-506-1524	Digital Electronics 2	6	2
ETPRJ-506-1518	Engineering Group Project	6	2
ETMTH-506-1511	Engineering Mathematics 3	6	2
ETELX-506-1525	MATLAB/CAD/FEA	6	2
ETELX-506-1527	Programmable Logic Controllers	6	2
ETMDL-506-1505	Biomedical Electronic Instrumentation	6	2
ETMDL-506-1506	Introduction to Biomedical Devices and Techniques	6	2
CDWBL-506-1902	Work based Learning – Part 2	6	2
ETELX-606-1530	Digital Signal Processing	6	3
ETELX-606-1528	Analogue Electronics 3	6	3
ETELX-606-1529	Control Systems Theory	6	3
ETELX-606-1532	Signals and Systems	6	3
ETMTS-606-1513	Engineering Materials for Biomedical Applications	6	3
ETMDL-606-1507	Design for Medical Instrumentation	6	3
ETMDL-606-1508	Gait Analysis and Human Movement	6	3
ETBIO-606-1503	Human Biology	6	3
ETRSH-600-1502	Research Methods	0	3
ETDIS-612-1501	Dissertation	12	3
	Total ECTS	**180**	**/**

Unit: ETELX-506 1519 Analogue Electronics 1

Unit level (MQF): 5

Credits : 6

Unit description

This is an introductory unit, which provides a wide-ranging introduction to fundamental aspects of analogue electronics. The learner will have the opportunity to gain familiarity with a range of passive and active components (including resistors, capacitors, diodes transistors, and operational amplifiers, etc). Particular attention is given to both the fundamental principles that underpin their operation and their basic characteristics. In this latter respect, the learner will be encouraged to review and interpret manufacturers' specification sheets and apply this information to the implementation of analogue circuits.

Throughout the duration of the unit each learner will be given the opportunity to apply concepts and ideas introduced in lectures and thereby gain important practical experience. Consequently, practical work forms a major component of this unit and will enable learners to gain familiarity with test equipment and with circuit implementation, testing and troubleshooting. In addition, learners will be encouraged to gain experience with various circuit construction techniques – from rapid prototyping using breadboards and vero board, through to the design and implementation of printed circuit boards.

This practical work will be complemented by the use of CAD software, which will provide the opportunity to verify designs prior to their construction.

Assessment for this unit is based on the evaluation of laboratory work coupled with a time-constrained assignment. In all laboratory sessions, learners will work under the guidance and support of a project tutor/supervisor and will be expected to be self-motivated and to conform to all relevant safety requirements.

Learning Outcomes

On completion of this unit the student will be able to

1. *Explain the properties and operation of key passive and active components;*
2. *Describe amplifier configurations implemented using both discrete components and operational amplifiers;*
3. *Apply integrated circuits to solve applied problems;*
4. *Simulate, construct and test basic analogue circuits.*

Unit: ETMGT-504-2003 Business Management Systems

Unit level (MQF): 5

Credits : 4

Unit description

This unit will help learners understand how the management system of an engineering company operates. Learners will become aware that engineers are employed in many different businesses across a range of sectors, and that the skills and knowledge of an engineer can be used across a variety of functions to solve business needs and contribute to a business' overall commercial success.

It is important that learners understand how an engineering business operates and how it is placed within its economic sector. This unit aims to develop learners' understanding of business and the economy and how an engineering organization affects the environment.

Learners will come to understand the external factors that affect an engineering organization and how these factors impact the business. It is important that learners understand that these issues are not limited to engineering organisations.

The unit will allow learners to look at a specific engineering company objectively to understand how it operates. It would be ideal if the learner was employed within an engineering company, but this is not essential to be able to understand the outcomes of this unit.

Learners will come to understand how an engineering company functions within its sector and how it achieves its strategic aims and objectives. This will involve a clear understanding of how the company works and the essential functions that ensure its success.

Learners will become familiar with current legislation and the constraints that this legislation places on an engineering company.

Finally, in this unit, learners will come to understand the relevant costing techniques that are used in a modern engineering firm and how these techniques further impact the success of the business.

Learning Outcomes

On completion of this unit the student will be able to

1. *Explain the operations of an engineering company;*
2. *Explain how the general operation of an engineering company can be affected by various external factors, and the economic environment itself;*
3. *Demonstrate how constraints, such as legislation and government regulations can have an impact on the successful operation of an engineering business;*
4. *Determine how cost effective an engineering activity is, by applying costing techniques.*

Unit: ETELX-506-1520 Digital Electronics 1

Unit level (MQF): 5

Credits : 6

Unit description

This unit will provide a wide-ranging introduction to fundamental aspects of digital electronics and to diverse skills that are of pivotal importance to today's electronic engineer. The learner will develop an understanding of basic techniques used in the implementation and testing of digital systems, and this will be applied to the development of both combinational and sequential logic circuits.

Throughout the duration of this unit each learner will be given the opportunity to apply concepts and ideas introduced in lectures and thereby gain important practical experience. Regular laboratory sessions will enable the learner to design, prototype and test digital circuits. This will not only provide a crucial insight into circuit design and implementation but will also provide hands-on experience with a range of general-purpose test equipment.

This practical work will be complemented by the use of CAD simulation software, which will provide the opportunity to evaluate and refine designs prior to their construction.

Assessment for this unit is based on the evaluation of laboratory work coupled with time-constrained assignment. In all laboratory sessions, learners will work under the guidance of a project tutor/supervisor and will be expected to conform to all relevant safety requirements.

Learning Outcomes

On completion of this unit the student will be able to

1. *Identify and compare different digital logic families;*
2. *Design, simulate, construct and test combinational logic circuits;*
3. *Design, simulate, construct and test sequential logic circuits;*
4. *Design and evaluate digital systems comprising both combinational and sequential logic circuits.*

Unit: ETELE-505-2000 Electrical and Electronic Principles

Unit level (MQF): 5

Credits : 5

Unit description

This unit introduces an understanding of electrical circuits used in a range of engineering careers and provides the basis for further study of more specialist areas of electrical and electronic engineering.

This unit deals with the basic principles of dc and ac circuit theory. The learner is given an introduction to d.c. theory, electrical principles with the relevant laws being applied to series and parallel circuits.

The unit then introduces single-phase a.c. circuit theory and its application to series and parallel RLC circuits. Transformation theorems such as Norton and Thevenin and superposition as well as mesh/nodal analysis are applied to series and parallel a.c. circuits.

Complex waveforms are introduced and their properties and subsequent analysis using Fourier series is dealt with.

Finally, the transient analysis and circuit response of first and second order RL and RLC series and parallel circuits is performed using Laplace Transforms.

Learning Outcomes

On completion of this unit the student will be able to

1. *Apply d.c. and a.c. circuit theory to series and parallel circuits;*
2. *Use transformation theorems to solve series and parallel circuits;*
3. *Determine the properties of complex waves using Fourier analysis;*
4. *Analyse the circuit response using transient analysis and Laplace transforms.*

Unit: ETMTH-506-1509 Engineering Mathematics 1

Unit level (MQF): 5

Credits : 6

Unit description

This unit will allow learners to build upon previous theoretical mathematical knowledge and develop the skills required to solve engineering problems. Furthermore, it acts as an essential basis for the successful completion of many other units within the qualification. Delivery of this unit should be set within the context of the award to which it contributes.

Learners will gain a knowledge and understanding of algebraic techniques that involve transposition of formula containing exponentials and logarithms, polynomial division, remainder and factor theorem, partial fractions, arithmetic and geometric progressions and binomial expansion and applying these techniques to solve engineering problems.

Learners will develop their existing knowledge of trigonometry. This will involve the recognising and analysing graphs of sine, cosine and tangent, solving trigonometric equations, recognising and using trigonometric identities to prove results and solve equations, solve problems that contain sinusoidal functions.

Calculus skills will be developed, which will enable learners to differentiate from first principles and integrate standard functions, solve optimisation problems and find the area under a curve. These skills will be developed further by learning the product, quotient and chain rules for differentiation and applying these techniques to solve engineering problems.

In outcome 4 complex numbers will be further explored.

The Unit is relevant to learners wishing to further develop their engineering mathematics skills.

Learning Outcomes

On completion of this unit the student will be able to

1. *Apply algebraic techniques to manipulate expressions and solve equations;*
2. *Recognise and analyse trigonometric graphs and solve trigonometric equations;*
3. *Apply differentiation and integration techniques;*
4. *Solve problems involving complex numbers.*

Unit: ETMTH-506-1510 Engineering Mathematics 2

Unit level (MQF): 5

Credits : 6

Unit description

This unit has been designed to build upon previous theoretical mathematical knowledge covered in Engineering Mathematics 1, to be used in a more practical engineering context. Therefore, it is assumed that the learner has successfully completed this unit prior to commencing Engineering Mathematics 2.

Furthermore, it acts as an essential basis for the successful completion of many of the other units within the qualification. Delivery of the unit should be set within the context of the award to which it contributes.

The first learning outcome will provide the skills necessary for learners to be able to use graphical and numerical methods to solve engineering problems. This involves using graphs and Newton-Raphson methods to solve equations, using Simpsons Rule or the Trapezium rule to find the area under a curve. Furthermore, curve sketching techniques will be explored.

Statistical techniques and probability is explored in learning outcome 2. This will include linear correlation and regression and using the rules of probability to solve Normal distributions, used in an engineering context.

Learning Outcome 3 expands previous calculus skills and includes first and second order linear differential equations, Euler and Euler's improved methods and applying these techniques to solve engineering problems. This outcome will also give the learner some knowledge on the use of power series methods to solve ordinary differential equations.

Learners will develop the skills to use Laplace transforms to solve differential equations in an engineering context in learning outcome 4.

The Unit is relevant to learners wishing to further develop their engineering mathematics skills, and is the second of a series of three mathematics units.

Learning Outcomes

On completion of this unit the student will be able to

1. *Use graphical and numerical methods to solve problems;*
2. *Use statistical and probability techniques to solve problems;*
3. *Manipulate and solve ordinary differential equations;*
4. *Use Laplace Transforms to solve problems.*

Unit: ETMEC-505-2001 Mechanical and Thermo-Fluid Principles

Unit level (MQF): 5

Credits : 5

Unit description

This unit aims to provide learners in the electrical / electronics field an introduction to mechanical engineering principles and fluid thermodynamic processes. The unit is made up of two sections: the theory of engineering mechanics and the theory of thermo-fluids. No prior knowledge of the subject is required; however, a solid basis of mathematics is required.

The first part of the unit is a theory based section where learners will be introduced to engineering statics and will familiarize with the analysis of slender members such as beams, columns, and circular shafts. Following this, learners will then be introduced to engineering dynamics and engineering problems with uniform acceleration. The principle of conservation of energy and energy transfer in systems are also tackled.

Learners are then introduced to the principles behind hydraulic systems and gravity-based pressure measurement instruments. The learner will also be able to apply theoretical knowledge to solve simple one dimensional fluid flow problems. Learners will be able to apply the principles of dimensional analysis and calculate the head loss in pipe systems: define the Reynolds number of fluid flow, identify the velocity flow profile and pipe friction losses for laminar/turbulent flow and evaluate pipe secondary losses. Learners will also be introduced to definition of drag and lift forces of flows past immersed bodies.

Learning Outcomes

On completion of this unit the student will be able to

1. *Determine the behaviour of mechanical static systems;*
2. *Determine the behaviour of mechanical dynamic systems;*
3. *Interpret and determine the thermodynamic properties of a fluid undergoing thermodynamic cycles;*
4. *Evaluate hydrostatic and fluid flow systems.*

Unit: ETSYS-505-2000 Microprocessor Systems

Unit level (MQF): 5

Credits : 5

Unit description

This unit focuses on the principles of microcontroller based system design and practical skills required for the design, construction and testing of microprocessor-based systems. Learners will use software tools to develop software and construct the required hardware for a microcontroller-based system using the ARM-based family of CPU microcontrollers, such as the LPC24XX.

This unit is relevant for learners wishing to develop their understanding of the applications of microcontroller-based systems and develop their skills required to design, write and test software and interface such systems. Learners will investigate the different families of microcontroller devices and the wide range of applications in which microcontroller based embedded control systems can be used.

Learners will become familiar with the typical microprocessor-based system design cycle and the tools used for executing each stage of the process. This unit will provide the learner with the ability to define the requirement for a given specification and representing the software program using state-charts, flowcharts, and pseudo code. The learner will also be able to use embedded IDE (Integrated Development Environment) in order to write the embedded code using low-level and high-level language compilers and the use of simulation tools such as Proteus to test and debug the system.

Finally, learners should have the underpinning knowledge and understanding to design and implement a microprocessor based system which interface and use I/O devices such as LED and LCD displays, switches, stepper motors, sensors, DC and Servo motors, Encoders, ADC and DAC. Use of different coding techniques such as ISR (interrupt service routines) and software polling in order to access peripherals and I/O will be familiar to learners.

Learning Outcomes

On completion of this unit the student will be able to

1. *Evaluate the different microprocessor families and understand the architecture of the microcontroller core and the peripherals units used for the I/O functions;*
2. *Demonstrate an understanding of the development cycle used to build microprocessor based embedded system;*
3. *Use of an embedded IDE to write code, assemble, compile, debug and test programs using both high and low level programming languages;*
4. *Demonstrate the ability to design and build embedded systems using a range of I/O devices in order to implement a working embedded system application;*
5. *Apply different coding techniques such as interrupt-driven and polling to interface with peripherals and other systems.*

Unit: ETELE-505-2000 Programming Techniques

Unit level (MQF): 5

Credits : 5

Unit description

This is a skills based unit, which will enable learners to gain proficiency in designing, implementing, and testing computer programs. Central to the unit is the use of structured design techniques, which enable key aspects of program development to be carried out within an engineering framework. In addition, unit content will enable learners to gain familiarity with a procedural programming language such as C/C++ and also with object oriented programming using C#.

No previous programming experience is assumed and so the unit is particularly relevant to learners wanting to gain a sound insight into the fundamentals of programming within the context of an engineering framework. Key aspects of the unit include the use of algorithms to identify solutions to specific problems, the formulation of structured programs based on these algorithms, and the testing of programs to verify their operation. In addition, emphasis is placed on developing meaningful and effective documentation thereby providing a basis for programs to be modified or extended at a later date.

An overarching theme of this unit is to provide hands-on practical experience. In this context, learners will design, develop, test and document their own programs and critically appraise exemplar programs written by others.

Learning Outcomes

On completion of this unit the student will be able to

1. *Design and implement computer programs using structured programming techniques;*
2. *Employ successfully structured modularisation techniques;*
3. *Design and develop comprehensive documentation to a professional standard;*
4. *Develop and apply test schedules in support of program validation and verification.*

Unit: CDWBL-506-1901 Work based Learning – Part 1

Unit level (MQF): 5

Credits : 6

Unit description

The aim of this unit is to provide learners reading a degree at MCAST with the opportunity for work-based learning (WBL) with a registered MCAST partner. WBL provides learners with real-life work experiences where they can apply academic and technical skills and develop their employability. Work-based learning deliberately merges theory with practice and acknowledges the intersection of explicit and tacit forms of knowing.

Learners will be doing this unit in the summer of their first year and they will have a follow up unit in the summer of their second year so as to provide them with experience as their knowledge of the subject increases. This will enable them to develop holistically in the area they have chosen enabling them to enter the world of work fully prepared and with experience to show in the sector they have chosen. This unit will assist learners in preparing themselves to take responsibility for their own learning in the workplace and to develop the necessary confidence and attitudes to carry out tasks responsibly in real life work situations. Learners are able to gain practical, hands on experience in their chosen field of study whilst producing a work based learning portfolio and journal demonstrating their achievements and learning experiences.

Learning Outcomes

On completion of this unit the student will be able to

1. *Evaluate the relationship between theory, college practice and their application and development in a real world work-based activity;*
2. *Evaluate critically own performance and learning experiences at the place of work through a reflective journal;*
3. *Set SMART objectives for own improvement following the reflective exercise;*
4. *Develop an action plan for personal and professional development to reach set objectives.*

Unit: ETELX-506-1522 Analogue Electronics 2

Unit level (MQF): 5

Credits : 6

Unit description

Success in Analogue Electronics 1 is a prerequisite for enrolling in this unit. This previous course laid important, wide-ranging foundations and provided the opportunity for learners to simulate, implement and test various simple circuits. Analogue Electronics 2 builds on these foundations by introducing a broader range of components/devices and adopts a design centric approach. In this latter respect, learners will be expected to interpret and apply information derived from manufacturers' data sheets, and to develop circuit solutions that meet given specifications. Key areas of focus include the development of circuits that employ both discrete components and operational amplifiers. Particular emphasis will be on filter, oscillator and linear power supply design.

Laboratory work is an essential part of this unit and provides learners with hands-on experience in circuit construction, testing, and troubleshooting. This will also extend learner competency in construction techniques, and in the use of standard laboratory equipment.

Practical work will be complemented by the use of the Proteus circuit simulation software, which will provide the opportunity to evaluate, verify and refine designs prior to their construction.

In all laboratory sessions, learners will work under the guidance of a project tutor/supervisor and will be expected to conform to all relevant safety standards.

Learning Outcomes

On completion of this unit the student will be able to

1. *Understand the operation and application of discrete devices;*
2. *Apply the properties of feedback in the application of operational amplifier based circuits;*
3. *Discuss a range of standard operational amplifier techniques;*
4. *Design, construct and test several power supply architectures.*

Unit: ETELX-506-1523 Automation and Control

Unit level (MQF): 5

Credits : 6

Unit description

This unit introduces the learners to the fundamental principles of Automatic Control Systems by covering basic topics on modelling, analysis and control of linear time-invariant dynamic systems.

The unit is organized into five parts. The first part introduces the subject of automatic control and its most fundamental concepts and terminology via a number of practical examples. The second part covers the Laplace transform, its mathematical properties, and its use in solving linear differential equations. This leads to the third part, which treats mathematical modelling of dynamic systems. This part enables the learner to develop transfer function models for a number of basic engineering systems including electrical, mechanical, thermal and fluid components. The fourth part deals with system analysis, and presents a set of tools for the analysis of linear dynamic systems. These include both time-domain and frequency-domain techniques. The final part of the unit introduces basic linear controller design including phase compensation techniques, Proportional-Integral-Derivative (PID) control, and the Ziegler-Nichols PID tuning rules.

This unit is relevant to learners wishing to acquire a good understanding of the fundamental concepts and the basic tools that are required to maintain or design automatic control systems. Throughout this unit the learners are also exposed to computer simulation tools that are typically employed in the field, as well as a number of practical experiments.

Learning Outcomes

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

1. *Predict the dynamic and steady state response of an engineering system;*
2. *Design a control system in the time domain to a specified performance requirement;*
3. *Design a control system in the frequency domain to meet a specified performance requirement;*
4. *Understand the need for and use of multi-loop and complex control systems.*

Unit: ETELX-506 1524 Digital Electronics 2

Unit level (MQF): 5

Credits : 6

Unit description

Success in Digital Electronics 1 is a prerequisite for enrolling in this unit, and it is also assumed that learners have a basic working knowledge of the C programming language. In Digital Electronics 1, important wide-ranging foundations were introduced and learners had the opportunity to simulate, implement and test various combinational and sequential logic circuits. Digital Electronics 2 builds on these foundations and has two overarching areas of focus. The first of these relates to the design, implementation, programming, testing and structured troubleshooting of embedded systems. This will provide the opportunity to develop I/O hardware (operating in both digital and analogue domains) and to incorporate a range of interesting transducers. Attention will also be given to the adoption of appropriate reliability and safety features. Real time safety critical applications of embedded systems will also receive attention. The second key area of focus relates to the design, implementation and testing of FPGA-based circuits, and in this context learners will have the opportunity to develop combinational logic which meets given specifications.

Laboratory work is a vital part of this unit and provides learners with hands-on experience in circuit construction, testing, and troubleshooting. This will also extend learner competency in construction techniques, and in the use of standard laboratory equipment (including the logic analyser).

Assessment for this unit is based on the evaluation of laboratory work coupled with an end of term exam. In all laboratory sessions, learners will work under the guidance of a project tutor/supervisor and will be expected to develop formal laboratory reports. Learners are required to conform to all relevant safety standards.

Learning Outcomes

On completion of this unit the student will be able to

1. *Describe the general principles that underpin embedded systems;*
2. *Apply appropriate techniques in interfacing embedded systems with external devices;*
3. *Design, implement and test embedded systems;*
4. *Design, implement and test field programmable gate array circuits.*

Unit: ETPRJ-506-1518 Engineering Group Project

Unit level (MQF): 5

Credits : 6

Unit description

The majority of engineering projects carried out today are team efforts. The complexity of modern engineering needs the contribution of a number of knowledge domains. Working in team requires extra skills than doing an individual project. It is important that these skills are transferred and honed in an educational environment. Hence the rationale of the group project.

The project lifecycle will be developed in a structured manner under the guidance of a supervisor. The supervisor will provide support and guidance where necessary. Learners will have the opportunity to discuss the division of responsibilities, plan the implementation, testing and subsequent documentation. The project will draw on the skills that have been acquired in other units for successful completion. Each team needs to map the technical and logistical aspects of the project, choose the resources that are required, setup effective communication strategies and keep a log of all the activities done. During the project group members will need to conform to the relevant health and safety legislation.

The final assessment mark of the project will be split into two parts. There will be mark for the individual work contributed and a second mark which will reflect the team effort in the project. These marks are reflected in the level criteria assessing the project. Each group will consist of 3-4 students. Marks are awarded both for the planning and technical aspect.

The group project may take different forms such as a) a project suggested by the supervisor b) the group may suggest a project of their own c) a common theme is proposed by the institute/department and each group will undertake the project around this theme d) a competition, where the institute/department issue a set of requirements that each group has to accomplish. In this case each group will be assessed individually according to the criteria laid down in this document and external sponsorship sought to choose the project overall.

Learning Outcomes

On completion of this unit the student will be able to

1. *Formulate a project specification, define procedures and plan a practical solution;*
2. *Design and implement a project solution in accordance with agreed procedures, specifications and time constraints;*
3. *Evaluate project outcomes;*
4. *Demonstrate and describe project outcomes within a structured framework.*

Unit: ETMTH-506-1511 Engineering Mathematics 3

Unit level (MQF): 5

Credits : 6

Unit description

This unit has been designed to build upon previous theoretical mathematical knowledge covered in Engineering Mathematics 1 and Engineering Mathematics 2, to be used in a more practical engineering context. Therefore, it is assumed that the learner has successfully completed these units prior to commencing Engineering Mathematics 3.

Furthermore, it acts as an essential basis for the successful completion of many of the other units within the qualification. Delivery of the unit should be set within the context of the award to which it contributes.

The first learning outcome will provide the skills necessary for learners to be able to use and manipulate Matrices and apply these skills to solve problems in an engineering context.

Learning outcome 2 will develop student's knowledge and understanding of vectors and manipulating vectors.

Learning outcome 3 will return to calculus to further develop techniques used to solve partial differential equations and applying this technique in an engineering context.

Learning outcome 4 will develop student's knowledge of Fourier series and use these skills to analyse, model and solve engineering problems.

Learning Outcomes

On completion of this unit the student will be able to

1. *Recognise and manipulate matrices to solve equations;*
2. *Manipulate vectors;*
3. *Solve partial differential equations;*
4. *Use Fourier series to solve problems.*

Unit: ETELX-506-1525 MATLAB/CAD/FEA

Unit level (MQF): 5

Credits : 6

Unit description

This is a skills based unit and will allow learners to demonstrate that they have the necessary skills to use three software tools for engineering.

They will be able to program in MATLAB competently by developing a deep understanding of the fundamentals of MATLAB programming with scripts, built-in and user-defined functions for solving real-world engineering problems. In learning outcome 1, learners will use the MATLAB software for solving real-world engineering problems represented digitally using mathematical relationships. Learning outcome 2 will develop further on Matlab with the introduction to the Simulink modelling environment and the concept of Matlab toolboxes.

Computer-Aided Design (CAD) and Computer-Aided Manufacture (CAM) technology meet a wide range of roles in a modern product development environment. 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. In learning outcome 3 the roles of CAD/CAM in product development and typical software and hardware requirements to run efficiently CAD/CAM technology are first discussed. Subsequently, the learner would be able to develop the required hands-on skills in 2D and 3D solid modelling, with the ability to export files to 3D printing machines.

In the 4th learning outcome, the 3D modelling techniques are enhanced further with finite-element-methods (FEM). The learner would acquire the skill sets to analyse 3D models for stress and strain and in the process would also acquire the basic theoretical framework for such skills.

Learning Outcomes

On completion of this unit the student will be able to

1. *Use MATLAB for interactive computations involving functions;*
2. *Build Simple systems using the Simulink modelling environment;*
3. *Build a 3D model from a drawing and re-generate the drawing from the solid model;*
4. *Analyse, with the use of software, simple 3D solid model structures using FEM.*

Unit: ETELX-506-1527 Programmable Logic Controllers

Unit level (MQF): 5

Credits : 6

Unit description

This unit focuses on the practical perspective of the design, operational characteristics, internal architecture, construction and testing of PLC systems.

The software could be different programming methods as per IEC 61131-3 and interface the necessary hardware for a PLC system using the MELSEC GX-IEC Developer with Mitsubishi FX1N-24MR.

This unit covers number systems, such as Binary, Octal, Decimal, Hexadecimal, BCD and ASCII and the basic Logic functions such as AND, OR, NOT, etc.

It then goes on to describe the internal architecture of a typical PLC system using an available PLC as a demonstration. The operational characteristics of the CPU in executing a PLC program such as the scanning-cycle; design characteristics (types); Communication media types (cable types); a range of input and output devices; forms of signals such as digital and analogue, voltage and current; basic signal conditioning circuits; digital resolution and relationships; comparison of communication standards; networking methods and standards.

The unit introduces different PLC programming methods for small-scale engineering applications including design of flowchart techniques and the use of ladder-logic diagrams and logic gates for the design and implementation of simple programs.

A range of instructions that includes contact types, set, reset, flag bits, coils, timer types, counter types, mathematical operators will be covered as well as their applications.

Good programming guidelines such as contact labelling, rung labelling, program comments, global variable listings will be encouraged throughout the design and programming stage.

The testing and debugging of PLC programs using the MELSEC GX-IEC Developer with the applications and programs being downloaded and applied to the Mitsubishi FX1N-24MR.

Learning Outcomes

On completion of this unit the student will be able to

1. *State the design and operational characteristics of a PLC system;*
2. *Describe PLC information and communication techniques;*
3. *Apply programmable logic programming techniques;*
4. *Test and debug PLC programs.*

Unit: ETMDL-506-1505 Biomedical Electronic Instrumentation

Unit level (MQF): 5

Credits : 6

Unit description

This unit focuses on the design of electronic instruments for the measurement of biopotentials and on the processes involved in the acquisition and conditioning of such signals.

The unit will provide learners with a thorough coverage of biopotential acquisition systems including the design criteria for biopotential amplifiers, the influence of artefacts, safety standards, and other issues that affect the operation of such systems. Students will first be introduced to the biological processes involved in the generation of biopotentials and the characteristics of different types of electrodes used for the acquisition of these signals. Students will learn how to design and test amplifiers and filters for the conditioning of biopotentials. The processes of sampling and quantisation involved in the analogue-to-digital conversion of biopotentials will also be covered.

The theoretical knowledge conveyed to the students will be complemented with a number of practical laboratory sessions. Through these sessions the students will gain practical experience in the construction and testing of biopotential amplifiers and filters.

On completion of this unit the learner should have a good understanding of the stages involved in the measurement of biopotential signals and should have acquired the knowledge, skills and ability to use modern engineering tools for the design and testing of biopotential acquisition systems.

Learning Outcomes

On completion of this unit the student will be able to

1. *Explain the origins of biopotentials and the acquisition process to measure these signals;*
2. *Produce biopotential amplifiers that meet a given set of specifications;*
3. *Produce passive and active filters for the filtering of biopotentials;*
4. *Explain the processes involved in the digitisation of biopotential signals.*

Unit: ETMDL-506-1506 Introduction to Biomedical Devices and Techniques

Unit level (MQF): 5

Credits : 6

Unit description

In this unit learners will acquire an understanding of the principles of operation of a range of medical devices and medical imaging systems, as well as the safety issues involved in the design and operation of such systems.

The operation of basic sensors including resistive sensors, capacitive sensors, and sensors for temperature measurement will first be covered. Subsequently, in this unit students will learn the principles of operation of a range of instruments including spectrophotometers, devices for the measurement of blood glucose levels and blood gas concentration, haemodialysis machines, and other devices used in clinical settings.

This unit will also provide learners with the required knowledge about the regulations, maintenance procedures and safety issues that have to be considered for the proper design and operation of medical devices. The physiological effects of electricity on the human body and the different types of electrical hazards that can pose a risk in a clinical setting will be explained.

Learners will also acquire a good understanding of the underlying physics, structure and operation of a range of medical imaging modalities. This will include medical imaging systems that rely on ionising radiation such as X-ray imaging and positron emission tomography (PET), as well as non-ionising imaging systems such as magnetic resonance imaging (MRI), functional MRI (fMRI), and ultrasonography. Learners will also become familiar with the safety issues associated with each of these imaging modalities.

By the end of the unit students are expected to have acquired a good understanding of the design and operation of a wide range of medical devices and medical imaging systems, as well as the associated procedures to ensure proper functioning of such systems.

Learning Outcomes

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

1. *Explain the design and operation of a range of medical devices*
2. *Identify and follow procedures to ensure conformity of medical devices with electrical safety standards.*
3. *Explain the components and operation of medical imaging systems that involve the use of ionising radiation*
4. *Explain the components and operation of medical imaging systems that do not involve the use of ionising radiation*

Unit: CDWBL-506-1902 Work based Learning – Part 2

Unit level (MQF): 5

Credits : 6

Unit description

Work-based learning is an instructional method that provides a direct link between work experience and college based learning. A key element in such experiences, is the development of critical thinking. The ability to think critically is fundamental and is sought after by employers in various sectors. Critical thinkers will approach and solve problems methodically rather than by intuition or instinct. Critical thinking is important because it helps individuals and teams more effectively diagnose problems and identify possible solutions that aren't entirely obvious at first. WBL exposes learners to real world environments in order to promote and develop critical thinking. Apprentices, particularly at degree level, are also expected to take initiative and propose solutions to different problems that are faced day to day in various workplace settings. Through their apprenticeship experience, learners are expected to develop strong problem solving skills and use particular incidents as learning opportunities.

Learning Outcomes

On completion of this unit the student will be able to

1. *Examine the significance of critical thinking in degree apprenticeships;*
2. *Discuss the role of critical reflection within an experiential learning cycle;*
3. *Apply the IDEALS approach to effective thinking and problem solving;*
4. *Evaluate critical incidents and compile a critical incident journal.*

Unit: ETELX-606-1530 Digital Signal Processing

Unit level (MQF): 6

Credits : 6

Unit description

Digital Signal Processing (DSP) is an area of science and engineering that has developed rapidly over the past 30 years as a result of the significant advances in digital computer technology and integrated-circuit fabrication. Inexpensive and relatively fast digital circuits have made it possible to construct highly sophisticated digital systems capable of performing complex digital signal processing functions and tasks, which are usually too difficult and too expensive to be performed by analogue circuitry or analogue signal processing systems.

Digital processing hardware also allows programmable operations, while the signal processing functions to be performed by the hardware may be easily modified by means of the corresponding software. This enables a higher order of precision to be achieved through digital hardware and software as compared with analogue circuits and analogue signal processing systems.

This module presents an introduction to the basic analysis tools and techniques for digital processing of signals. It will particularly emphasise on signal analysis using Fourier transforms, linear system analysis, and filter design exposing the student to real world signal processing problems.

Learning Outcomes

On completion of this unit the student will be able to

1. *Understand discrete-time signals and systems;*
2. *Analyse systems using the DTFT and DFT transforms;*
3. *Evaluate discrete-time LTI systems by applying the z-transform;*
4. *Design an appropriate digital filter using system specifications and MATLAB.*

Unit: ETELX-606-1528 Analogue Electronics 3

Unit level (MQF): 6

Credits : 6

Unit description

During the last decade of the 20th century rapid expansion of digital circuits have led to predictions that almost everything would become digital. Such predictions appear to become reality today as most mass-produced applications such as telephony, mobile communications and high definition television adopt a digital approach. This leaves an impression that digital circuits will simply replace analogue circuits until the latter totally disappear from the electronic systems in use. In reality, the pervasiveness of digital circuits has increased the importance of analogue circuits for the simple reason that most digital systems need analogue circuits to interface with the real world which is purely analogue. Although analogue circuits often occupy only a small fraction of the total area of an electronic circuit, their performance is critical in deciding the overall performance of the system. Understanding analogue electronics is, therefore, among the most sought after skills by the industry.

Since the purpose of this module is to provide students with the appropriate knowledge and skills which will enable them to understand, analyse and design various analogue electronic circuits, this module offers essential material for the understanding and application of analogue signal processing using analogue electronic devices through operational amplifier and analogue voltage comparator basics, analogue circuits' frequency response, signal generation and a study of the fundamentals of analogue filtering.

Learning Outcomes

On completion of this unit the student will be able to

1. *Understand and determine the behaviour of various forms of op amp circuits;*
2. *Appraise and design wave generating and shaping circuits;*
3. *Evaluate and design linear and nonlinear analogue processing circuits;*
4. *Design and construct passive and active filter circuits.*

Unit: ETELX-606-1529 Control System Theory

Unit level (MQF): 6

Credits : 6

Unit description

Control theory is an interdisciplinary branch of engineering that deals with the behaviour of dynamical systems. Unlike many others it might integrate all areas of electrical engineering with mechanical or civil engineering for the purpose of designing complex systems. Even though the system is not very often recognized as the control system (CS), any modern system embeds the control subsystem to keep it running according to desired performances. In many cases in industry or in consumer electronics, an approach to design control system without a notion of the world around it would suffice. Furthermore, it is well supported by modern control technology and integrated in various components. To gain full impact, the control system must be designed as a complex, multi-disciplinary, hierarchically organized system, sometimes even with ability to interact with process in an intelligent way.

This course covers the basics needed to design stand-alone applications. It provides a critical review of Control Systems Theory by revisiting already acquired knowledge. It also delves into other fields, particularly those of state space system representation, analysis and design heavily supported by MATLAB and SIMULINK examples. This which will help the students' transition to tackling realistic control problems met in modern industry environment (mechanical systems, transmission, DC and AC motors, power electronics, filters, etc.).

Learning Outcomes

On completion of this unit the student will be able to

1. *Obtain mathematical models in both s-domain and state space forms of electromechanical systems and use MATLAB to obtain responses of SS models;*
2. *Provide a linear state space model from a non-linear one and test for controllability and observability;*
3. *Design full state feedback using an observer;*
4. *Understand how to design simple compensators, controllers using root locus diagrams, and be able to use automated tuning in MATLAB using root locus.*

Unit: ETELX-606-1532 Signals and Systems

Unit level (MQF): 6

Credits : 6

Unit description

The need to understand the mathematical properties of signals and the ability to process them whether in the frequency or time domain is at the basis of the fundamental engineering subjects. Typical examples are DSP, Communication, Control and Electronics. A firm grounding in this type of mathematical background is therefore a pre-requisite for the fore-mentioned modules consolidated by applications drawn from filtering, audio and image processing, communications, and automatic control.

The course starts with elementary signals and basic systems. Their fundamental properties, such as causality, time-invariance and linearity are discussed. The behaviour of continuous systems is modelled through differential equations, while the behaviour of discrete systems is modelled using difference equations. The concept of the impulse response and convolution is introduced. The course investigates the Fourier series and transforms, the properties of the Laplace Transform and the Z transform, as well as its use in the frequency domain analysis of the continuous and discrete systems. The concept of State Variables is introduced, followed by methods for solving the matrix State Equations. Finally, the sampling theorem is presented, as an interconnection between the continuous and discrete world.

The purpose of this course is to give students a fundamental knowledge on signals and systems. It is necessary for understanding literature in many engineering fields, such as digital signal processing, image processing, or multimedia processing. Students are to be equipped with the skills of mathematical modelling of discrete and continuous systems, simulating systems on a computer, and to be able to carry out elementary signal processing in the time and frequency domain.

Learning Outcomes

On completion of this unit the student will be able to

1. *Develop and use mathematical models to analyse signals and solve linear systems;*
2. *Use the four variants of the Fourier transform and be familiar with their properties;*
3. *Determine the frequency response of LTI systems; explain the behaviour of mixed continuous/discrete systems and understand the sampling theorem;*
4. *Use various transform methods to understand the properties and determine the response of linear systems; develop state-space models to solve linear systems.*

Unit: ETMTS-606-1513 Engineering Materials for Biomedical Applications

Unit level (MQF): 6

Credits : 6

Unit description

The role of the electrical and mechanical engineer has changed over the past few decades with the extensive use of new materials and technologies. Biomedical applications are an excellent example of how classical disciplines such as material science and engineering have developed into a focal point for electrical and mechanical engineering students. The success of modern medical devices and implants is highly dependent on the biomaterials used. Various types of metals, ceramics, polymers and even composites have contributed to significant advances in the field.

This module provides an understanding, appropriate at the undergraduate level, on the engineering, and where deemed important on the processing aspects, of biomaterials used in medical applications. The relationships between material properties, the respective processing methods, the design and the application are highlighted.

This module assumes that learners have a basic knowledge of commercial materials and their respective properties, structures and behavior and is designed to give participants a comprehensive overview of material structure, properties, behaviour and performance in biomedical applications, including biomaterial technology and specific problems like biocompatibility.

A broad approach to material science and engineering is adopted, including classification based on different types of materials (metals, ceramics, polymers and composites) and comprehensive analysis of their microstructure and properties. Topics include description of typical metals (stainless steels, nickel and titanium alloys), ceramics (alumina, zirconia, hydroxyapatite, α and β TCP), polymers (PLA, PGA, hydrogels) and composites applied in biomedical engineering. Special attention is paid to material behaviour in reaction with human body, i.e. classification to biodegradable, bio-inert and bioactive materials. Finally, modelling of biomaterial structural behaviour using modern numerical methods such as (FEM) both for solids and fluids is also presented in the course.

Learning Outcomes

On completion of this unit the student will be able to

1. *Understand the properties and applications of polymeric biomaterials, bioceramics as well as biocomposites.*
2. *Understand the properties and applications of titanium alloys, polymeric biomaterials, bioceramics as well as biocomposites.*
3. *Understanding the in-service causes of failure of biomaterials.*

Unit: ETMDL-606-1507 Design for Medical Application

Unit level (MQF): 6

Credits : 6

Unit description

The world of medical equipment technology advances at an ever-increasing pace. This module is aimed at providing the key knowledge and experience to allow students to pursue a career in the design of biomedical equipment. The course will expose you to various modern medical equipment technologies, as well as exploring the design and application of electrodes, biopotential amplifiers, ECG, EEG equipment. Additionally, this course covers the measurement of human respiratory system, blood pressure measurement techniques medical imaging and electrical safety in the medical environment.

Learning Outcomes

On completion of this unit the student will be able to

1. *Apply biomedical instrumentation and measurement techniques and describe the principal functions of the body system;*
2. *Evaluate the various bioelectric amplifier configurations, sensors, noises sources, electrodes, transducers and filters;*
3. *Evaluate the functionality of ECG, EEG, human nervous system and blood pressure measurement techniques and respiratory system processes;*
4. *Evaluate the functionality and features of medical laboratory instrumentation, hearing aids, delivery insulin devices and medical imaging equipment including electrical safety in medical environment.*

Unit: ETMDL-606-1508 Gait Analysis and Human Movement

Unit level (MQF): 6

Credits : 6

Unit description

Movement, or motion, involves a change in place, position, or posture relative to some point in the environment. Movement is the means by which we interact with our environment, whether we are simply taking a walk in a park, strengthening the muscles in a bench press, competing in the high jump at a collegiate track meet, or stretching or rehabilitating an injured joint. A thorough understanding of various aspects of human movement may facilitate better teaching, successful coaching, more observant therapy, knowledgeable exercise prescription, and new research ideas. Human movement represents a broad area of study in two disciplines, kinesiology and biomechanics.

This module aims to provide students basic knowledge of human movement assessment, in areas such as gait analysis, in order to enhance critical thinking in the common areas of kinesiology and biomechanics.

This module provides enough kinesiological and biomechanical details for the students of the Mechanical Engineering and Electrical Engineering Streams. Students should be interested in anatomy and functions of the human body and should be familiar with modern day, wide spread disorders and injuries.

Students are given an overview of human movement and gait analysis. After finishing this module, students should have a good understanding of human movement. It is designed to familiarise students with fundamental terms, concepts and principles of human movement analysis. This knowledge will be useful to students in their personal life as well as in other modules. The module will address specific areas of human movement, such as how human movement occurs and what may potentially impair or limit human movement. Accordingly, these aspects will be dealt with as the central focus of this module. It will also extend to exposing students to basic functions of some of the modern mechanical and electronic apparatus that are used in everyday kinesiology and biomechanics work.

The module begins with by defining the terminology of kinesiology and biomechanics. Basics of functional anatomy of the musculoskeletal system will be presented prior to studying considerations for movement and the musculoskeletal response and adaptation to loading. The topics will be followed by mechanical analysis of human

motion. Studying of human gait, because of its complexity, will be divided in several parts, i.e. gait fundamentals, normal and pathologic gait. Finally, the students will be introduced to gait analysis systems and their practical applications. All topics will be studied through examination of a non-invasive experimentation with their own bodies, computer simulations, reading, and attending lectures/discussions.

Though taking this module will not qualify students as "experts" in the field, it will give them a greater understanding, appreciation and, in some areas, working knowledge of human movement and gait analysis

Learning Outcomes

On completion of this unit the student will be able to

1. *Identify anatomical structures of the muscular, skeletal and nervous system and understand the interaction between each;*
2. *Understand functional anatomy and musculoskeletal response and adaptation to loading;*
3. *Define and identify human movement and gait analysis;*
4. *Understand the basic features of normal human gait and pathological gait;*
5. *Be familiar with gait analysis systems and solve biomechanics problems.*

Unit: ETBIO-606-1503 Human Biology

Unit level (MQF): 6

Credits : 6

Unit description

Human biology is an interdisciplinary academic field of biology, biological anthropology, nutrition and medicine which focuses on humans. It has been taught all over the world for decades like biology, biology and anatomy or anatomy with physiology. During its development it became closely related to number of other fields. One of those fields is biomedical engineering. That vastly popular and well spread science consists of basics of technical, mechanical and electrical engineering implemented in medicine. It took lots of years and hardworking experiments in biomedical engineering laboratories to develop todays' apparatus and medical devices which are now common part of every modern hospital. Nowadays we cannot even imagine an ambulance without medical devices developed on mechanical and electrical engineering principles. Even more, the basic intention of all the people working in biomedical engineering is to construct better and more reliable medical devices adjusted to all quality standards which will be ready to reply to all demands of modern medicine.

This module should provide basic knowledge of human biology from the cellular level to the level of organ systems. Students will study molecular and cellular basis of life and the nature of inheritance and genetics. The major systems of the human body, including musculoskeletal system, nervous control and senses, heart and circulation, respiration, urinary system and skin and superficial soft tissues will also be studied.

Learning Outcomes

On completion of this unit the student will be able to

1. *Explain the role biological chemicals play in the structure and function of cells;*
2. *Describe the structure and the main physiological functions of the major body systems;*
3. *Explain the concept of homeostasis;*
4. *Review the current research on modern medical devices.*