CORE MODULES: BEng (Hons) Electrical and Electronic Control Systems Engineering

You must take modules worth 120 credits at each level of the course. Each module is worth a specified number of credits.

Year one for full-time students (Level 4)

Introduction to Engineering Mathematics (15 credits)

- *The aim of this module is to develop student's awareness and skills in the mathematical principles and theories that underpin the engineering curriculum. The mathematical topics covered in this module relate to problems and applications in the engineering industry. Both statistical and engineering maths knowledge will be underpinned in order to prepare students for higher level mathematics modules and modules involving engineering principles. Successful completion of this module will allow students to utilise mathematical methods within a variety of challenging problems, interpret data using statistical software MS Excel and analyse and solve engineering problems in mechanical and electrical contexts.*

Programming for Engineers (15 credits)

- *The ability to program in a computer language is a necessary skill for modern electronics design and development engineers. In the world of embedded systems languages such as C/C++ are considered the most widely used and language of choice in the creation of software for embedded applications also known as firmware. This module will use a medium level language such as C to underpin knowledge of programming techniques and will take advantage of its efficiency, functionality and portability. The module not only covers basics of computer programming including data types, math operators, control flow and arrays but will also focus on concept problem solving. Successful completion of this module will provide students to create a C program from a specification taking into account reliability, efficiency and maintainability. Students will also be aware of up to date coding guidelines for safe and reliable software and also knowledgeable of advanced C features raised in technical interviews.*

Digital and Analogue Electronics (15 credits)

- *This module firstly introduces students to the types of analogue signals and their characteristics before moving onto electronic devices, circuits and systems that condition these signals for further processing. Students will be able to design through calculation then construct, test and simulate their designs on ECAD / Simulation packages. The module will cover the use of discrete semiconductor devices such as BJT and MOSFET transistors before moving onto active devices such as operational amplifiers. There will also be an exploration into conversion methods to the digital domain. This module will then move on to provide a fundamental understanding of logic design, both combinational systems for control purposes and sequential for conversion, counting and memory applications. The skills and techniques learnt in this module will be useful for engineers wishing to pursue a career in computer hardware development or the automation industry. Upon completion of this module students will be aware of the characteristics of analogue signals, the techniques involved in the design and evaluation of analogue subsystems used in the development of complete electronic systems, and a firm foundation of digital electronics.*

Product Specification and Design (15 credits)

- *Successful design engineering transforms ideas into useful artefacts or a problem into a solution or an old inefficient costly process into a safe and reliable one. However, without a clear understanding of the design process engineers may never meet the needs of the end user. The aim of this module is to introduce students to specific methods within an overall strategy from concept to design detail. The module also outlines the nature of design thinking and sets it within broader contexts of product development and design process management. Design engineering investigates topics such as project management techniques, stakeholder requirements, market analysis, design process management, drawings and concepts, ergonomics design calculations, modelling and prototyping, manufacturability, reliability testing, ethics, risk analysis and environmental considerations. Successful completion of this module will enable students to prepare an engineering specification based on end user requirements, develop technical solutions using engineering principles and present solutions to a target audience.*

Further Engineering Mathematics (15 credits)

- *Further Engineering Mathematics builds upon the methods acquired in Introduction to Engineering Mathematics to support and strengthen the analytical techniques applied in the core curriculum subject areas e.g. mechanical and electrical principles. The module will prepare students to analyse and model engineering situations using mathematical techniques and will provide a natural bridge to Applied Engineering Mathematics. Topics covered in this module include: complex numbers, matrix theory, and solutions to linear and non-linear equations, introduction to first and 2nd order differential equations and introduction to Laplace Transforms which is explored further in Applied Engineering Mathematics. Successful completion of this module will allow students to use applications of number theory in engineering problems solve systems of linear and non-linear equations related to engineering problems, model and solve engineering systems using ordinary differential equations.*

Electronic Circuit Design and Manufacture (15 credits)

- *Electronics is the science of controlling energy electrically where electrons play a fundamental role. Applications of electronics are endless. With the emergence of the Internet of Things revolution, almost everything in the domestic home will have some electronic system. Over the decades different topologies, circuits and systems have been developed and integrated to increase efficiency, performance, reliability whilst reducing size, cost and impact to the environment. The module aims to build upon the fundamentals of Digital Electronics and Analogue Electronics investigating mixed signal electronic measurement and control circuits as well as dc power supply circuits. Students will also learn the basics of printed circuit board design, current manufacturing techniques, testing and fault location strategies as well as exploring current EMC standards and legislation.*

Mechanical Principles 1 (15 credits)

- *Knowledge of basic mechanical principles is an essential background for all engineering disciplines ranging from space exploration through Formula 1 racing down to the design and development of everyday objects such as washing machines and office furniture as well as in all civil engineering activities. The module prepares students to solve simple problems in both static and dynamic mechanical systems. Simple power transmission systems are analysed and vibrations in a mass-spring system are investigated to understand the concepts of resonance and natural frequency.*

Electrical Principles (15 credits)

- *Knowledge of Electrical Principles is an essential part of electrical system design and development. Applications of these principles are found in a wide variety of everyday systems e.g. mobile phones, computers, cooking equipment, cars, TV's, power chargers, portable devices and lighting systems. Knowledge of electric principles also supports electronic principles analysis and design. The module explores the fundamentals of electrical quantities and concepts before closer investigation of dc circuit laws including Ohms, Kirchhoff's, Thevenin's, maximum power transfer and transient behaviour. The module then looks at ac properties, circuit principles including RL, RC and RLC series and parallel systems and finally explore electric transformer characteristics and operation. On successful completion of this module will enable students to prepare for level 5 electrical systems and provide underpinning knowledge for design and development roles in sectors such as electrical power engineer, senior electrical technician, test and commissioning engineer.*

Year two for full-time students (Level 5)

Applied Engineering Mathematics (15 credits)

- *Applied Engineering Maths builds upon the methods acquired in Further Engineering Maths to support and strengthen the analytical techniques applied in the core curriculum subject areas e.g. mechanical and electrical principles. This module will enable students from both Electrical and Mechanical disciplines to use the techniques of mathematical modelling to analyse and improve engineering systems. Topics covered in this module include: Solution of 1st and 2nd order differential equations using Laplace Transforms and eigenvalues and eigenvectors. Analysis of periodic functions using Fourier series. Successful completion of this module will allow students to model, analyse and improve engineering systems using mathematical techniques including Fourier analysis, Laplace transforms, eigenvalues and eigenvectors.*

Business Management for Engineers (15 credits)

- *Engineers need to understand the wide range of factors that contribute to the need for a business to grow and move forward whether they are the employee or the employer. Engineering solutions must also be business solutions constrained by budgets, resources and time. This module will provide engineering students with key knowledge and understanding of how business management works. The module aims to give students an insight into how successful businesses are organised and set up, how they plan for future success, how costing techniques are used to maximise profits and how performance analysis is used to make decisions and improve profitability. Students will be introduced to financial tools, including profitability forecasts, cash flow forecasts, contribution analysis, variance analysis and performance analysis. This module will provide engineering students with the key fundamentals of business operation and management and fundamental knowledge for L6 Project Management.*

Embedded Systems Development (15 credits)

- *An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real time computing constraints. Embedded systems find numerous applications in various fields such as digital electronics, telecommunications, computing network, smart cards, satellite systems, military defence system equipment, research system equipment, and so on. This module builds on the knowledge of Programming for Engineers utilizing the C language to develop firmware. Students will also be able to apply knowledge from the Digital and Analogue Electronics module. This module starts with an overview of modern microcontroller architecture and software followed by a series of practical experiments illustrating techniques in embedded C programming on a 32bit ARM microcontroller. Topics include GPIO, ADC, PWM, SPI, and I2C, use of timers and interrupts to build electronic measuring and control circuits. The module aims to provide a foundation of knowledge for engineers wishing to move into the field of embedded systems engineering and preparation for level 6 Embedded Software Engineering.*

Instrumentation (15 credits)

- *It can come as a surprise to students when they discover that the equations describing the suspension system on a car are essentially the same as those describing the oscillations of a quartz crystal clocking a computer. This module emphasises the underlying unity of apparently different physical systems (electrical, thermal, mechanical, fluid, chemical, biological etc.) by developing the concept of the system model and using the method of analogy. The module will focus on simple 'lumped parameter' models with particular reference to instrumentation and control systems. The module contrasts signal types and discusses methods of characterisation. The module concentrates on linear systems, developing the use of the Laplace transform, system block diagrams and the system transfer function as key tools. The difference between static and dynamic system models is explored and practical dynamic models developed. The use of computer tools and packages is integral to the module. Non-linear systems are introduced and methods of dealing with non-linearity outlined. Students will carry out practical studies involving the analysis, test and design of systems, sensors and associated conditioning circuits. Successful completion of this module will provide background knowledge of L6 Control Systems Engineering.*

Electrical Systems and Applications (15 credits)

- *Electrical Systems and Applications builds upon the fundamentals theories of level 4 Electrical Principles and where they are applied in everyday life in domestic and commercial circumstances. The module will cover essential topics for electrical engineers including transformers, variable speed drives, energy storage, DC and AC Motors, converters, harmonics and transients. Students will be expected to build upon the knowledge Electrical Principles in analysing systems and designing for requirements. On Successful completion of this module will enable students to prepare for level 6 Power Systems Engineering and provide underpinning knowledge for design and development roles in sectors such as electrical power engineer, senior electrical technician, test and commissioning engineer.*

Engineering Design Team Project (15 credits)

- *The key to successful engineering projects from concept to shipment relies upon a solid team working ethos. Good team working is where everyone know what they are doing and just as important know what everyone else's role is. Communication is one of the factors in engineering team projects especially when half of the team maybe half way round the world where English may not be the first language, local customs and techniques have to be foreseen and accounted for etc. It is very uncommon that engineers work alone and they may be placed in either small or large teams depending upon the project size where each engineer has a speciality. Heading the project team will me the project manager responsible for setting, maintaining and meeting targets, driving the project forward with strong leadership and supporting the team where possible. This module allows students to experience what it's like to work on a project as a team and reflect upon the challenges presented to them. Teams will be selected by the module leader in consultation with the course leader to ensure fairness, however teams will be allowed to identify and choose the individual team roles which will be one of their 1st challenges. Each team will be given a project from the module leader and will be expected to present their findings at the end of the module. All projects will need to go through the ethics approval process to assess their suitability and to conform to ARU standards. Students will be expected to draw up their knowledge from previous completed modules. During the module students will become conversant with planning, meeting deadlines and enhancing employment skills. The module is assessed on the team's performance and individual contribution. On successful completion of the module students will be able to form a functional team, hold regular documented team meetings, formulate a plan, undertake engineering calculations judgments where appropriate, produce detailed reports, demonstrate communication and team management and interpersonal skills. This module will also provide good preparation for L6 Project Management for Engineers.*

Automation in Industry (30 credits)

- *Manufacturing Automation took its roots from the automotive sector to cut time and costs of developing, maintaining and changing production lines. This was first achieved using programmable logic controllers during the 1970's. The application of PLC's then grew to other manufacturing sectors such as food and drink processing, controlling conveyers, filling and sealing systems. Industrial robots were also developed around the same time. Despite their path controls being unique to each system, the overall supervisory would be done by a master PLC. Nowadays modern manufacturing has led to consumers buying products that may have never been touched by human hand. This module allows students to investigate and evaluate components within automation in industry mainly Programmable Logic Controllers and Industrial Robots that can be programmed to implement an automated engineering solution. The module PLC types and selection, programming languages, safety standards, application programming, robot theory and operation, programming, simulation and safety. The module will also explore the fourth industrial revolution better known as Industry 4.0. Students will have access to state of the art PLC systems and industrial robot technology. Upon completion of this module students will be able to select and program a PLC and Industrial robot for a given task, evaluate applications and consider safety in design. Students will also gain a rounded knowledge of Industry 4.0.*

Final year for full-time students (Level 6)

Undergraduate Major Project (30 credits)

- *This final year module gives an opportunity for students to choose a topic of their choice from engineering or manufacturing that they will investigate. The dissertation will be counted towards the classification of their degree and should be summarised in their CV, so an appropriate topic should be chosen. This module will provide students with the knowledge to formulate a proposal that will be the outline of their final dissertation. The proposal is the foundation of the dissertation that will include the aim and objectives of their topic, a literature review, an exit plan, Gantt chart, CV and ethics form. Projects will be subject to ethical approval by a panel committee. The dissertation will give students the opportunity to research, investigate and critically evaluate data, document and present their chosen topic, and manage their dissertation.*

Control Systems Engineering (15 credits)

- *The Control Systems module will aim to bring together prior knowledge of mechanic and electrical/electronic systems to understand the building blocks of automated systems. The module will cover the definition of control systems and its applications, types of control systems (open loop and closed loop systems) with the advantages and disadvantages of both systems, types of input signals and controllers and the impact of that on the overall systems, types of responses (transient and steady state), and change of the signals between time domain and frequency domain. The concept and design of root locus. An experiment on root locus design under special specification to check the rising time, settling time, and steady state error. The module will also cover a digital control design (bode and Nyquist), conversion from time domain into Z domain. Application of Control systems engineering will focussed around autonomous vehicles. The module will also be based on mathematical problems and its interpretation on MATLAB. Upon completion of this module students will understand the principles and theory of the most used techniques in control systems with its mathematical and programmable methodologies. The module will provide students with knowledge in analogue and digital control which mostly used in various engineering fields and be aware of design challenges with safe and reliable automated systems.*

Project Management for Engineers (15 credits)

- *Project Management is used throughout the engineering and manufacturing industries. Project Management is the application of processes, methods, knowledge, skills and experience to achieve the project objectives. This module will provide students with the knowledge to plan and control engineering projects. The purpose of the module is to introduce students to a variety of techniques to manage people and resources, monitor and control budgets and issues, and to appreciate a project life cycle.*

Embedded Software Engineering (15 credits)

- *Embedded Software Engineering builds on the knowledge from level 5 Embedded Systems Development taking the applications programmer to system designer expected at senior roles within the sector. The module will take a generalised approach to software engineering of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of software. Developing software for an embedded system is unique compared to software for a server application for example. Due to memory and processing power constraints and the wide range of interaction with the physical world, the design of embedded software needs to be both reliable and flexible to meet these requirements and to be able to handle multiple tasks concurrently. These demands involves careful use of abstraction and interfaces to break the design into modules that are understandable, testable and adaptable. The module will cover system architectures suited to responsive real time systems and for safety critical systems with an in depth look at safety standards. The growth in IoT systems including autonomous vehicles will be discussed including security and scalability. The module will also allow students to investigate and evaluate real time operating systems (RTOS) and alternative platforms such as FPGA's for improved reliability. Students will also be able to gain experience of model-based development such as MATLAB/Simulink. The module aims to provide key knowledge and skills for the role of an Embedded Software Engineer.*

RF Systems and Circuit Design (15 credits)

- *The design of radio frequency (RF) systems and their circuits underpin the production of mobile communications, satellite communications, radar, intelligent wireless devices, broadcasting and other technologies, as well as understanding of the system concepts. This module builds on the electrical & electronic principles covered at level 4 to focus on the state of the art applications and demonstrate the importance of the underlying theoretical and design concepts. By taking a number of case study examples, this module aims to show how principles in RF engineering are applied to problem solving for state of the art radio transmitters and receivers. The assessment strategy for this module is designed to provide students with the opportunity to demonstrate their competence in using fundamentals of RF electronics and applying them to real life problem solving scenarios. This is achieved in part through computer aided design laboratory (CAD) assessment, which reflects a simulation task a student would be required to carry out and document in a professional context. In the examination students will be required to answer questions of a problem solving nature which will include evaluating RF systems and circuit design through knowledge of the relevant parameters.*

Digital Signal Processing (15 credits)

- *Digital Signal Processing is an understanding of the types of signal an their properties, Principles and concept of the Discrete time systems (sampling continuous time signals) and their use in Engineering, Mathematical techniques of solving Convolution and Properties of LTI systems, the Z-transformation and its Properties, the Z transform of Differential equations. Fourier series and Fourier Transform (FS and FT) where then will lead to Discrete FT and Fast FT, convolution used in DFT (circular convolution), and Signal and systems analysis (deterministic, random), use of auto correlation/cross correlation functions and their applications. . The unit will also provide approaches to the DSP algorithms and Processors such as the ARM Cortex M4. Upon completion of this module students will understand the principles and theory of the most used signals and the mathematical and programmable techniques used. The module will provide students with knowledge in digital signal processing techniques which mostly used in various engineering fields such as telecommunication, Sonar and radar, and medical systems.*

Power Systems Engineering (15 credits)

- *The modern world increasingly relies upon electrical power to supply our industries, commercial centres and homes with a convenient, flexible and reliable source of energy. To meet the customer's expectations, electrical power must be provided at a reasonable cost and transmitted to the customer, at the appropriate voltage and current levels. The customer utilisation of the energy source needs to be appropriate, without undue complexity, to facilitate energy generation and transmission. This module provides an overview of modern electrical power systems together with sources of and applications of renewable energy. The module will provide an introduction to the main components of and electric power systems including power generation, transmission, distribution and conversion as well as the quality and economics of power systems. The module also addresses both traditional and modern renewable energy sources as well as sustainable technologies such as fuel cells, hybrid vehicles and bio-energy. The module builds upon basic electric circuit principles and is delivered through a combination of lectures and lab exercises. The module aims to provide a foundation of knowledge for engineers wishing to move into the field of power systems engineering.*