CORE MODULES: BEng (Hons) Mechanical and Manufacturing 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.*

Manufacturing Processes (15 credits)

- *This module is designed to provide students with a basic understanding of manufacturing and joining processes. It examines the need to select a manufacturing process based on the technological requirements (e.g. required tolerances) and the target cost for a component. It goes on to consider how product and component design can be influenced by consideration of manufacturing processes. Students will have the opportunity to make a component or product using typical machining processes such as milling and turning and bench fitting. Students will also be instructed in the key elements of safe workshop practice and they will be expected to adhere to them at all times. About fifty per cent of the module will be based on the practical design and manufacture of a component or product. Students can work either as a group or individually depending on the complexity of the product they make; however, the final report must be prepared individually. This module will be assessed by project based practical coursework.*

Engineering Materials (15 credits)

- *The advancements and redevelopment of everyday items such as PC's, smart phones, TV's, cars and buildings rely heavily on the development and understanding of materials. Correct material application is critical to reliable and safe engineering design and engineers should have a broad underpinning knowledge of materials and their properties. The aim of this module is to provide this basic knowledge by looking at the atomic structure of common engineering materials and how this affects their properties, physical nature and performance. The module will also cover standard methods of testing and processing treatments as well as causes of failure. Successful completion of this module will enable students to explain the relationship between the atomic structure and physical properties of materials, determine the suitability of materials for use in an engineering role, investigate testing techniques to determine physical properties and recognise material failure in service. The module will also benefit students undertaking an engineering design module, group project and final undergraduate major project. This module will be assessed by coursework comprising lab reports, case studies and technical questions.*

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.*

Introduction to Fluid Mechanics and Thermodynamics (15 credits)

- *Fluid mechanics and thermodynamics are an integral part of any mechanical engineering programme. Fluid mechanics is the study of the forces and flow within gases, liquids and plasmas. Thermodynamics is the study of the transfer of energy in the form of heat and work, and their relationship to a system's macroscopic variables of volume, pressure and temperature. This module will provide students with the knowledge of the forces exerted by a static fluid on immersed surfaces and the principle of centre of pressure. Students will examine a selection of hydraulic devices and systems that incorporate the transmission of hydraulic pressure. Students will then examine viscosity in fluids, its measurement and the characteristics of Newtonian and non-Newtonian fluids. The module then examines fluid flow through the use of Bernoulli's equation. Head loss in pipes and skin friction coefficient and Reynold's number will be introduced to model viscous flows. Finally, students will examine the operational characteristics of hydraulic machines, by looking at the operating principles of turbines and pumps. Students will investigate thermodynamic systems, be able to use the steady flow energy equation and show an understanding of the Otto and Diesel cycles (internal combustion engines). They will be introduced to the property enthalpy and the first law. This module will be assessed by a combination of coursework comprising lab reports and problem solving and open book time constrained exercises.*

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.*

Computer Aided Engineering (15 credits)

- *Computer Aided Engineering is an essential part of a mechanical engineering programme. 3D CAD utilises parametric technologies to realise design ideas and create individual parts, sub-assemblies, assemblies & 2D drawings that are linked to automate revisions. This module will provide students with the knowledge and ability to translate 2D drawings into 3D part models and assemblies, then recreate fully annotated 2D part drawings, assemblies and exploded assemblies with balloon references and parts lists in a standard drawing template to BS EN ISO standards. Finally, students will gain the knowledge to export 3D models in different neutral formats. The delivery method combines lectures, with practice of 3D modelling techniques using an up to date, industry standard, 3D CAD package. This module enables students to create designs, produce 3D models or 2D drawings for the manufacture of prototype parts and assemblies, but also, with further research, simulate and analyse designs. This module will be assessed by coursework comprising case study design projects.*

Applied Fluid Mechanics and Thermodynamics (15 credits)

- *This module will build on the Level 4 module, Introduction to Fluid Mechanics and Thermodynamics through the introduction of the second law and the concept of entropy. The second law and its corollaries will be applied to a variety of heat engines to allow a deeper understanding of ideal cycles. Air standard cycles will be introduced as the basis for measuring efficiencies. Students will also learn how to use steam tables to analyse power plants. The Fluid Mechanics section considers polytropic, isenthalpic and isentropic expansions before going on to a more detailed study of incompressible, viscous and boundary layer flow. The concept of dimensionless groups will be further developed and their use in model testing outlined. This module will be assessed by a combination of lab work coursework and examination.*

Mechanical Principles 2 (15 credits)

- *This module revisits and expands on Mechanical Principles 1 to introduce several new topics and more complicated examples in the areas already studied. The module will cover topics such as: Three dimensional loading of materials, forces and moments in loaded beams and pressurized vessels, analysis of power transmission elements and dynamic balancing of rotating systems along with an introduction to vibration and viscous damping. Students will be expected to draw and build upon the material covered in Mechanical Principles 1. On successful completion of this module students will be ready for a level 6 mechanics module and have the necessary background to embark on industry specific training for design and development roles in various sectors. This module will be assessed by Examination and Case study report.*

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 (15 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.*

Structural Mechanics and Finite Element Analysis (15 credits)

- *Following an introduction to mechanics through the Mechanical Principles modules, which give a general introduction to dynamics and statics, this module focusses on statics and develops several key topics to a more advanced level before introducing Finite Element Analysis. Finite Element Analysis is readily available in most CAD packages and it would be advantageous for students entering a design environment to have an appreciation of its operation. This module begins with a macro view of structures by analysis the forces in 2D and 3D trusses as well as frames. It then goes on to determine the deflections these forces may cause through the principle of virtual work and Macaulay's method for analysing beam deflections. The study of statics continues with a move to the micro level and a review of yield criteria and the complex relationship between shear stress and plan stress through the use of Mohr's Circle. Following this the principles of FEA are introduced and a project is undertaken requiring students to complete an FE analysis on a mechanical component. On completion of this module students will be able to analyse the inertial forces induced in mechanical systems and the resulting distortions – both factors which must be properly considered in the design of a mechanical system. This module will be assessed by a combination of Coursework and Examination.*

Advanced Fluid Mechanics and Thermodynamics (15 credits)

- *This module will build on the Level 5 module, Applied Fluid Mechanics and Thermodynamics, through an introduction to compressible flow and convergent-divergent nozzles. Open channel flow with particular reference to hydraulic jumps will also be analysed. In the thermodynamics section more complicated steam cycles with reheat will be considered along with an introduction to stoichiometric combustion and heat transfer. On completion of this module students will have further in depth knowledge and application of fluid dynamics and thermodynamics for engineering systems. This module will be assessed by a combination of examination and coursework.*

Lean Manufacturing (15 credits)

- *Improving productivity and quality are at the heart of all manufacturing engineering activities and this module introduces the study of the theories and practices that underpin the modern approach to these subjects through a detailed review of lean manufacturing based on the Toyota Production System, which is widely acknowledged as best practice in this field. This module first introduces students to origins of lean philosophy and the focus on waste elimination in all its forms. This is followed with a consideration of the benefits of a lean approach to the organisation balanced with the challenges likely to be faced during an implementation programme. Consideration will also be given to the use of lean principles in transactional processes. The Toyota Production System (TPS) and some of the key tools within it, such as TPM, SMED and Kanban, are considered in detail before recent developments in the transformation of this into a generalised lean system are outlined, including to move towards Lean Sigma in which the principles of lean manufacturing are combined with those of 6 Sigma. The assignment will focus on the softer topics related to lean implementation. On completion of this module students will be able to explain the principles of lean manufacturing and the Toyota Production System. They will also be able to use a range of tool used within these frameworks and recognise some of the difficulties and challenges faced when implementing them. This module will be assessed by combination of examination and coursework.*

Polymer Processing and Recycling (15 credits)

- *Recent developments in advanced polymer materials and manufacturing technologies offer today's engineers and designers a new opportunity to create bespoke and customised products that will provide better technical solutions to the challenges of the modern world. At the same time, this can generate additional polymer waste if recycling options are not considered and fully utilised. This module firstly introduces students to plastics and rubber processing technologies through a review of materials, equipment and manufacturing processes available to produce specific engineering products. The effect of processing on thermoplastics will be examined in relation to rheology, heat and structural changes in material. Deterioration in properties caused by repeated processing (e.g. injection moulding or extrusion) and consecutive use of special additives will also be considered. The importance of plastics recycling will be reviewed from environmental and economic point of view with special focus on mechanical recycling. Due to their complex structure, rubber materials cannot be recycled by traditional recycling techniques. This module will introduce students to innovative rubber recycling technologies capable of converting rubber waste into a high quality material. There will also be an opportunity to develop professional skills by carrying out practical experiments based on identification, processing and testing of polymers and through industrial visits to advanced manufacturing and recycling companies. Upon completion of this module students will recognise how traditional and advanced polymer materials can be effectively converted into a range of engineering products by selection from the relevant manufacturing technologies. Moreover, students will also be able to critically assess established and innovative polymer recycling technologies in order to propose the most suitable recycling option for a specific engineering product. The module will be assessed by a course work, comprising of a presentation of initial research and a case study report based on the outcomes of practical investigations..*