# Mechanical Engineering BEng (Hons) module details

## Year one

### Block 1: Engineering Tools and Principles 1

The module provides background in the fundamental principles of Mathematics and Mechanical Principles (Solid Mechanics) covering topics such as stress and strain, shear forces, torsion and how power is transferred via shafts as in jet engines; it also covers topics in Electronic Principles relevant to all engineering disciplines.

### Block 2: Engineering Tools and Principles 2

This module builds on knowledge gained in Engineering Tools and Principles 1. It provides further understanding in Mathematics and Mechanical Principles (Dynamics) covering topics such as Newton's laws, linear and angular motion, friction, inertia etc. it also covers Electronic Principles including analysis of RLC circuits and operational amplifiers.

### Block 3: Mechanical Design and Manufacturing 1

Design is a fundamental part of modern Mechanical Engineering. In addition to being exposed to the design process through a project, students will learn the skills required to describe and analyse their design through CAD and Programming. Furthermore, to aid in the design process students will learn the basis of Machines and Mechanisms together with Thermodynamics.

In the project, the students will work as part of a team to develop a solution for a design challenge while tackling a range of issues to produce a cost-effective solution while considering the product life cycle. The students will work to a timetable and budget while interfacing with a range of personnel. They also receive essential training on operating manufacturing machines, and health and safety aspects.

### Block 4: Mechanical Design and Manufacturing 2

In this module, the students follow on from Mechanical Design and Manufacturing 1, by manufacturing and testing their designs as well as continuing their education on CAE and Programming this time looking at more advanced features together with more advance Machines and Mechanisms, and Thermodynamics.

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## Year two

### Block 1: Mechanical Principles

The module complements the material covered in Engineering Tools and Principles 1 and 2 modules by extending the Mathematical and Engineering concepts required for advanced study of Mechanical Engineering. There are three parts to the module a Mathematics part, a part on Fluid Mechanics and a part on Heat Transfer. The mathematics part covers subjects such as vector calculus, Fourier series, partial differential equations and numerical methods. These mathematical concepts will be used in the other two parts of this module and in other modules taught later in the programme. Fluid Mechanics part includes compressible and incompressible flows, non-dimensional parameter such as Reynolds number, Mach number which are extensively used to understand if the flow is subsonic, transonic, or supersonic. The other topics covered are Bernoulli, continuity, momentum equations and analysis of boundary layers which are useful in aircraft fuselage and wing design. The Heat Transfer part covers the basics of heat transfer and how various modes of heat transfer can be analysed via application of theoretical and emphatical equations.

### Block 2: Dynamic, Instrumentation and Control

The first part of the module introduces students to modelling and analysis of dynamic systems through the investigation of system response, with an emphasis on the free and forced oscillations. The student will learn about modelling physical systems, characteristic equations, natural frequencies, and vibration modes. These concepts are useful in understanding stability, control, and design of mechanical systems. The second part of the module introduces students to instrumentation aspects of computer control systems. The students will learn about principles of interfacing and instrumentation required for this purpose. The third part of the module introduces students to the theory of control systems and computer control. The aim is to teach analysis and design of single-input single-output continuous and digital feedback systems. The background theory is supported by computer aided design studies (e.g., using the MATLAB/Simulink package) and practical laboratory experiments.

### Block 3: Mechanical Materials and Structures

The module provides students with an opportunity to study materials science and the effect on solid mechanics. The module focuses on materials structure and properties, materials processing, materials testing, engineering materials, and computer-aided material information and selection. This enables students to analyse engineering problems involving materials issues and select solutions which meet functional requirements. In addition, the students develop practical, experimental and measurement skills via a structured programme of laboratory exercises.

### Block 4: Design and Project Management

Projects need to deliver a design solution (e.g., a product), which require planning and initiation, and need to be budgeted, costed, and scheduled and completed within these projections. Projects require management of stakeholder expectations, and they need to be undertaken at an agreed level of quality within an accepted level of risk. This module presents some of the background, theory, and practice to enable learners to embed professional project management expertise in their professional and academic development.

## Year three

### Block 1: Advanced Mechanical Materials and Professional Practice

This module combines professional practice and employability with the science and technology of materials (including emerging materials) deposition/processing such as: spin coating, dip-coating, electrochemical deposition, evaporation, sputtering and chemical vapour deposition. Topics closely related to thin film and emerging nanomaterials will also be discussed. This will provide students with a depth of core knowledge and skills allowing them to make informed choices concerning applications, selection, and design of advanced materials. Besides special types of metallic alloys, metallic glasses and new polymer materials, composite materials and graphene will be covered.

### Block 2: Mechanical Energy Analysis

Power generation and jet propulsion make up a significant portion of Mechanical Engineering and, in many ways, represent the pinnacle of advanced Mechanical Engineering. The module addresses concepts of power generation and jet propulsion based on efficient conversion and utilisation of energy.

In power generation part, the module focuses on thermo-fluid analysis of a range of power plants including steam turbine power plants, gas-turbines, co-generation plants, combine cycle plants, and internal combustion engines covering aspects such as plant efficiency analysis, operational limits, emissions and sustainability and noise issues.

The module also covers thermo-fluid analysis of propulsion systems. To facilitate the understanding of jet propulsion, initially, a range of topics related to fluid mechanics will be covered i.e., isentropic flow through nozzles, shockwaves and expansion fans, and supersonic aerofoil theory.

The above fluid mechanics topics will be then followed by thermodynamic full cycle analysis of turbojet and turbofan engines, velocity triangles applied to stator and rotor blades of aircraft engine, combustion chambers and combustion analysis, future fuels for aircrafts, aero engine noise generation, and noise mitigation techniques.

### Blocks 3 & 4: Project based modules

The ability to successfully complete a technical project is a critical competence required by all engineers. The programme offers a range of individual projects in the context of the skills required to complete them. The individual modules are described below, however, all of them cover the generic parts of completing a project including management, report writing, presentational skills, etc. together with a detailed study of some specialist fields in which the project falls. For this reason, the project modules are in two parts. In the first part, most of the technical information will be taught and assessed whilst students make a start on their projects (Block 3). In the second part, the students will mainly concentrate on their individual project with the technical skills assessed in this context rather than generically (Block 4).

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In Mechanical Engineering the school offers projects in the following broad areas (choose one of):

## Modelling and Simulation

The module Modelling and Simulation for Mechanical Projects (Block 3) will address the main concepts and methods of Computational Fluid Dynamics (CFD) and Finite Element Method (FEM) in the context of a project. The taught component will equip the student with the skills in mesh generation, application of boundary conditions, use of commercial CFD/FEA packages and applications of CFD/FEA to selected engineering problems. The complementary second module Mechanical Project with Modelling and Simulation (Block 4) is your individual project. Possible project areas could be in stress and strain analysis of mechanical structures, CFD modelling of external airflow, CFD modelling of flow inside combustion chambers, analysis of cooling systems etc.

This project path would normally suit students who wish to follow a career focused on Simulation of complex engineering components and systems both in mechanical and aeronautical industries.

## Analysis, Programming and Simulation

The Analysis, Programming and Simulation for Mechanical Projects module (Block 3) will provide students with a core understanding of analytical skills using programming, mathematical analysis, and user-defined simulation within the context of an individual project. The complementary second module is Mechanical Project with Analysis, Programming and Simulation (Block 4) which is your individual project. Possible project areas could be related to Flight Simulator software and hardware programming and design technologies, or any other programming intensive projects related to mechanical systems or aviation.

This project path would normally suit students who wish to follow a career focused on software programming related to the mechanical and aviation industries, covering a broad range of areas such as design, implementation, maintenance, and operation of software tools for both mechanical and aeronautical industries. It would also be suitable for students who wish to use these skills as transferable skills in other industries.

## Materials and Design

The Materials and Design for Mechanical Projects module (Block 3) will provide students with a core understanding of advanced materials and design within the context of an individual project. The taught component will be in two parts: technical tools for materials and design projects and transferable tools which could be used in your final year project or in industry. The complementary second module Mechanical Project with Materials and Design (Block 4) is your individual project. The design project areas could be in structures, vibrational aspects in mechanical design, use of novel materials etc.

This project path would normally suit students who wish to follow a career focused on the materials or structural parts of engineering including both mechanical and aeronautical industries.

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## 3D Printing and FEM

The module 3D Printing and FEM for Mechanical Projects (Block 3) will address the main concepts and methods of 3D Printing and Finite Element Method in the context of a project using these techniques. The module will provide students with a detailed background in modern rapid prototyping and finite element analysis of the design. The companion module, Mechanical Projects with 3D Printing and FEM (Block 4) is the individual project in which students will design, prototype, and analyse a mechanical device. Examples include brake pedals, prosthetics, implants, etc.

This project path would normally suit students who wish to follow a career focused on mechanical design and rapid prototyping including mechanical, aeronautical, and bio-medical industries.