BTEC

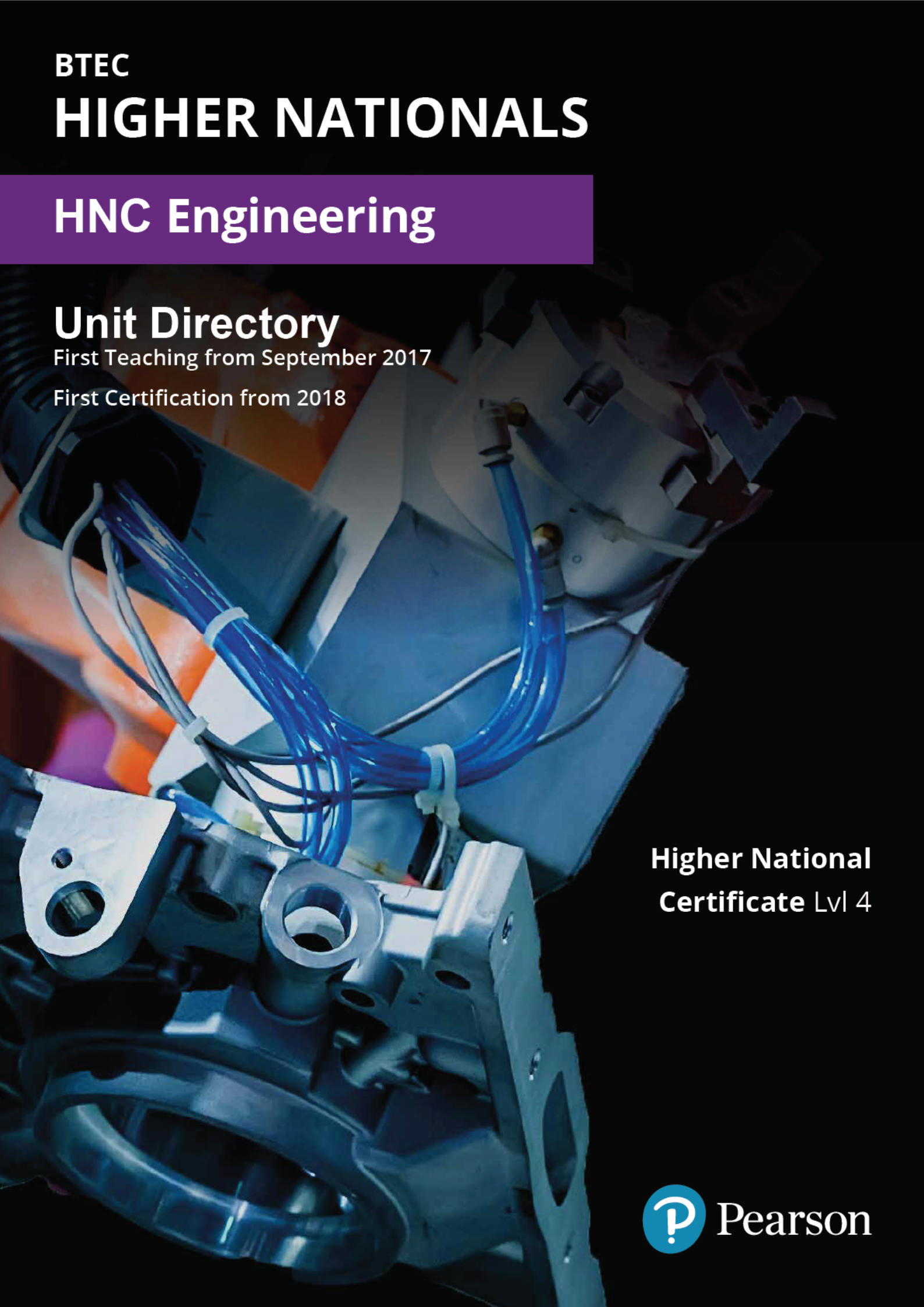
HIGHER NATIONALS

HNC Engineering

Unit Directory

First Teaching from September 2017

First Certification from 2018



Higher National Certificate Lvl 4

Pearson

HNC Engineering (2020/21)

60 Credits

Core Unit - Mandatory

Unit 1	Engineering Design	15 Credits
Unit 3	Engineering Science	15 Credits
Unit 4	Managing a Professional Engineering Project (Pearson Set)	15 Credits

Optional

Unit 6	Mechatronics	15 Credits

Unit 1: Engineering Design

Unit code	**K/615/1475**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

The tremendous possibilities of the techniques and processes developed by engineers can only be realised by great design. Design turns an idea into a useful artefact, the problem into a solution, or something ugly and inefficient into an elegant, desirable and cost effective everyday object. Without a sound understanding of the design process the engineer works in isolation without the links between theory and the needs of the end user.

The aim of this unit is to introduce students to the methodical steps that engineers use in creating functional products and processes; from a design brief to the work, and the stages involved in identifying and justifying a solution to a given engineering need.

Among the topics included in this unit are: Gantt charts and critical path analysis, stakeholder requirements, market analysis, design process management, modelling and prototyping, manufacturability, reliability life cycle, safety and risk, management, calculations, drawings and concepts and ergonomics.

On successful completion of this unit students will be able to prepare an engineering design specification that satisfies stakeholders' requirements, implement best practice when analysing and evaluating possible design solutions, prepare a written technical design report, and present their finalised design to a customer or audience.

Learning Outcomes

By the end of this unit students will be able to:

1. Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements.
2. Formulate possible technical solutions to address the student-prepared design specification.
3. Prepare an industry-standard engineering technical design report.
4. Present to an audience a design solution based on the design report and evaluate the solution/presentation.

Essential Content

LO1 **Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements**

Planning techniques used to prepare a design specification:

Definition of client's/users objectives, needs and constraints

Definition of design constraints, function, specification, milestones

Planning the design task: Flow charts, Gantt charts, network and critical path analysis necessary in the design process

Use of relevant technical/engineering/industry standards within the design process

Design process:

Process development, steps to consider from start to finish

The cycle from design to manufacture

Three- and five-stage design process

Vocabulary used in engineering design

Stage of the design process which includes:

Analysing the situation, problem statement, define tasks and outputs, create the design concept, research the problem and write a specification

Suggest possible solutions, select a preferred solution, prepare working drawings, construct a prototype, test and evaluate the design against objectives, design communication (write a report)

Customer/stakeholder requirements:

Converting customer request to a list of objectives and constraints

Interpretation of design requirements

Market analysis of existing products and competitors

Aspects of innovation and performance management in decision-making

LO2 **Formulate possible technical solutions to address the student-prepared design specification**

Conceptual design and evaluating possible solutions:

Modelling, prototyping and simulation using industry standard software, (e.g. AutoCAD, Catia, SolidWorks, Creo) on high specification computers

Use of evaluation and analytical tools, e.g. cause and effect diagrams, CAD, knowledge-based engineering

LO3 **Prepare an industry-standard engineering technical design report**

Managing the design process:

Recognising limitations including cost, physical processes, availability of material/components and skills, timing and scheduling

Working to specifications and standards, including:

The role of compliance checking, feasibility assessment and commercial viability of product design through testing and validation

Design for testing, including:

Material selection to suit selected processes and technologies

Consideration of manufacturability, reliability, life cycle and environmental issues

The importance of safety, risk management and ergonomics

Conceptual design and effective tools:

Technologies and manufacturing processes used in order to transfer engineering designs into finished products

LO4 **Present to an audience a design solution based on the design report and evaluate the solution/presentation**

Communication and post-presentation review:

Selection of presentation tools

Analysis of presentation feedback

Strategies for improvement based on feedback

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements</td><td rowspan="2">D1 Compare and contrast the completed design specification against the relevant industry standard specification</td></tr>
<tr><td>P1 Produce a design specification from a given design brief

P2 Explain the influence of the stakeholder's design brief and requirements in the preparation of the design specification

P3 Produce a design project schedule with a graphical illustration of the planned activities</td><td>M1 Evaluate potential planning techniques, presenting a case for the method chosen

M2 Demonstrate critical path analysis techniques in design project scheduling/planning and explain its use</td></tr>
<tr><td colspan="2">LO2 Formulate possible technical solutions to address the student-prepared design specification</td><td rowspan="2">D2 Evaluate potential technical solutions, presenting a case for the final choice of solution</td></tr>
<tr><td>P4 Explore industry standard evaluation and analytical tools in formulating possible technical solutions

P5 Use appropriate design techniques to produce a possible design solution</td><td>M3 Apply the principles of modelling, simulation and/or prototyping, using appropriate software, to develop an appropriate design solution</td></tr>
</table>

Pass	Merit	Distinction
LO3 Prepare an industry-standard engineering technical design report		**D3** Evaluate the effectiveness of the industry standard engineering technical design report for producing a fully compliant finished product
P6 Prepare an industry-standard engineering technical design report **P7** Explain the role of design specifications and standards in the technical design report	**M4** Assess any compliance, safety and risk management issues specific to the technical design report	
LO4 Present to an audience a design solution based on the design report and evaluate the solution/presentation		**D4** Justify potential improvements to the design solution and/or presentation based on reflection and/or feedback
P8 Present the recommended design solution to the identified audience **P9** Explain possible communication strategies and presentation methods that could be used to inform the stakeholders of the recommended solution	**M5** Reflect on the effectiveness of the chosen communication strategy in presenting the design solution	

Recommended Resources

Textbooks

DUL, J. and WEERDMEESTER, B. (2008) *Ergonomics for beginners*. 3rd Ed. Boca Raton: CRC Press.

DYM, C.L., LITTLE, P. and ORWIN, E. (2014) *Engineering Design: a Project Based Introduction*. 4th Ed. Wiley.

GRIFFITHS, B. (2003) *Engineering Drawing for Manufacture*. Kogan Page Science.

REDDY, K.V. (2008) *Textbook of Engineering Drawing*. 2nd Ed. Hyderabad: BS Publications.

Websites

www.epsrc.ac.uk	Engineering and Physical Sciences Research Council (General Reference)
www.imeche.org	Institution of Mechanical Engineers (General Reference)

Links

This unit links to the following related units:

Unit 23: Computer Aided Design and Manufacture (CAD/CAM)

Unit 34: Research Project

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Identify the relevance of mathematical methods to a variety of conceptualised engineering examples</td><td rowspan="5">LO1 & LO2

D1 Present data in a method that can be understood by a non-technical audience</td></tr>
<tr><td>P1 Apply dimensional analysis techniques to solve complex problems

P2 Generate answers from contextualised arithmetic and geometric progressions

P3 Determine solutions of equations using exponential, logarithmic, trigonometric and hyperbolic functions</td><td>M1 Use dimensional analysis to derive equations</td></tr>
<tr><td colspan="2">LO2 Investigate applications of statistical techniques to interpret, organise and present data</td></tr>
<tr><td>P4 Summarise data by calculating mean and standard deviation

P5 Calculate probabilities within both binomially distributed and normally distributed random variables</td><td>M2 Interpret the results of a statistical hypothesis test conducted from a given scenario</td></tr>
</table>

Unit 3: Engineering Science

Unit code	**T/615/1477**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

Engineering is a discipline that uses scientific theory to design, develop or maintain structures, machines, systems, and processes. Engineers are therefore required to have a broad knowledge of the science that is applicable to the industry around them.

This unit introduces students to the fundamental laws and applications of the physical sciences within engineering and how to apply this knowledge to find solutions to a variety of engineering problems.

Among the topics included in this unit are: international system of units, interpreting data, static and dynamic forces, fluid mechanics and thermodynamics, material properties and failure, and A.C./D.C. circuit theories.

On successful completion of this unit students will be able to interpret and present qualitative and quantitative data using computer software, calculate unknown parameters within mechanical systems, explain a variety of material properties and use electromagnetic theory in an applied context.

Learning Outcomes

By the end of this unit students will be able to:

1. Examine scientific data using both quantitative and qualitative methods.
2. Determine parameters within mechanical engineering systems.
3. Explore the characteristics and properties of engineering materials.
4. Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties.

Essential Content

LO1 **Examine scientific data using both quantitative and qualitative methods**

International system of units:

The basic dimensions in the physical world and the corresponding SI base units

SI derived units with special names and symbols

SI prefixes and their representation with engineering notation

Interpreting data:

Investigation using the scientific method to gather appropriate data

Test procedures for physical (destructive and non-destructive) tests and statistical tests that might be used in gathering information

Summarising quantitative and qualitative data with appropriate graphical representations

Using presentation software to present data to an audience

LO2 **Determine parameters within mechanical engineering systems**

Static and dynamic forces:

Representing loaded components with space and free body diagrams

Calculating support reactions of beams subjected to concentrated and distributed loads

Newton's laws of motion, D'Alembert's principle and the principle of conservation of energy

Fluid mechanics and thermodynamics:

Archimedes' principle and hydrostatics

Continuity of volume and mass flow for an incompressible fluid

Effects of sensible/latent heat of fluid

Heat transfer due to temperature change and the thermodynamic process equations

LO3 **Explore the characteristics and properties of engineering materials**

Material properties:

Atomic structure of materials and the structure of metals, polymers and composites

Mechanical and electromagnetic properties of materials

Material failure:

Destructive and non-destructive testing of materials

The effects of gradual and impact loading on a material.

Degradation of materials and hysteresis

LO4 **Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties**

D.C. circuit theory:

Voltage, current and resistance in D.C. networks

Exploring circuit theorems (Thevenin, Norton, Superposition), Ohm's law and Kirchhoff's voltage and current laws

A.C. circuit theory:

Waveform characteristics in a single-phase A.C. circuit

RLC circuits

Magnetism:

Characteristics of magnetic fields and electromagnetic force

The principles and applications of electromagnetic induction

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine scientific data using both quantitative and qualitative methods</td><td rowspan="2">D1 Analyse scientific data using both quantitative and qualitative methods</td></tr>
<tr><td>P1 Describe SI units and prefix notation

P2 Examine quantitative and qualitative data with appropriate graphical representations</td><td>M1 Explain how the application of scientific method impacts upon different test procedures</td></tr>
<tr><td colspan="2">LO2 Determine parameters within mechanical engineering systems</td><td rowspan="2">D2 Compare how changes in the thermal efficiency of a given system can affect its performance.</td></tr>
<tr><td>P3 Determine the support reactions of a beam carrying a combination of a concentrated load and a uniformly distributed load

P4 Use Archimedes' principle in contextual engineering applications

P5 Determine the effects of heat transfer on the dimensions of given materials</td><td>M2 Determine unknown forces by applying d'Alembert's principle to a free body diagram</td></tr>
</table>

Pass	Merit	Distinction
LO3 Explore the characteristics and properties of engineering materials		**D3** Compare and contrast theoretical material properties of metals and non-metals with practical test data
P6 Describe the structural properties of metals and non-metals with reference to their material properties **P7** Explain the types of degradation found in metals and non-metals	**M3** Review elastic and electromagnetic hysteresis in different materials	
LO4 Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties		**D4** Evaluate different techniques used to solve problems on a combined series-parallel RLC circuit using A.C. theory.
P8 Calculate currents and voltages in D.C. circuits using circuit theorems **P9** Describe how complex waveforms are produced from combining two or more sinusoidal waveforms. **P10** Solve problems on series RLC circuits with A.C. theory.	**M4** Explain the principles and applications of electromagnetic induction	

Recommended Resources

Textbooks

BIRD, J. (2012) *Science for Engineering*. 4th Ed. London: Routledge.

BOLTON, W. (2006) *Engineering Science*. 5th Ed. London: Routledge.

TOOLEY, M. and DINGLE, L. (2012) *Engineering Science: For Foundation Degree and Higher National*. London: Routledge.

Journals

International Journal of Engineering Science.

International Journal of Engineering Science and Innovative Technology.

Websites

https://www.khanacademy.org/	Khan Academy Physics (Tutorials)

Links

This unit links to the following related units:

Unit 9: Materials, Properties and Testing

Unit 3: Engineering Science

Unit 4: Managing a Professional Engineering Project

Unit code	**A/615/1478**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

The responsibilities of the engineer go far beyond completing the task in hand. Reflecting on their role in a wider ethical, environmental and sustainability context starts the process of becoming a professional engineer – a vial requirement for career progression.

Engineers seldom work in isolation and most tasks they undertake require a range of expertise, designing, developing, manufacturing, constructing, operating and maintaining the physical infrastructure and content of our world. The bringing together of these skills, expertise and experience is often managed through the creation of a project.

This unit introduces students to the techniques and best practices required to successfully create and manage an engineering project designed to identify a solution to an engineering need. While carrying out this project students will consider the role and function of engineering in our society, the professional duties and responsibilities expected of engineers together with the behaviours that accompany their actions.

Among the topics covered in this unit are: roles, responsibilities and behaviours of a professional engineer, planning a project, project management stages, devising solutions, theories and calculations, management using a Gantt chart, evaluation techniques, communication skills, and the creation and presentation of a project report.

On successful completion of this unit students will be able to conceive, plan, develop and execute a successful engineering project, and produce and present a project report outlining and reflecting on the outcomes of each of the project processes and stages. As a result, they will develop skills such as critical thinking, analysis, reasoning, interpretation, decision-making, information literacy, and information and communication technology, and skills in professional and confident self-presentation.

This unit is assessed by a Pearson-set assignment. The project brief will be set by the centre, based on a theme provided by Pearson (this will change annually). The theme and chosen project within the theme will enable students to explore and examine a relevant and current topical aspect of professional engineering.

***Please refer to the accompanying Pearson-set Assignment Guide and the Theme Release document for further support and guidance on the delivery of the Pearson-set unit.**

Learning Outcomes

By the end of this unit students will be able to:

1. Formulate and plan a project that will provide a solution to an identified engineering problem.
2. Conduct planned project activities to generate outcomes which provide a solution to the identified engineering problem.
3. Produce a project report analysing the outcomes of each of the project processes and stages.
4. Present the project report drawing conclusions on the outcomes of the project.

Essential Content

LO1 **Formulate and plan a project that will provide a solution to an identified engineering problem**

Examples of realistic engineering based problems:

Crucial considerations for the project

How to identify the nature of the problem through vigorous research

Feasibility study to identify constraints and produce an outline specification

Develop an outline project brief and design specification:

Knowledge theories, calculations and other relevant information that can support the development of a potential solution

Ethical frameworks:

The Engineering Council and Royal Academy of Engineering's Statement of Ethical Principles

The National Society for Professional Engineers' Code of Ethics

Regulatory bodies:

Global, European and national influences on engineering and the role of the engineer, in particular: The Royal Academy of Engineering and the UK Engineering Council

The role and responsibilities of the UK Engineering Council and the Professional Engineering Institutions (PEIs)

The content of the UK Standard for Professional Engineering Competence (UKSPEC)

Chartered Engineer, Incorporated Engineer and Engineering Technician

International regulatory regimes and agreements associated with professional engineering:

European Federation of International Engineering Institutions.

European Engineer (Eur Eng)

European Network for Accreditation of Engineering Education

European Society for Engineering Education

Washington Accord

Dublin Accord

Sydney Accord

International Engineers Alliance

Asia Pacific Economic Cooperation (APEC) Engineers Agreement

LO2 **Conduct planned project activities to generate outcomes which provide a solution to the identified engineering problem**

Project execution phase:

Continually monitoring development against the agreed project plan and adapt the project plan where appropriate

Work plan and time management, using Gantt chart or similar.

Tracking costs and timescales

Maintaining a project diary to monitor progress against milestones and timescales

Engineering professional behaviour sources:

Professional responsibility for health and safety (UK-SPEC)

Professional standards of behaviour (UK-SPEC)

Ethical frameworks:

The Engineering Council and Royal Academy of Engineering's Statement of Ethical Principles

The National Society for Professional Engineers' Code of Ethics

LO3 **Produce a project report analysing the outcomes of each of the project processes and stages**

Convincing arguments:

All findings/outcomes should be convincing and presented logically where the assumption is that the audience has little or no knowledge of the project process

Critical analysis and evaluation techniques:

Most appropriate evaluation techniques to achieve a potential solution

Secondary and primary data should be critiqued and considered with an objective mindset

Objectivity results in more robust evaluations where an analysis justifies a judgement

LO4 **Present the project report drawing conclusions on the outcomes of the project**

Presentation considerations:

Media selection, what to include in the presentation and what outcomes to expect from it. Audience expectations and contributions

Presentation specifics. Who to invite: project supervisors, fellow students and employers. Time allocation, structure of presentation

Reflection on project outcomes and audience reactions

Conclusion to report, recommendations for future work, lessons learned, changes to own work patterns

Reflection for learning and practice:

The difference between reflecting on performance and evaluating a project − the former considers the research process, information gathering and data collection, the latter the quality of the research argument and use of evidence

The cycle of reflection:

To include reflection in action and reflection on action

How to use reflection to inform future behaviour, particularly directed towards sustainable performance

The importance of Continuing Professional Development (CPD) in refining on-going professional practice

Reflective writing:

Avoiding generalisation and focusing on personal development and the research journey in a critical and objective way

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Formulate and plan a project that will provide a solution to an identified engineering problem</td><td rowspan="2">D1 Illustrate the effect of legislation and ethics in developing the project plan</td></tr>
<tr><td>P1 Select an appropriate engineering based project, giving reasons for the selection

P2 Create a project plan for the engineering project</td><td>M1 Undertake a feasibility study to justify project selection</td></tr>
<tr><td colspan="2">LO2 Conduct planned project activities to generate outcomes which provide a solution to the identified engineering problem</td><td rowspan="2">D2 Critically evaluate the success of the project plan making recommendations for improvements</td></tr>
<tr><td>P3 Conduct project activities, recording progress against original project plan</td><td>M2 Explore alternative methods to monitor and meet project milestones, justify selection of chosen method(s)</td></tr>
<tr><td colspan="2">LO3 Produce a project report analysing the outcomes of each of the project processes and stages</td><td rowspan="4">LO3 & LO4

D3 Critically analyse the project outcomes making recommendations for further development</td></tr>
<tr><td>P4 Produce a project report covering each stage of the project and analysing project outcomes</td><td>M3 Use appropriate critical analysis and evaluation techniques to analyse project findings</td></tr>
<tr><td colspan="2">LO4 Present the project report drawing conclusions on the outcomes of the project</td></tr>
<tr><td>P5 Present the project report using appropriate media to an audience</td><td>M4 Analyse own behaviours and performance during the project and suggest areas for improvement</td></tr>
</table>

Recommended Resources

Textbooks

PUGH, P. S. (1990) *Total Design: Integrated Methods for Successful Product Engineering*. Prentice Hall.

STRIEBIG, B., OGUNDIPE, A. and PAPADAKIS, M. (2015) *Engineering Applications in Sustainable Design and Development*. Cengage Learning.

ULRICH, K. and EPPINGER, S. (2011) *Product Design and Development*. 5th Ed. McGraw-Hill Higher Education.

Journals

Journal of Engineering Design.

Links

This unit links to the following related units:

Unit 34: Research Project

Unit 35: Professional Engineering Management

Unit 6: Mechatronics

Unit code	**T/615/1480**
Unit level	**4**
Credit value	**15**

Introduction

Auto-focus cameras, car cruise control and automated airport baggage handling systems are examples of mechatronic systems. Mechatronics is the combination of mechanical, electrical and computer/controlled engineering working together in automated systems and 'smart' product design.

Among the topics included in this unit are: consideration of component compatibility, constraints on size and cost, control devices used, British and/or European standards relevant to application, sensor types and interfacing, simulation and modelling software functions, system function and operation, advantages and disadvantages of software simulation, component data sheets, systems drawings, flowcharts, wiring and schematic diagrams.

On successful completion of this unit students will be able to explain the basic mechatronic system components and functions, design a simple mechatronic system specification for a given application, use appropriate simulation and modelling software to examine its operation and function, and solve faults on mechatronic systems using a range of techniques and methods.

Learning Outcomes

By the end of this unit students will be able to:

1. Explain the design and operational characteristics of a mechatronic system.
2. Design a mechatronic system specification for a given application.
3. Examine the operation and function of a mechatronics system using simulation and modelling software.
4. Identify and correct faults in a mechatronic system.

Essential Content

LO1 **Examine the design and operational characteristics of a mechatronic system**

Origins and evolution:

History and early development, evolution

Practical examples and extent of use

Current operational abilities and anticipated improvements

Systems characteristics:

Design of systems in an integrated way

Sensor and transducer types used

Consideration of component compatibility

Constraints on size and cost

Control device requirements and examples of applications

LO2 **Design a mechatronic system specification for a given application**

Systems specifications:

British and/or European standards relevant to application

Sensor types and interfacing

Actuator technology availability and selection

Selection and use of appropriate control software/devices.

Consideration of the interaction of system variables

System commissioning parameters

LO3 **Examine the operation and function of a mechatronics system using simulation and modelling software**

Operation and functions:

Simulation and modelling software functions

System function and operation

Modes of operation simulation, loading and surges

Advantages and disadvantage of software simulation

LO4 **Identify and correct faults in a mechatronic system**

Locating and correcting system faults:

Component data sheets, systems drawings, flowcharts, wiring and schematic diagrams

Original system correct function and operation

Inspection and testing using methodical fault location techniques and methods, use of control software to aid fault location

Identification, evaluation and verification of faults and their causes, rectification, final system testing and return to service

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine the design and operational characteristics of a mechatronic system</td><td rowspan="2">D1 Investigate an actual mechatronics system specification to propose alternative solutions</td></tr>
<tr><td>P1 Describe the key components of a given mechatronics system
P2 Identify the types of actuators, sensors and transducers used in the mechatronics system</td><td>M1 Explore how the mechatronics components operate as part of an integrated system
M2 Investigate the methods of control used by mechatronics systems</td></tr>
<tr><td colspan="2">LO2 Design a mechatronic system specification for a given application</td><td rowspan="2">D2 Evaluate the operational capabilities and limitations of the mechatronics system design specification produced</td></tr>
<tr><td>P3 Select the relevant sensor and the appropriate actuator technologies and produce a design specification suitable for these selections</td><td>M3 Justify the sensor and actuator technologies selected with reference to available alternatives</td></tr>
<tr><td colspan="2">LO3 Examine the operation and function of a mechatronics system using simulation and modelling software</td><td rowspan="2">D3 Explain the function and operation of a simulated mechatronics system</td></tr>
<tr><td>P4 Demonstrate industry standard mechatronics simulation/modelling software</td><td>M4 Describe the advantages and disadvantages of the software simulation</td></tr>
</table>

Pass	Merit	Distinction
LO4 Identify and correct faults in a mechatronic system		**D4** Investigate the causes of faults on a mechatronics system and suggest alternatives to the design specification to improve reliability
P5 Explain the safe use of fault finding test equipment **P6** Locate and rectify faults on a mechatronic system	**M5** Apply and document the correct use of fault finding techniques/ methods	

Recommended Resources

Textbooks

BOLTON, W. (2015) *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*. 5th Ed. Essex: Pearson Education Limited.

MAHALIK, N.P. (2010) *Mechatronics: Principles, Concepts and Applications*. New Delhi: McGraw-Hill.

ONWUBOLU, G.C. (2005) *Mechatronics: Principles and Applications*. Oxford: Elsevier.

RAMACHANDRAN, K.P., VIJAYARAGHAVAN, G.K. and BALASUNDARAM, M.S. (2008) *Mechatronics: Integrated Mechanical Electronic Systems*. India: Wiley.

Journals

International Journal of Advanced Mechatronic Systems.

Links

This unit links to the following related units:

Unit 15: Automation, Robotics and Programmable Logic Controllers (PLCs)

Unit 54: Further Control Systems Engineering