

Unit 1: Analytical Methods for Engineers

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will provide the analytical knowledge and techniques needed to succeed in engineering and will provide a base for further study of engineering mathematics.

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to analyse and model engineering situations and solve problems using algebraic methods	1.1 determine the quotient and remainder for algebraic fractions and reduce algebraic fractions to partial fractions 1.2 solve engineering problems that involve the use and solution of exponential, trigonometric and hyperbolic functions and equations 1.3 solve scientific problems that involve arithmetic and geometric series 1.4 use power series methods to determine estimates of engineering variables expressed in power series form
2 Be able to analyse and model engineering situations and solve problems using trigonometric methods	2.1 use trigonometric functions to solve engineering problems 2.2 use sinusoidal functions and radian measure to solve engineering problems 2.3 use trigonometric and hyperbolic identities to solve trigonometric equations and to simplify trigonometric expressions
3 Be able to analyse and model engineering situations and solve problems using the calculus	3.1 differentiate algebraic and trigonometric functions using the product, quotient and function of function rules 3.2 determine higher order derivatives for algebraic, logarithmic, inverse trigonometric and inverse hyperbolic functions 3.3 integrate functions using the rules, by parts, by substitution and partial fractions 3.4 analyse engineering situations and solve engineering problems using the calculus

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to analyse and model engineering situations and solve problems using statistics and probability	4.1 represent engineering data in tabular and graphical form 4.2 determine measures of central tendency and dispersion 4.3 apply linear regression and product moment correlation to a variety of engineering situations 4.4 use the normal distribution and confidence intervals for estimating reliability and quality of engineering components and systems

Unit 2: Engineering Science

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit aims to provide learners with an understanding of the mechanical and electrical principles that underpin mechanical and electrically focused engineering systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to determine the behavioural characteristics of elements of static engineering systems	1.1 determine distribution of shear force, bending moment and stress due to bending in simply supported beams 1.2 select standard rolled steel sections for beams and columns to satisfy given specifications 1.3 determine the distribution of shear stress and the angular deflection due to torsion in circular shafts
2 Be able to determine the behavioural characteristics of elements of dynamic engineering systems	2.1 determine the behaviour of dynamic mechanical systems in which uniform acceleration is present 2.2 determine the effects of energy transfer in mechanical systems 2.3 determine the behaviour of oscillating mechanical systems
3 Be able to apply DC theory to solve electrical and electronic engineering problems	3.1 solve problems using Kirchhoff's laws to calculate currents and voltages in circuits 3.2 solve problems using circuit theorems to calculate currents and voltages in circuits 3.3 solve problems involving current growth/decay in an L-R circuit and voltage growth/decay in a C-R circuit
4 Be able to apply single phase AC theory to solve electrical and electronic engineering problems.	4.1 recognise a variety of complex waveforms and explain how they are produced from sinusoidal waveforms 4.2 apply AC theory to solve problems on R, L, C circuits and components 4.3 apply AC theory to solve problems involving transformers

Unit 3: Project Design, Implementation and Evaluation

QCF Level 5: Higher National

Credit value: 20

Aim

To develop learners' skills of independent enquiry by undertaking a sustained investigation of direct relevance to their vocational, academic and professional development.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to formulate a project	1.1 formulate and record possible outline project specifications. 1.2 identify the factors that contribute to the process of project selection. 1.3 Produce a specification for the agreed project 1.4 produce an appropriate project plan for the agreed project.
2 Be able to implement the project within agreed procedures and to specification	2.1 match resources efficiently to the project 2.2 undertake the proposed project in accordance with the agreed specification. 2.3 organise, analyse and interpret relevant outcomes
3 Be able to evaluate the project outcomes	3.1 use appropriate project evaluation techniques. 3.2 interpret and analyse the results in terms of the original project specification. 3.3 make recommendations and justify areas for further consideration.
4 Be able to present the project outcomes	4.1 produce a record of all project procedures used. 4.2 use an agreed format and appropriate media to present the outcomes of the project to an audience.

Unit 4: Mechanical Principles

QCF level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop learners' understanding of an extended range of mechanical principles that underpin the design and operation of mechanical engineering systems.

Learning Outcomes On successful completion of this unit a learner will:	Assessment criteria The learner can:
1. Be able to determine the behavioural characteristics of materials subjected to complex loading systems	1.1 apply the relationship between longitudinal and transverse strain to determine the dimensional effects of uniaxial loading on a given material 1.2 determine the effects of two-dimensional and three-dimensional loading on the dimensions of a given material 1.3 determine volumetric strain and change in volume due to three-dimensional loading 1.4 apply the relationship between elastic constants
2. Be able to determine the behavioural characteristics of loaded beams and cylinders	2.1 apply the relationship between bending moment, slope and deflection to determine the variation of slope and deflection along a simply supported beam 2.2 determine the principal stresses that occur in a thin-walled cylindrical pressure vessel 2.3 determine the distribution of the stresses that occur in a pressurised thick-walled cylinder
3. Be able to determine the dynamic parameters of power transmission system elements	3.1 determine the dynamic parameters of a belt drive 3.2 determine the dynamic parameters of a friction clutch 3.3 determine the holding torque and power transmitted through compound and epicyclic gear trains

Learning Outcomes On successful completion of this unit a learner will:	Assessment criteria The learner can:
4. Be able to determine the dynamic parameters of rotating systems	4.1 determine the parameters of a slider-crank and a four-bar linkage mechanism 4.2 determine the balancing masses required to obtain dynamic equilibrium in a rotating system 4.3 determine the energy storage requirements of a flywheel 4.4 determine the dynamic effects of coupling two freely rotating systems

Unit 5: Electrical and Electronic Principles

QCF level 5: BTEC Higher National

Credit value: 15

Aim

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

Learning outcomes On completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to apply electrical and electronic circuit theory	1.1 calculate the parameters of AC equivalent circuits using transformation theorems 1.2 apply circuit theory techniques to the solution of AC circuit problems 1.3 analyse the operation of magnetically coupled circuits 1.4 use circuit theory to solve problems relating to series and parallel R-L-C tuned circuits
2 Be able to apply two-port network models	2.1 apply two-port network model to the solution of practical problems 2.2 design and test symmetrical attenuators against computer models
3 Understand the use of complex waves	3.1 calculate the properties of complex periodic waves 3.2 analyse complex periodic waves
4 Be able to apply transients in R-L-C circuits	4.1 use Laplace transforms for the transient analysis of networks 4.2 calculate circuit responses to a step input in practical situations

Unit 6: Health, Safety and Risk Assessment in Engineering

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit aims to provide learners with an understanding of health and safety planning, implementation and legislation within an engineering environment.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to select and apply safe working procedures to engineering operations	1.1 select and justify choice of protective clothing and equipment to ensure personal protection in a given environment 1.2 evaluate a range of permit-to-work systems and identify isolation requirements for given applications 1.3 use monitoring equipment to ensure the promotion of a safe working environment
2 Understand the nature and use of current health and safety legislation	2.1 identify industrial work areas where current regulations would apply and describe the role of the HSE inspectorate 2.2 implement a schedule for the setting up of a safety audit system 2.3 select the relevant codes of practice to enhance safety
3 Be able to analyse engineering activities for the assessment of risk	3.1 identify a hazard and produce a risk rating 3.2 evaluate frequency and severity of an identified hazard 3.3 produce a hazard proforma for a given application 3.4 analyse a recording system that tracks and highlights potential hazards

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to manage and minimise risk to life, property and engineering activities within an industrial environment	4.1 evaluate evidence that would specify the existence of a risk or risks 4.2 analyse the implications of the risk and the effect on life, property and activities 4.3 obtain and use accurate information on the risk for the protection of others 4.4 produce a report on how best to minimise the risk to people, property and activities and recommend effective methods of implementation and control 4.5 identify routes and methods of implementation within a company to ensure that compliance with codes of practice and regulations pertaining to the risk are fully understood

Unit 7: Business Management Techniques for Engineers

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit investigates the functions, structures and inter-relationships of an engineering business. Learners will apply the skills of costing, financial planning and control associated with engineered products or services.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Know how to manage work activities to achieve organisational objectives	1.1 define engineering business functions 1.2 outline the inter-relationships between the different processes and functions of an engineering organisation 1.3 organise work activities to meet specifications and standards
2 Be able to select and apply costing systems and techniques	2.1 create appropriate costing systems and techniques for specific engineering business functions 2.2 measure the impact of changing activity levels on engineering business performance
3 Understand the key functions of financial planning and control	3.1 explain the financial planning process in an engineering business 3.2 examine the factors influencing the decision-making process during financial planning 3.3 analyse standard costing techniques
4 Be able to apply project planning and scheduling methods to an engineering project.	4.1 establish the project resources and requirements 4.2 produce a plan with appropriate time-scales for completing the project 4.3 plan the human resource requirement and costs associated with each stage of the project

Unit 8: Engineering Design

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will enable learners to prepare an engineering design specification that meets customer requirements and produce a final design report.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to prepare a design specification to meet customer requirements	1.1 establish customer requirements 1.2 present the major design parameters 1.3 obtain design information from appropriate sources and prepare a design specification 1.4 demonstrate that the design specification meets requirements.
2 Be able to analyse and evaluate possible design solutions and prepare a final design report	2.1 produce an analysis of possible design solutions 2.2 produce and evaluate conceptual designs 2.3 select the optimum design solution 2.4 carry out a compliance check 2.5 produce a final design report.
3 Understand how computer-based technology is used in the engineering design process.	3.1 explain the key features of a computer-aided design system 3.2 use computer-aided design software to produce a design drawing or scheme 3.3 evaluate software that can assist the design process.

Unit 9: Manufacturing Planning and Scheduling Principles

QCF Level L4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learner's knowledge and understanding of the principles, methodologies and techniques that are used in process planning and scheduling for the manufacture of products.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Know how to use a range of process planning, capacity assessment and scheduling techniques	1.1 describe the use of three different process planning techniques 1.2 select and describe a capacity assessment technique for two different types of manufacturing process 1.3 describe the use of a range of scheduling techniques.
2. Understand inventory management including stock control, shop floor documentation systems and the functions of shop control	2.1 explain an application of the principle of inventory management 2.2 compare two different stock control systems 2.3 examine two different shop floor documentation systems 2.4 explain the functions of shop control.
3. Understand the methods of classifying and coding component parts as key elements of group technology and their processing through grouped facilities	3.1 explain the methods of classifying and coding component parts into family groups 3.2 explain how family groups of components are sequenced for processing through grouped facilities.
4. Be able to plan and schedule a manufacturing activity.	4.1 produce a process plan from a given set of data 4.2 produce a production schedule from a process plan.

Unit 10: Manufacturing Process

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' knowledge of manufacturing processes and techniques that can be applied to a range of materials for a variety of manufacturing applications.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Know about suitable conventional machining processes and techniques for generating geometrical forms for a given component specification	1.1 select suitable data and processes for component manufacture using a range of conventional machining techniques 1.2 describe tooling requirements and work-holding techniques for a given component using a range of conventional machining techniques
2 Know about suitable moulding and shaping processes for a given component specification	2.1 select suitable data and processes for component manufacture using moulding and shaping techniques for metals and ceramics 2.2 identify changes to material properties due to the moulding and shaping processes 2.3 describe the tooling requirements for producing a given component by moulding and shaping
3 Know about suitable less-conventional machining techniques for a given component specification	3.1 select suitable data and processes for component manufacture using a less-conventional machining process 3.2 describe the tooling and ancillary equipment requirements to manufacture a given component by a less-conventional machining process

Unit 11: Supply Chain Management

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to examine the main principles, concepts and practices of supply chain management.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the strengths, weaknesses and competitive advantage of supply chains	1.1 outline and explain three supply chains for an organisation and make comparisons with similar and dissimilar types of organisation 1.2 analyse the differences between the types and directions of flows in a supply chain 1.3 evaluate the main strengths and weaknesses of an organisation's supply chain and the extent to which it provides competitive advantage for the business
2 Understand the use of supply chain planning	2.1 explain how company objectives are translated into a meaningful supply chain strategy 2.2 analyse the pattern and requirements for inventory in an organisation's supply chain 2.3 devise suitable alternative supply chain solutions including outsourcing potential 2.4 describe the importance of the key elements of the supply chain
3 Be able to analyse an organisation's supply chain operation	3.1 prepare a cost report on the various activities within the supply chain operation 3.2 measure the performance of an organisation's supply chain 3.3 benchmark supply-chain performance against that of similar organisations 3.4 evaluate the suitability of benchmarks for use against company objectives

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to evaluate a supply chain, determine an optimum supply chain solution and prepare an implementation plan	4.1 conduct and evaluate a supply chain audit 4.2 analyse the different trade-offs involved in a supply chain 4.3 determine an optimum supply chain solution 4.4 devise a suitable implementation plan

Unit 12: Material Handling Systems

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to familiarise learners with the knowledge and skills required in the management of materials in the engineering/manufacturing industries.

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand the aims and strategies used for logistics	1.1 identify the aims of logistics for material handling 1.2 explain strategies used for achieving the aims of logistics
2. Know the operation of material handling systems	2.1 describe the stages of engineering material handling 2.2 describe the criteria used for the selection of a material handling system 2.3 compare different material handling systems 2.4 carry out a cost benefit analysis by comparing and contrasting two modern material handling systems
3. Understand the control of material handling systems	3.1 explain the systems used for the control of material flow 3.2 explain material tracking and identification methods 3.3 evaluate a controlled material handling system using a range of techniques
4. Be able to plan the layout of a material handling operation	4.1 identify modern material handling equipment and its application 4.2 identify and analyse the movements, conditions, requirements and constraints of a proposed materials handling system 4.3 justify the selection of material handling equipment for the system 4.4 use critical path analysis to plan the materials handling operation 4.5 present a layout of the proposed system using appropriate graphical techniques

Unit 13: Application of Machine Tools

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop the skills and understanding needed for the safe and efficient production of components on manual machine tools.

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the characteristics of a range of machine tools	1.1 explain the typical axis conventions of given machine tools 1.2 explain the operation of types of drive and the axis control systems, such as hand-wheels and servo-motors, for given machine tools 1.3 describe the six degrees of freedom of a rigid body and how they relate to work holding techniques 1.4 describe work and tool holding devices for given machine tools
2 Understand machining operations	2.1 assess the suitability of machine tool types for the production of specific components and geometries 2.2 plan the sequence of operations required to produce specific components 2.3 describe the machining and forming processes involved in the production of specific features
3 Understand material removal and forming principles	3.1 select appropriate tooling for the production of specific features on specific materials 3.2 determine the forces acting on the tool face and work piece during ideal orthogonal cutting 3.3 calculate speeds and feeds for turning and milling operations for a variety of tool and work piece materials 3.4 describe the mechanisms and effects of different types of tool wear and catastrophic failure 3.5 estimate the life of given tools for specific applications

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to produce components to specification using safe working practices	4.1 demonstrate awareness of health and safety issues related to the specific machine tools used and the workshop in general 4.2 select correct tooling and machine settings 4.3 produce given components to specification in compliance with the planned sequence of operations

Unit 14: Computer-Aided Machining

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of computer-aided machining (CAM) systems and the related skills found in manufacturing and engineering companies.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Know about the design and operational characteristics of CAM systems	1.1 describe the hardware and software elements of a CAM system 1.2 identify the inputs and outputs of a CAM system 1.3 describe the methods of component location, clamping and tool holding in CNC machines
2 Be able to produce and prove manual part programs	2.1 utilise elements and structures of a CNC part program when producing and proving a manual part program 2.2 use appropriate ISO standards with respect to codes and program format when producing and proving a manual part program 2.3 use programming techniques to promote enhanced system performance 2.4 produce manually written part programs for engineered components 2.5 input manually written part programs to a CNC machine and prove their accuracy
3 Be able to produce and prove computer-assisted part programs	3.1 use an appropriate range of functions when producing and proving computer-assisted part programs 3.2 use a database in support of computer-assisted part programming 3.3 use macro routines in support of computer-assisted part programming 3.4 produce computer-assisted part programs for engineered components 3.5 pass computer-assisted part programs to a CNC machine and prove their accuracy

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Understand inspection and quality control in CAM systems	4.1 review the various levels of inspection in CAM systems 4.2 assess the techniques used for data capture in automated inspection systems 4.3 explain the significance of adaptive control methods in CAM systems

Unit 15: Design for Manufacture

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the processes involved analysing a product design and preparing for its manufacture.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand how to analyse a product design for its economic manufacture	1.1 examine the most appropriate manufacturing methods for a product 1.2 discuss the elements involved in the total cost of a product 1.3 explain the advantages and disadvantages of standardisation 1.4 analyse the manufacturing process and material requirements for a component
2. Understand the product design features and techniques that facilitate economic assembly	2.1 explain the most appropriate method of assembly for a product 2.2 explain the flexible manufacturing systems and robots used in the economic manufacture of a product 2.3 evaluate the features of a component that assist and/or prevent economic manufacture using automatic assembly methods
3. Be able to apply the principles of geometrical tolerancing	3.1 apply the principles of geometric tolerancing to the manufacture of a product 3.2 report on the effects of tolerance build-up and assess its application on an assembled product 3.3 select and use dimensional data for the manufacture and inspection of a component
4. Be able to select and use appropriate computer-aided manufacturing software.	4.1 demonstrate how CNC software can be used for component manufacture 4.2 demonstrate how CAM software programs can be used for the assembly of a product 4.3 demonstrate how CAM software can be used for material selection and handling processes

Unit 16: Advanced Manufacturing Technologies

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit develops learners' understanding of advanced manufacturing technologies and the safety and technical requirements of producing goods economically.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand health and safety requirements in the manufacturing workplace	1.1 explain how health and safety is catered for within an organisation 1.2 assess the legal requirements and procedures for health and safety inspections 1.3 discuss the safety requirements and features which should be included in the design of automated areas
2 Understand the function and purpose of existing Advanced Manufacturing Technology (AMT) installations	2.1 review the use of a range of Advanced Manufacturing Technology (AMT) installations 2.2 evaluate the benefits of different manufacturing strategies
3 Understand the benefits and drawbacks of building flexibility into the manufacturing process	3.1 calculate break-even points and identify suitable processes for given quantities 3.2 calculate cycle times for given components using specified equipment 3.3 specify CAM layouts for single spindle autos 3.4 make decisions based on the initial costs and running costs of Flexible Manufacturing Systems (FMS), Flexible Manufacturing Cells (FMC) and stand-alone machinery
4 Know the applications of special manufacturing processes	4.1 describe the technical requirements, uses and applications of special manufacturing processes 4.2 summarise the benefits and drawbacks of special manufacturing processes 4.3 identify the mix of manufacturing process equipment required to produce a range of given components and assemblies economically

Unit 17: Business Improvement Techniques

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will provide learners with knowledge of some of the business improvement methodologies and techniques that can be applied in a variety of manufacturing situations.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to apply the principles of lead-time analysis by creating a lead-time profile, frequency diagram and by using a cause and effect diagram	1.1 gather information and create lead-time profiles 1.2 produce a frequency diagram listing the major bottlenecks or constraints as identified by lead-time profiles 1.3 use a cause and effect diagram to identify improvement opportunities and determine waste
2 Be able to use techniques in set-up reduction and prepare an improved standard operating procedure	2.1 carry out a set-up reduction activity on a chosen machine, or process using the appropriate techniques 2.2 produce standard operating procedures for a new set-up
3 Know the benefits of total productive maintenance (TPM) techniques	3.1 describe a range of techniques used in TPM 3.2 identify the countermeasures for chronic and sporadic loss and explain the scope of TPM
4 Understand optimised production technology (OPT)	4.1 describe the importance of the principles of OPT to the aims of OPT 4.2 use throughput accounting to measure the performance of a factory or unit 4.3 make recommendations for improvements to meet the aims of OPT

Unit 18: Advanced Machine Tools

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit introduces the theory of safe and efficient production of components on computer numeric control (CNC) machine tools. It also provides a broad knowledge about automated and flexible manufacturing.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to determine the cost of producing simple components on CNC equipment	1.1 determine the economics of producing a simple component on CNC equipment 1.2 determine the relative merits of manual and CNC machine tools
2 Understand the design and construction of CNC machine tools	2.1 assess typical configurations of CNC machine tools and relevant axis conventions 2.2 explain the relationships between the main design features of CNC machine tools 2.3 examine the use of control systems applied to CNC equipment
3 Understand the use of tool management in automated environments	3.1 review the requirements of an automated tool management system 3.2 illustrate the uses of adaptive control and sister tooling for tool life management and the use of probing systems for tool setting and tool wear compensation 3.3 analyse the requirements of an automated tool delivery system
4 Know about the requirements of a flexible manufacturing cell (FMC) and the uses of programmable logic controllers (PLCs).	4.1 describe the main physical features of a flexible manufacturing cell 4.2 outline the uses of automated material handling systems within the FMC environment 4.3 outline simple programs for applications of PLC cell control

Unit 19: Computer Aided Design and Manufacture

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will enable the learner to acquire a broader and deeper understanding of the practical applications of a Computer-Aided Design and Computer-Aided Manufacture (CAD/CAM) system.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to produce a component drawing suitable for transfer onto a CAM system and produce a simple 3D surface	1.1 produce a working drawing for subsequent manufacture 1.2 demonstrate the significance of drawing attributes for CAD/CAM with specific reference to profile data and parts listing 1.3 produce a variety of geometrical shapes from datum in 3D space
2 Be able to transfer data generated in CAD to a CAM system for subsequent machining	2.1 demonstrate the significance of structured data within a CAD/CAM system 2.2 create a DXF (data exchange file) from a standard drawing file 2.3 produce geometry within a CAM system through the use of a DXF file
3 Be able to simulate the cutter paths on a CAM system to optimise the machining sequences	3.1 generate cutter paths on a component profile through the use of suitable CAM software 3.2 demonstrate how to obtain optimum cutting performances by modifying generated cutter paths
4 Know how to transfer a generated tape file to a CNC machine and produce the component	4.1 identify common methods of data transfer 4.2 describe the process for inputting a program processed from CAM software to a CNC machine 4.3 define the method for producing a component on a suitable CNC machine

Unit 20: Quality and Business Improvement

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the principles and applications of quality and business improvement.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to apply continuous improvement principles and techniques	1.1 identify potential areas for improvements within a working area or activity 1.2 produce standard operating procedures for a working area or activity 1.3 identify and calculate key performance indicators
2 Understand the key factors of six-sigma methodology	2.1 explain the key factors of six sigma methodology 2.2 produce a metric chart for a six sigma project 2.3 identify the critical to quality characteristic of a six sigma project
3 Be able to carry out potential failure modes and effects analysis (FMEA)	3.1 carry out a potential failure modes and effects analysis 3.2 describe the activities to be analysed
4 Be able to create a worksheet of a mistake/error proofing activity and identify suitable solutions	4.1 create a worksheet of a mistake/error proofing activity 4.2 identify suitable solutions

Unit 21: Materials Engineering

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will provide learners with the necessary background knowledge and understanding of the properties, selection, processing and failure of engineering materials.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to determine the properties and selection criteria of materials from tests and data sources	1.1 detail the appropriate properties and criteria for the selection of a metallic, ceramic, polymer and composite material 1.2 explain the particular characteristics related to the microstructure and macroscopic behaviour of the four categories of engineering materials 1.3 generate and process test data to assess material properties for two categories of material 1.4 investigate and assess the quality of suitable data from three different sources
2 Understand the relationships between manufacturing processes and material behaviour	2.1 explain how one heat treatment process and two other treatment processes effect the structure properties and behaviour of the parent material 2.2 explain how one liquid processing method and two mechanical processing methods effect the structure, properties and behaviour of the parent material 2.3 investigate how the composition and structure of metal alloys, polymers and polymer matrix composites, influences the properties of the parent material
3 Be able to select suitable materials and processing methods for a specific product	3.1 analyse the function/s of a product in terms of the materials' constraints on its design 3.2 identify the required properties for the product and select the most appropriate materials and processing methods 3.3 identify and explain the possible limitations on the product imposed by the processing and by the need to safeguard the environment and minimise costs

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Understand the in-service causes of failure of engineering materials	4.1 explain the common causes of in-service failure for products or structures produced from each or a combination of the four categories of engineering materials 4.2 for one product or material structure, identify and explain the in-service conditions that may contribute to early failure 4.3 explain the methods for investigating materials failure and for estimating product service life, when a product is subject to creep and fatigue loading 4.4 determine and make recommendations for remedial/preventive measures for a given product or materials structure, that will help improve its service life

Unit 22: Programmable Logic Controllers

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to investigate programmable logic controller (PLC) concepts and their applications in engineering.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the design and operational characteristics of a PLC system	1.1 evaluate the design characteristics of typical programmable logic devices 1.2 describe different types of input and output device 1.3 evaluate the different types of communication link used in programmable logic control systems 1.4 describe the internal architecture and operational characteristics of the CPU of a typical programmable logic device
2 Understand PLC information and communication techniques	2.1 evaluate the different forms of signal used in programmable logic control 2.2 describe the resolution and relationship between analogue inputs and outputs and word length 2.3 express numbers using different number systems 2.4 describe typical protocols used in signal communication and evaluate networking methods and networking standards
3 Be able to apply programmable logic programming techniques	3.1 identify elements associated with the preparation of a programmable logic controller program 3.2 write programs using logic functions based on relay ladder logic 3.3 evaluate the range and type of advanced functions of programmable logic controllers 3.4 use and justify methods of testing and debugging hardware and software
4 Understand alternative implementations of programmable control	4.1 evaluate PICs and other programmable devices as programmable devices and embedded controllers 4.2 compare the operation, functionality, advantages and limitations of PLC simulators

Unit 23: Engineering Procurement

QCF Level 4: Higher National

Credit value: 15

Aim

This unit examines procurement or purchasing strategies and their importance in engineering management. The unit shows how procurement contributes to profit and how it helps to maintain a competitive edge.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the principles of resource management and its application to an engineering operation	1.1 assess the methods available for managing materials 1.2 explain the principles involved when procuring equipment and the on-going requirements over the life of that equipment
2 Understand how the procurement strategy contributes to the achievement of an engineering operation's objectives	2.1 recommend procurement systems and processes with related performance indicators and benchmarking for an engineering operation 2.2 analyse the risks involved in a procurement strategy 2.3 examine the role of the procurement officer within an engineering operation
3 Understand the importance of the procurement contract and its application to engineering operations	3.1 explain the importance of a procurement contract 3.2 evaluate the sourcing issues for a procurement situation using a range of suppliers 3.3 review the management techniques used to appraise and evaluate the suppliers of an engineering management operation
4 Understand procurement pricing and management strategies within an engineering organisation	4.1 explain the management strategies that can be used to maximise the purchasing power of the procurement officer 4.2 compare pricing management techniques used in an engineering procurement situation
5 Be able to review and evaluate procurement strategies within an engineering organisation	5.1 plan a review and evaluation to measure the success of a company's procurement strategy 5.2 conduct a review and evaluation for a procurement scenario in an engineering operation

Unit 24: Applications of Pneumatics and Hydraulics

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit aims to extend learners' understanding of pneumatic and hydraulic fluid power systems and their modern industrial applications and enable them to select components and design fluid power circuits.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to read and interpret pneumatic and hydraulic fluid power diagrams	1.1 recognise and describe given fluid power symbols that conform to the latest ISO 1219 standards or their national/international equivalent 1.2 from a given system diagram, read, interpret and explain the operation of either a pneumatic or hydraulic multi-actuator sequential system that uses a minimum of four actuators 1.3 produce a suitable circuit design drawing for either a pneumatic or hydraulic reversible rotary actuation system that includes speed control in both directions
2 Understand the construction, function and operation of pneumatic and hydraulic components, equipment and plant	2.1 identify the features, describe the function and explain the operation of given items of pneumatic and hydraulic equipment 2.2 analyse, compare and contrast the performance characteristics for two given items of pneumatic and two given items of hydraulic equipment
3 Be able to design pneumatic and hydraulic circuits	3.1 design and produce a circuit design diagram for either a pneumatic or hydraulic multi-actuator sequential operation circuit, that includes emergency stop functions 3.2 design and produce a circuit design diagram for either a pneumatic or hydraulic rotary actuation system that includes speed control in both directions 3.3 design and produce a circuit design diagram for either an electro-pneumatic or electro-hydraulic system arrangement 3.4 design and produce a circuit design for either a pneumatic or hydraulic 'fail-safe' circuit application

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to evaluate and justify industrial applications of pneumatics and hydraulics	4.1 evaluate and justify the use of either pneumatic or hydraulic fluid power technology for a given industrial application 4.2 evaluate and discuss the technical requirements and commercial considerations for the given industrial application 4.3 identify and discuss the appropriate health and safety requirements for the design, installation, maintenance and use of the given industrial application

Unit 25: Engine and Vehicle Design and Performance

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' knowledge of engine and vehicle design and will enable them to evaluate engine and vehicle performance.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand engine design features	1.1 identify and discuss the engine design features that contribute to the selection of an engine for a given application 1.2 analyse the effects of altering engine design features for a given application
2 Be able to evaluate engine performance	2.1 determine the performance characteristics of a given engine 2.2 carry out and record the outcomes of an engine performance mapping procedure 2.3 interpret performance curves and select an appropriate engine for a given application
3 Understand vehicle design features	3.1 identify and describe the features of vehicle design that contribute to the selection of a vehicle for a given application 3.2 analyse the effects of altering the features of vehicle design for a given application
4 Be able to evaluate vehicle performance	4.1 explain the terms used in vehicle performance monitoring 4.2 determine the performance characteristics of a given vehicle 4.3 perform calculations to determine vehicle air resistance and describe the effects of air resistance on engine speed and fuel economy 4.4 interpret performance curves and select an appropriate vehicle from given information

Unit 26: Employability Skills

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit provides learners with the opportunity to acquire honed employability skills required for effective employment.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Be able to determine own responsibilities and performance	1.1 develop a set of own responsibilities and performance objectives 1.2 evaluate own effectiveness against defined objectives 1.3 make recommendations for improvement 1.4 review how motivational techniques can be used to improve quality of performance
2. Be able to develop interpersonal and transferable skills	2.1 develop solutions to work based problems 2.2 communicate in a variety of styles and appropriate manner at various levels 2.3 identify effective time management strategies
3. Understand the dynamics of working with others	3.1 explain the roles people play in a team and how they can work together to achieve shared goals 3.2 analyse team dynamics 3.3 suggest alternative ways to complete tasks and achieve team goals
4. Be able to develop strategies for problem solving	4.1 evaluate tools and methods for developing solutions to problems 4.2 develop an appropriate strategy for resolving a particular problem 4.3 evaluate the potential impact on the business of implementing the strategy

Unit 27: Personal and Professional Development

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to help the learner become an effective and confident self-directed employee. This helps the learner become confident in managing own personal and professional skills to achieve personal and career goals.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand how self-managed learning can enhance lifelong development	1.1 evaluate approaches to self managed learning 1.2 propose ways in which lifelong learning in personal and professional contexts could be encouraged 1.3 evaluate the benefits of self-managed learning to the individual and organisation
2. Be able to take responsibility for own personal and professional development	2.1 evaluate own current skills and competencies against professional standards and organisational objectives 2.2 identify own development needs and the activities required to meet them 2.3 identify development opportunities to meet current and future defined needs 2.4 devise a personal and professional development plan based on identified needs
3. Be able to implement and continually review own personal and professional development plan	3.1 discuss the processes and activities required to implement the development plan 3.2 undertake and document development activities as planned 3.3 reflect critically on own learning against original aims and objectives set in the development plan 3.4 update the development plan based on feedback and evaluation
4. Be able to demonstrate acquired interpersonal and transferable skills	4.1 select solutions to work-based problems 4.2 communicate in a variety of styles and appropriate manner at various levels 4.3 evaluate and use effective time management strategies

Unit 28: Research Project

QCF Level 5: BTEC Higher National

Credit value: 20

Aim

To develop learners' skills of independent enquiry and critical analysis by undertaking a sustained research investigation of direct relevance to their Higher Education programme and professional development.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand how to formulate a research specification	1.1 formulate and record possible research project outline specifications. 1.2 identify the factors that contribute to the process of research project selection. 1.3 undertake a critical review of key references 1.4 produce a research project specification 1.5 provide an appropriate plan and procedures for the agreed research specification.
2 Be able to implement the research project within agreed procedures and to specification	2.1 match resources efficiently to the research question or hypothesis 2.2 undertake the proposed research investigation in accordance with the agreed specification and procedures. 2.3 record and collate relevant data where appropriate.
3 Be able to evaluate the research outcomes	3.1 use appropriate research evaluation techniques 3.2 interpret and analyse the results in terms of the original research specification 3.3 make recommendations and justify areas for further consideration
4 Be able to present the research outcomes	4.1 use an agreed format and appropriate media to present the outcomes of the research to an audience

Unit 29: Work-based Experience

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to enable learners to experience the scope and depth of learning which may take place in a work-based context by planning, monitoring and evaluating the work experience.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to negotiate industry experience	1.1 research and evaluate suitable organisations that could provide industry experience 1.2 negotiate with work and academic supervisors a proposal for the work experience 1.3 recognise the business constraints on the work experience offered
2 Understand the specific requirements of the placement	2.1 agree and prioritise the tasks and responsibilities involved in the work experience 2.2 produce a plan for the work experience 2.3 analyse the benefits of the proposed activities to the business and the learner
3 Be able to undertake work experience as identified	3.1 fulfil specified requirements of placement conforming to all related codes of practice 3.2 produce systematic records of work undertaken 3.3 revise the initial plan as required 3.4 make suggestions for improvement and review these with appropriate supervisor
4 Be able to monitor and evaluate own performance and learning	4.1 monitor progress against original proposal 4.2 evaluate the quality of own performance 4.3 analyse the learning which has taken place during the work experience using suitable reflections 4.4 make recommendations on how the experience could have been enhanced

Unit 30: Quality Assurance and Management

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' knowledge and understanding of the principles and applications of quality management.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand how Total Quality Management (TQM) systems operate	1.1 explain the principles of TQM in relation to a specific application 1.2 evaluate management structures that can lead to an effective quality organisation 1.3 analyse the application of TQM techniques in an organisation
2 Know the key factors of Quality Assurance (QA) techniques	2.1 identify the key factors necessary for the implementation of a QA system within a given process 2.2 interpret a given internal and external quality audit for control purposes 2.3 describe the factors affecting costing
3 Be able to apply Quality Control (QC) techniques	3.1 report on the applications of quality control techniques 3.2 apply quality control techniques to determine process capability 3.3 use software packages for data collection and analysis

Unit 31: Value Management

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop the skills and knowledge needed to analyse products and parts in order to improve value.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to carry out a Pareto analysis	1.1 carry out a Pareto analysis against at least four criteria 1.2 describe what information will be required to conduct a Pareto analysis 1.3 describe the principles and process of Pareto analysis
2 Be able to produce part families using a range of criteria	2.1 produce part families from a given set of parts and a range of bill of materials 2.2 describe a part numbering system which would be helpful for putting parts into families
3 Be able to produce a total cost model and supply chain map for a product or process	3.1 produce a total cost model for a product or process 3.2 produce a supply chain map for a product or process 3.3 show how costs are related to functions and align these to Porter's Value Chain model
4 Be able to produce a detailed proposal from the findings of value management activities	4.1 develop and produce a detailed proposal following the use of value management activities 4.2 justify appropriate alternatives produced from the use of value management activities

Unit 32: Industrial Robot Technology

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of robots and the skills needed to use them for a range of industrial applications.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the key elements of industrial robots	1.1 analyse the key elements of a robot manipulator and their principles of operation 1.2 describe the main control elements of a robot system and explain their functions 1.3 describe the devices and methods used to improve the intelligence of a robot 1.4 investigate the possible sources of error or malfunction in an industrial robot system
2 Be able to program an industrial robot	2.1 describe common programming methods 2.2 describe the facilities available in a structured robot program 2.3 generate a robot program to simulate an industrial task using a structured technical language 2.4 set up the robot and execute the program so that the robot functions safely and efficiently
3 Be able to design a robot cell and plan its implementation	3.1 identify and evaluate the parameters which relate to the design of an efficient and safe robot cell 3.2 describe the criteria which must be considered in the selection of a robot for an industrial application 3.3 design a robot cell for an industrial application 3.4 describe the factors which must be considered in the implementation of a robot cell

Unit 33: Workplace Study and Ergonomics

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' ability to identify and carry out productivity measurement and improvement, work-study, ergonomic and layout design

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand productivity measurement techniques and the effect of a range of improvement methods	1.1 describe techniques of productivity measurement 1.2 analyse and evaluate the usefulness of the range of productivity measurement techniques 1.3 describe methods of productivity improvement 1.4 analyse and evaluate the effects of the range of productivity improvement methods
2 Understand the features of work measurement and method study techniques	2.1 explain how work study comprises of work measurement and method study techniques 2.2 describe work measurement and method study techniques 2.3 analyse a range of work measurement and work study techniques used for a given situation
3 Be able to assess the ergonomic and layout planning features of workstation and manufacturing operations design	3.1 describe ergonomic and layout planning features of workstation and manufacturing operations design 3.2 assess these features to develop criteria for good layout design
4 Be able to select and apply appropriate industrial engineering techniques to a given engineering/manufacturing situation	4.1 gather and present appropriate information from a given engineering/manufacturing situation 4.2 select industrial engineering techniques appropriate to a given engineering/manufacturing situation 4.3 apply industrial engineering techniques to a given engineering/manufacturing situation

Unit 34: Integrated Logistical Support Management

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to develop the knowledge and skills needed to develop and apply an integrated logistics support programme.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to develop an integrated logistic support (ILS) programme	1.1 prepare an ILS programme in the form of accuracy required, programme and schedules 1.2 describe dependencies, restraints and uncertainties in an ILS programme 1.3 identify resources required for an ILS programme
2 Be able to produce a work breakdown structure (WBS) for the tasks required to achieve an ILS programme	2.1 describe the key factors influencing the implementation of an ILS programme 2.2 produce and present a work breakdown structure for the tasks required to achieve ILS programme requirements
3 Be able to use techniques to monitor an ILS programme and a system of quality assurance	3.1 produce a report to show the progress made and the quality assurance systems used to assure quality in an ILS programme 3.2 justify the use of monitoring techniques applied and quality assurance systems used to measure progress for an ILS programme
4 Be able to apply risk management techniques and recommend mitigating measures against an ILS programme	4.1 describe and use techniques of risk management when applied to an ILS programme 4.2 compare different measures of mitigation in relationship to an ILS programme

Unit 35: Further Analytical Methods for Engineers

QCF level 5: BTEC Higher National

Credit Value: 15

Aim

This unit aims to further develop the analytical knowledge and techniques necessary to analyse and solve a variety of engineering situations and problems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to analyse and model engineering situations and solve problems using number systems	1.1. use estimation techniques and error arithmetic to establish realistic results from experiment 1.2. convert number systems from one base to another, and apply the binary number system to logic circuits 1.3. perform arithmetic operations using complex numbers in Cartesian and polar form 1.4. determine the powers and roots of complex numbers using de Moivre's theorem 1.5. apply complex number theory to the solution of engineering problems when appropriate
2 Be able to analyse and model engineering situations and solve problems using graphical and numerical methods	2.1. draw graphs involving algebraic, trigonometric and logarithmic data from a variety of scientific and engineering sources, and determine realistic estimates for variables using graphical estimation techniques 2.2. make estimates and determine engineering parameters from graphs, diagrams, charts and data tables 2.3. determine the numerical integral of scientific and engineering functions 2.4. estimate values for scientific and engineering functions using iterative techniques

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
3 Be able to analyse and model engineering situations and solve problems using vector geometry and matrix methods	3.1 represent force systems, motion parameters and waveforms as vectors and determine required engineering parameters using analytical and graphical methods 3.2 represent linear vector equations in matrix form and solve the system of linear equations using Gaussian elimination 3.3 use vector geometry to model and solve appropriate engineering problems
4 Be able to analyse and model engineering situations and solve problems using ordinary differential equations	4.1 analyse engineering problems and formulate mathematical models using first order differential equations 4.2 solve first order differential equations using analytical and numerical methods 4.3 analyse engineering problems and formulate mathematical models using second order differential equations 4.4 solve second order homogeneous and non-homogenous differential equations 4.5 apply first and second order differential equations to the solution of engineering situations

Unit 36: Statistical Process Control

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will enable learners to apply relevant statistical techniques used in process quality control and to evaluate a process against a given specification.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the basic types, variations and characteristics of statistical techniques used in process control	1.1 evaluate the two basic types of inspection used in sampling for process control 1.2 describe the significance of natural and assignable causes of variation 1.3 use selected data to construct frequency distribution and calculate mean, range and standard deviation 1.4 relate the characteristics of the normal curve to the distribution of the means of small samples
2 Be able to select data, construct process control charts and initiate a control program for a specified application	2.1 select and group sample data based on variable inspection and attributable inspection and calculate appropriate control chart limits 2.2 construct control charts for variables, rejects per unit and percentage defectives per batch 2.3 initiate a control program for a specified application.
3 Be able to evaluate process capability against a given product or component quality requirement using modified control chart limits	3.1 describe process capability 3.2 investigate the purpose of modified control chart limits 3.3 evaluate processes against a given quality requirement
4 Be able to analyse types of variation within a process and record information on that variation	4.1 analyse a range of processes for types of variation 4.2 record information on variation from a process

Unit 37: Management of Projects

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit provides knowledge and experience of project management principles, methodologies, tools and techniques that may be used in industry and the public sector.

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the principles of project management	1.1 examine the background and principles of project management 1.2 discuss the viability of projects with particular emphasis on the criteria for success/failure 1.3 explore the principles behind project management systems and procedures 1.4 examine the key elements involved in terminating projects and conducting post-project appraisals
2 Be able to plan a project in terms of its organisation and people	2.1 plan the most appropriate organisational structure 2.2 discuss roles and responsibilities of participants within a project 2.3 carry out the control and co-ordination of a project 2.4 document project leadership requirements and qualities 2.5 plan specific human resources and requirements for a project
3 Be able to manage project processes and procedures	3.1 design the project organisation with reference to prepared project management plans 3.2 demonstrate project scheduling, estimating and cost control techniques 3.3 report the methods used to measure project performance 3.4 report project change control procedures

Unit 38: Managing People in Engineering

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners understanding of the methods, processes and procedures used when managing people in engineering.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the processes and procedures involved in people management	1.1 explain how workforce planning is used to assess staffing requirements 1.2 analyse how the general employment environment affects effective workforce recruitment and selection 1.3 outline the processes and procedures carried out when recruiting and selecting personnel for a given engineering post
2 Understand the working relationships within an engineering context	2.1 explain different working relationships within an engineering organisation 2.2 examine lines of authority within an engineering organisation 2.3 discuss roles and responsibilities of employees within an engineering organisation 2.4 review the relevance of objectives of working relationships within an engineering context 2.5 explain how sub-contractors can be managed
3 Understand the methods of managing and developing human resources	3.1 explain the importance of employee motivation and involvement 3.2 evaluate a range of training techniques which are employed within an engineering organisation 3.3 explain the role of reward systems, appraisal and development schemes within an engineering organisation 3.4 explain the benefits of training and development to the organisation and the individual

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Understand industrial relations and legislation within an employment relationship.	4.1 describe contractual regulations of employment 4.2 justify the use of employment practices in an engineering organisation 4.3 explain the constraints imposed by legislation on termination of employment 4.4 examine and report on the main features of current employment legislation

Unit 39: Electronic Principles

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to further develop learners' understanding of analogue electronics to a wide audience of engineering sector needs.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to apply testing procedures for semiconductor devices and circuits	1.1 apply testing procedures to a range of semiconductor devices and circuits 1.2 use relevant literature for testing semiconductor devices and circuits
2 Understand the characteristics and operation of amplifier circuits	2.1 analyse the operation of different types of amplifier 2.2 evaluate the actual performance of different types of amplifier 2.3 compare the analysis with the measured results 2.4 modify circuit designs to meet revised specifications
3 Understand the types and effects of feedback on circuit performance	3.1 describe types of feedback and determine the effects on circuit performance when feedback is applied 3.2 design a circuit employing negative feedback 3.3 investigate the effects of applying feedback to single and multi-stage circuits
4 Understand the operation and applications of sine wave oscillators	4.1 describe the circuit conditions and the methods used to achieve sinusoidal oscillation 4.2 build and evaluate a sine wave oscillator to a given specification 4.3 explain the advantages of crystal-controlled oscillator circuits

Unit 40: Knowledge-Based Systems and Techniques

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will introduce learners to the concepts and techniques used in artificial intelligence and knowledge-based systems and develop an understanding of rule-based systems, fuzzy logic, artificial neural networks.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the use of knowledge-based and rule-based systems	1.1 explain knowledge-base and rule-base terminology 1.2 devise and interpret semantic networks 1.3 describe applications of knowledge-based and rule-based systems
2 Be able to use fuzzy logic	2.1 describe human reasoning and expert knowledge 2.2 use fuzzy logic theory to produce fuzzy rules, fuzzification and defuzzification 2.3 describe and evaluate applications of fuzzy logic 2.4 design and evaluate fuzzy logic systems using appropriate software
3 Be able to use artificial neural networks	3.1 explain the biological analogy of neural networks 3.2 explain network topologies and operating characteristics 3.3 describe and evaluate applications of neural networks 3.4 design and evaluate neural networks using appropriate software

Unit 41: Fluid Mechanics

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to extend learners' knowledge of the principles of fluid mechanics and the techniques used to predict the behaviour of fluids in engineering applications.

Outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Be able to determine the behavioural characteristics and parameters static fluid systems	1.1 determine the hydrostatic pressure and thrust on immersed surfaces 1.2 determine the centre of pressure on immersed surfaces 1.3 determine the parameters of devices in which a fluid is used to transmit force
2. Understand the effects of viscosity in fluids	2.1 explain the characteristics of and parameters of viscosity in fluids 2.2 describe viscosity measurement techniques 2.3 describe the effects of shear force on Newtonian and non-Newtonian fluids
3. Be able to determine the behavioural characteristics and parameters of real fluid flow	3.1 determine head losses in pipeline flow 3.2 determine Reynolds' number for a flow system and assess its significance 3.3 determine viscous drag of bluff and streamlined bodies 3.4 apply dimensional analysis to fluid flow
4. Understand the operating principles of hydraulic machines	4.1 evaluate the impact of a jet of fluid on a moving vane 4.2 identify and explain the operating principles of water turbines and pumps

Unit 42: Heat Transfer and Combustion

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of heat transfer principles and empirical relationships enabling them to solve practical problems involving heat transfer, combustion and the specification of practical engineering equipment.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand heat transfer rates for composite systems	1.1 apply Fourier's law and the Newton rate equation to composite solids and fluid/solid interfaces 1.2 calculate heat transfer rates for combined modes including radiation 1.3 evaluate lagging for optimum performance
2. Understand heat transfer mechanisms and coefficients	2.1 apply dimensional analysis to energy and mass transfer relationships 2.2 evaluate heat transfer mechanisms 2.3 determine heat transfer coefficients using experimental and tabulated data
3. Be able to evaluate heat transfer equipment	3.1 evaluate various types and layout of recuperators 3.2 estimate heat transfer performance 3.3 specify recuperator type, size and fluids for given applications
4. Be able to analyse the combustion processes	4.1 derive combustion equations 4.2 determine calorific value 4.3 analyse products of combustion

Unit 43: Plant and Process Principles

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of some of the engineering principles that underpin the design and operation of plant engineering systems and equipment.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand thermodynamic systems as applied to plant engineering processes	1.1 discuss thermodynamic systems and their properties 1.2 examine the application of the 1 st law of thermodynamics to thermodynamic systems 1.3 evaluate polytropic processes 1.4 determine the relationships between system constants for a perfect gas
2 Understand power transmission system elements in relation to plant engineering equipment	2.1 determine the maximum power which can be transmitted by means of a belt and by a friction clutch 2.2 determine the torque and power transmitted through gear trains
3 Understand static and dynamic fluid systems with reference to plant engineering	3.1 determine the hydrostatic pressure and thrust on immersed surfaces 3.2 determine the centre of pressure on immersed surfaces 3.3 explain viscosity in fluids 3.4 determine fluid flow in a pipeline 3.5 assess the impact of a jet of fluid
4 Understand combustion processes associated with plant engineering	4.1 explain the combustion process using terminology associated with combustion chemistry 4.2 determine energy of combustion 4.3 explain how products of combustion are formed

Unit 44: Plant Maintenance and Decommissioning

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the types and need for maintenance of engineering plant and the skills needed to prepare maintenance procedures and evaluate decommissioning procedures.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the need for and types of maintenance associated with engineering plant and equipment	1.1 explain need for maintenance of plant in an engineering environment 1.2 describe the types of maintenance associated with engineering plant and equipment 1.3 determine and explain the requirements for monitoring of maintenance procedures 1.4 specify the health and safety requirements in relation to maintenance
2 Be able to prepare and evaluate maintenance procedures and related documentation for engineering plant	2.1 justify and prepare maintenance procedures for a given plant engineering situation 2.2 determine resource requirements, identify costs and prepare maintenance documentation 2.3 evaluate maintenance procedures against relevant criteria
3 Be able to identify and evaluate decommissioning procedures for engineering plant	3.1 identify the appropriate decommissioning requirements and procedures 3.2 ensure compliance of all information and recording processes 3.3 determine appropriate criteria for evaluating both procedures 3.4 evaluate decommissioning procedures against relevant criteria

Unit 45: Plant Operations and Performance

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the installation, commissioning, performance and efficient functioning of engineering plant and equipment.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand how to plan the installation of engineering plant and equipment to meet identified specifications	1.1 assess specifications and schedules for the installation of engineering plant and equipment 1.2 justify the overall cost of installing engineering plant and equipment 1.3 describe necessary health and safety checks for the installation of engineering plant and equipment
2 Understand how to undertake commissioning procedures on engineering plant and equipment to achieve operational objectives	2.1 determine operational objectives in commissioning engineering plant and equipment 2.2 explain the use of procedures and schedules for commissioning 2.3 describe component and acceptance tests involved in commissioning
3 Be able to monitor the operational performance of engineering plant and equipment	3.1 plan the procedures used to monitor engineering plant and equipment parameters 3.2 report on the relevance and reliability of parameters and data sources 3.3 report on performance data in relation to operational objectives
4 Understand the performance capability of engineering plant and equipment.	4.1 justify when the operational performance of a system is in steady state 4.2 compare evaluated and rated performance characteristics for relevant engineering plant and equipment 4.3 propose remedial action to improve performance

Unit 46: Plant and Process Control

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop learners' understanding of time and frequency domain analysis of plant and process control systems and the use of controller designs to achieve specified system performance.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to predict the dynamic and steady state response of an engineering system	1.1 determine transfer functions from differential equation models 1.2 manipulate first and second order transfer functions into standard form and extract standard coefficients 1.3 determine output response to step and ramp inputs
2 Be able to design a control system in the time domain to a specified performance requirement	2.1 manipulate transfer functions and determine closed-loop transfer function 2.2 determine closed-loop dynamic and steady state parameters 2.3 design a controller to meet given performance criteria 2.4 assess the effect of controller settings on steady state and dynamic response
3 Be able to design a control system in the frequency domain to meet a specified performance requirement	3.1 examine response of systems to sinusoidal inputs and plot Bode frequency response plots 3.2 determine frequency response of higher order systems 3.3 predict stability and time domain performance of a closed loop system from open loop frequency response 3.4 design a controller to meet given performance criteria 3.5 assess the effect of controller settings on frequency and time response
4 Understand the need for and use of multi-loop and complex control systems	4.1 identify the limitations of PID control in ensuring effective control in some situations 4.2 investigate alternative control strategies 4.3 investigate and review some advanced control strategies

Unit 47: Engineering Plant Technology

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners understanding of the operation and testing of engineering plant and the application of the related underpinning principles of operation.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand procedures for safe and effective operation and testing of plant	1.1 analyse and review safe operating and testing procedures 1.2 interpret data and results to produce written reports 1.3 compare test results with accepted norms
2 Be able to apply the steady flow energy equation (SFEE) to plant and equipment	2.1 derive, from first principles, the steady flow energy equation 2.2 specify assumptions when applying SFEE to plant items 2.3 generate and apply specific equations based on stated assumption to specific plant items
3 Be able to apply the principles of heat transfer to plant processes	3.1 apply formulae involving U and k values to composite walls 3.2 realise the effect of boundary layers 3.3 apply heat transfer formulae to heat exchangers 3.4 compare heat losses through lagged and unlagged pipes
4 Be able to analyse and report on the performance of power supply equipment	4.1 analyse and report on the performance of a diesel engine 4.2 analyse and report on the performance of a steam turbine 4.3 analyse and report on the performance of a gas turbine

Unit 48: Analytical Instrumentation

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the techniques used in the detection of variables in industrial processes.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the principles of process sampling	1.1 explain the importance of sampling and explain the need for provision of a representative sample 1.2 describe essential sample components for continuous measurements in typical process systems 1.3 explain general design, maintenance and safety considerations for typical sampling systems 1.4 design a sampling system
2 Understand the principles, design and operation of analytical measurement instruments	2.1 explain the principle of operation of analytical measurement methods 2.2 describe the design features of a range of analytical measurement instruments 2.3 select the transducer capable of making a specified measurement, using manufacturers' technical data sheets 2.4 evaluate a measurement system which is relevant to the learner's place of work
3 Understand the principles, design operation and developments of chemical composition measurement instruments	3.1 explain the principle of operation of chemical composition measurement methods 3.2 evaluate design features of thermal conductivity detectors, flame ionisation detectors and electron capture detectors 3.3 select the transducer capable of making a specified measurement, using manufacturers' technical data sheets 3.4 evaluate a measurement system which is relevant to the learner's place of work

Unit 49: Computer Control of Plant

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop the learner's ability to design and use computer systems to monitor and control engineering and industrial plant.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to select computer control strategies for a complex control system	1.1 identify and review alternative computer control strategies 1.2 select and implement the appropriate strategy to meet a specification 1.3 demonstrate that the chosen strategy is easy to maintain and flexible enough to accommodate change as production needs change
2 Be able select remote smart sensors/devices to meet given specification	1.1 select appropriate sensors/devices to meet a specification 2.2 describe the operation, characteristics and limitations of the various sensors and devices 2.3 interface/configure two different sensors/devices to the computer system
3 Be able to select and develop programs and use machine interfaces to monitor plant operation	3.1 select/develop programs to solve real control problems, these could be simulations on controlled rigs 3.2 appraise ergonomics of commercial plant displays and process mimic devices 3.3 configure display devices to a given format for operators and maintenance staff 3.4 acquire continuous data display for real time production planning and control

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Understand the different types of data communication systems used in control and instrumentation	4.1 explain the different types of communication used in control and instrumentation systems 4.2 explain the layering and structure of the ISO 7 layer model 4.3 describe the use of LANs in a factory/plant environment 4.4 identify the requirements of fieldbus and explain its protocols 4.5 describe the use of fieldbus in control network systems.

Unit 50: Condition Monitoring and Fault Diagnosis

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to provide learners with an understanding of condition monitoring techniques and enable them to use a systematic approach towards fault diagnosis.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand the concepts of condition monitoring	1.1 describe the causes of failure and breakdown in plant and equipment and explain the use of statistical data for analysing such failure/breakdown 1.2 describe plant and machinery monitoring arrangements and explain the relative merits of each arrangement 1.3 provide a computer data analysis printout of machine operating parameters 1.4 explain how condition monitoring may be integrated within normal plant and machinery, control and data acquisition systems
2. Understand the nature and use of condition monitoring techniques	2.1 explain the nature of the condition monitoring techniques used to monitor temperature and vibration and to detect leakage, corrosion and cracks 2.2 analyse an overall system for plant and machinery condition monitoring and report findings
3. Be able to locate faults in engineering systems	3.1 investigate and identify sources of information and documentation used as an aid to fault finding and fault location and report on their usefulness 3.2 select appropriate inspection and test equipment for fault location 3.3 carry out appropriate fault finding procedures to locate and verify faults in systems

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4. Be able to analyse the cause and effect of faults in engineering systems	4.1 investigate and report on the causes of failure and identify the failure states of components within a given system 4.2 carry out a failure mode and effect analysis 4.3 carry out a fault tree analysis 4.4 prepare a cause and effect diagram

Unit 51: Emergency Shutdown and Safety Systems

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will provide learners with an understanding of safety shutdown systems as employed in modern industry.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the principles of safety shutdown systems	1.1 explain the principles of safety shutdown systems 1.2 evaluate a conceptual proposal for an overall process safety shutdown system
2 Understand the applied technology and techniques used in safety shutdown systems	2.1 identify the applied technology and techniques used in safety shutdown systems 2.2 explain the design criteria that are applied to safety shutdown systems
3 Understand the use of instrumentation in safety system applications	3.1 select suitable instrumentation for use in a safety shutdown application 3.2 identify specific requirements for safety instrumentation in a hazardous area environment 3.3 evaluate the use of instrumentation in a safety system application
4 Understand the operational and maintenance requirements for safety shutdown systems	4.1 determine the operational requirements for a safety shutdown system 4.2 determine the maintenance requirements for a safety shutdown system

Unit 52: Energy Management

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

The unit investigates energy management principles and techniques. The principal focus is to establish and develop an energy audit in the context of a plant engineering environment.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand environmental management policies	1.1 analyse the environmental management policies relevant to plant engineering 1.2 evaluate the types of energy technologies associated with plant engineering 1.3 assess the various aspects of resource management in the context of plant engineering
2 Know about energy sources, conservation and applications	2.1 define the various sources of fuel likely to be encountered in industry 2.2 describe the materials associated with energy conservation 2.3 identify industrial and commercial activities where energy conservation procedures can be adopted
3 Understand system and energy-saving requirements	3.1 assess systems which will provide an energy analysis 3.2 review a documented system analysis relating to the energy distribution 3.3 evaluate the appropriate cost-saving technique for the chosen situation
4 Be able to carry out an energy management audit	4.1 follow guidelines to determine the energy saving 4.2 specify the type, size and range of metering equipment as part of the audit process 4.3 set targets for performance parameters to be used whilst monitoring the processes

Unit 54: Industrial Plant Services

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of electrical supply systems, industrial compressors, steam services and refrigeration and heat pumps used in a range of engineering industrial plant.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the use and applications of electrical supply systems	1.1 use the relevant sections of the IEE regulations 1.2 design appropriate lighting circuits 1.3 classify starting and speed control mechanisms 1.4 determine appropriate values for transformer outputs 1.5 perform power factor correction calculations
2 Be able to apply the gas laws to industrial compressors	2.1 derive formulae with reference to the gas laws 2.2 apply the gas laws to an industrial compressor system
3 Understand the provision of steam services for process and power use	3.1 explain the requirements for process steam according to use 3.2 discuss the need for superheated steam for power use 3.3 determine overall plant efficiencies for process, power and combined heat and power systems 3.4 produce illustrative sketches of heat distribution in systems
4 Understand industrial applications of refrigerators and heat pumps	4.1 determine coefficient of performance, heating effect and refrigeration effect of reversed heat engines 4.2 use refrigeration tables and charts 4.3 sketch refrigerator and heat pump cycles 4.4 discuss the economics of heat pumps 4.5 explain the apparent contradiction between refrigeration cycles and the second law of thermodynamics

Unit 55: Instrumentation and Control Principles

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to introduce learners to the principles and practice of instrumentation and control in process industries

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand instrumentation systems used in process control	1.1 describe the terminology used in process measurements 1.2 evaluate a range of sensors and transducers with reference to manufacturers' terminology 1.3 explain the construction and operation of modern sensors used to measure pressure, level, temperature and flow 1.4 describe typical applications for the sensors examined 1.5 explain signal conditioning and transmission
2 Understand process control systems and controllers	2.1 explain the need for process control 2.2 describe process control terminology 2.3 determine the medium required for successful transmission 2.4 name sensors, conditioners and display units for a range of specific purposes 2.5 examine tuning techniques 2.6 describe the control actions required for different systems 2.7 represent systems using standard diagrams
3 Understand the use of regulating units	3.1 identify the main parts of a regulating unit 3.2 evaluate a regulating unit with reference to standard terminology, including manufacturers' specifications 3.3 select the plug characteristics required for a specified process 3.4 describe the characteristics of a range of regulating units 3.5 describe the use of valve positioners

Unit 57: Mechatronic Systems

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

The aim of the module is to investigate and evaluate a range of mechatronic systems that exist within industrial and domestic environments.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the applications of a range of mechatronic systems and products	1.1 identify mechatronic systems by their discipline integration 1.2 explain the need for system development in an integrated way 1.3 identify and describe mechatronic applications in consumer products and industrial processes
2 Understand electro-mechanical models and components in mechatronic systems and products	2.1 derive a mathematical model for 1 st and 2 nd order electrical and mechanical system 2.2 analyse analogies between the models of physically different systems 2.3 describe typical sensors and actuators for mechatronic systems and products
3 Be able to produce a specification for a mechatronic system or mechatronic product	3.1 produce a specification for a mechatronic system to meet current British Standards 3.2 select suitable sensor and actuator technologies for a mechatronic system 3.3 specify appropriate computer control hardware for a mechatronic system
4 Be able to apply mechatronic design philosophies to carry out a design analysis	4.1 carry out a design analysis on a system or product using mechatronic design philosophies 4.2 compare a system or product which has been designed employing traditional methods with one employing mechatronic methods

Unit 58: Microprocessor Systems

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of microprocessor-based systems and their use in instrumentation, control, or communication systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand microprocessor-based systems	1.1 compare types of microprocessor device families 1.2 evaluate three typical applications of microprocessor-based systems
2 Be able to design software, write and test programs for a microprocessor-based system	2.1 design software to a given specification using a structured design technique 2.2 write programs to implement designs using an appropriate computer language 2.3 test software to ensure it meets the given specification
3 Be able to design and build programmable interface devices	3.1 evaluate and choose programmable interface devices for a particular situation 3.2 design, build, program and test an interface for an external device to a microprocessor-based system

Unit 59: Advanced Mathematics for Engineering

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to provide the analytical knowledge necessary for studying engineering to Degree level and will provide the more advanced knowledge required for a range of careers in engineering.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to analyse and model engineering situations and solve engineering problems using series and numerical methods for the solution of ordinary differential equations	1.1 determine power series values for common scientific and engineering functions 1.2 solve ordinary differential equations using power series methods 1.3 solve ordinary differential equations using numerical methods 1.4 model engineering situations, formulate differential equations and determine solutions to these equations using power series and numerical methods
2 Be able to analyse and model engineering situations and solve engineering problems using Laplace transforms	2.1 determine Laplace transforms and their inverse using tables and partial fractions 2.2 solve first and second order differential equations using Laplace transforms 2.3 model and analyse engineering systems and determine system behaviour using Laplace transforms
3 Be able to analyse and model engineering situations and solve engineering problems using Fourier series	3.1 determine Fourier coefficients and represent periodic functions as infinite series 3.2 apply the Fourier series approach to the exponential form and model phasor behaviour 3.3 apply Fourier series to the analysis of engineering problems 3.4 use numerical integration methods to determine Fourier coefficients from tabulated data and solve engineering problems using numerical harmonic analysis

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to analyse and model engineering situations and solve engineering problems using partial differential equations	4.1 solve rates of change problems and problems involving stationary values using partial differentiation 4.2 solve partial differential equations using direct partial integration and separation of variables methods 4.3 model and analyse engineering situations using partial differential equations

Unit 60: Dynamics of Machines

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will deepen learners' knowledge of the principles and techniques used in the design of machine elements.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Be able to determine the kinetic and dynamic parameters of mechanical power transmission system elements	1.1 analyse geared systems to determine velocity ratio and required accelerating torque 1.2 determine the operating efficiency of screw jacks and lead screws 1.3 analyse turning moment diagrams for reciprocating engines and presses to determine the required flywheel parameters for specific operating conditions 1.4 analyse the characteristics of Hooke's joints and constant velocity joints and recognise the conditions for a constant velocity ratio
2. Be able to determine the kinetic and dynamic parameters of mechanical systems	2.1 determine the output motion of radial plate and cylindrical cams 2.2 determine the velocities and accelerations of points within plane mechanisms and the associated inertia forces 2.3 analyse systems in which gyroscopic motion is present to determine the magnitude and effect of gyroscopic reaction torque
3. Be able to determine the behavioural characteristics of translational and rotational mass-spring systems.	3.1 determine the natural frequency of vibration in translational and rotational mass-spring systems 3.2 determine the critical whirling speed of shafts 3.3 determine the transient response of damped mass-spring systems when subjected to a disturbance 3.4 determine the steady state response of damped mass-spring systems when subjected to sinusoidal excitation

Unit 61: Engineering Thermodynamics

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will extend learners' knowledge of heat and work transfer. It will develop learners' understanding of the principles and laws of thermodynamics and their application to engineering thermodynamic systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand the parameters and characteristics of thermodynamic systems	1.1 evaluate polytropic process parameters 1.2 explain the operation thermodynamic systems and their properties 1.3 apply the first law of thermodynamics to thermodynamic systems 1.4 determine the relationships between system constants for an ideal gas
2. Be able to evaluate the performance of internal combustion engines	2.1 apply the second law of thermodynamics to the operation of heat engines 2.2 evaluate theoretical heat engine cycles 2.3 evaluate the performance characteristics of spark ignition and compression ignition internal combustion engines 2.4 discuss methods used to improve the efficiency of internal combustion engines
3. Be able to evaluate the performance of reciprocating air compressors	3.1 evaluate property diagrams for compressor cycles 3.2 determine the performance characteristics of compressors 3.3 apply the first law of thermodynamics to compressors 3.4 identify compressor faults and hazards

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4. Understand the operation of steam and gas turbine power plant.	4.1 explain the principles of operation of steam and gas turbines 4.2 illustrate the functioning of steam power plant by means circuit and property diagrams 4.3 determine the performance characteristics of steam power plant

Unit 62: Strengths of Materials

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This aim of this unit is to broaden and deepen the learner's knowledge of the principles and techniques used in stress analysis.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to determine the behavioural characteristics of engineering components subjected to complex loading systems	1.1 analyse two-dimensional stress systems making appropriate use of Mohr's stress circle 1.2 carry out experimental strain analysis using electrical resistance strain gauges 1.3 apply the appropriate theory of elastic failure to loaded components to determine operational factors of safety
2 Be able to determine the behavioural characteristics of loaded beams, columns and struts	2.1 determine the support reactions, slope and deflection of simply supported beams 2.2 determine the distribution of stress in the materials of reinforced concrete beams 2.3 determine the stress distribution in columns and walls which are subjected to asymmetrical bending 2.4 determine the appropriate critical load for axially loaded struts 2.5 carry out tests to validate critical load calculations
3 Be able to determine the behavioural characteristics of loaded structural members by the consideration of strain energy.	3.1 determine the strain energy stored in a member due to direct loading, shear loading, bending and torsion 3.2 determine the elastic deflection of loaded members making appropriate use of Castigliano's theorem 3.2 carry out tests to validate deflection calculations 3.3 predict the effects of shock loading on struts and ties

Unit 63: Electrical Power

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners understanding of electrical power systems and power distribution and the advantages and disadvantages of alternative energy sources.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to analyse three-phase systems	1.1 solve problems involving fault free three-phase systems 1.2 measure power in three-phase systems 1.3 solve problems involving faulted three-phase systems 1.4 describe three-phase transformers 1.5 describe the characteristics of a three-phase induction motor 1.6 assess the effect of load dynamics
2 Understand the sources and effects of harmonics in power systems	2.1 identify typical sources of harmonics in a power system 2.2 explain the effects of harmonics in power systems 2.3 evaluate at least four different methods of mitigation of harmonics
3 Understand methods of power distribution	3.1 compare different power system topologies 3.2 analyse the operating parameters of a radial and a ring distribution system
4 Understand the economics of components, power systems and alternative energy	4.1 compare the economics of single-phase and three-phase distribution 4.2 compare and evaluate the different forms of alternative energies

Unit 64: Electrical and Electronic Measurement and Testing

QCF level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop the knowledge and skills required to perform complex measurement and test procedures on electrical and electronic systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to analyse a measurement system and solve problems relating to the characteristics of a signal	1.1 analyse a measurement system 1.2 solve problems relating to the characteristics of signals 1.3 compare different types of transmission systems
2 Be able to analyse the principles and techniques employed in measurement	2.1 solve problems relating to data that has been measured 2.2 solve problems using graphical techniques 2.3 solve problems using spreadsheets
3 Be able to select and use test equipment to measure a range of signals	3.1 describe the operation of items of test equipment 3.2 select and use items of test equipment to measure signals
4 Be able apply the principles and techniques used in data acquisition systems	4.1 identify the hardware and software required to capture data from an item under test 4.2 investigate the operation of a data acquisition system 4.3 apply a data acquisition system to determine the performance of an item under test 4.4 analyse the results obtained from the data acquisition

Unit 65: Utilisation of Electrical Energy

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop learners' understanding of the underlying technology involved in the utilisation of electrical energy in some of the more important areas of electrical engineering.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Know the operation of power transformers	1.1 describe the construction of different types of power transformer 1.2 identify the operating principles of a power transformer under no-load and load conditions 1.3 describe the modes of connection for polyphase transformers
2 Understand the applications of circuit protection for distribution and installation systems	2.1 describe the construction of over-current protection devices 2.2 explain the operating principles of circuit over-current protection devices 2.3 explain the operating principles of earth fault protection devices
3 Understand the design and construction of lighting systems	3.1 describe the construction, operation and associated circuitry of common lamp types 3.2 explain the principles of good lighting design 3.3 plan a light scheme
4 Be able determine the cost of energy used in a system in order to be energy efficient	4.1 describe the factors governing tariff structures 4.2 analyse methods for reducing energy consumption 4.3 determine the cost of energy used in a system
5 Understand the operation of a polyphase induction motor	5.1 describe the types and construction of induction motors 5.2 explain the operating principles and methods of starting induction motors 5.3 describe the methods of speed control of induction motors

Unit 66: Electrical, Electronic and Digital Principles

QCF level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop learners' understanding of the electrical, electronic and digital principles needed for further study of electro-mechanical systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to apply complex notation in the analysis of single phase circuits	1.1 solve problems involving LCR circuits 1.2 evaluate the effects on circuit performance of changes in values of impedances
2 Be able to apply circuit theory to the solution of circuit problems	2.1 solve problems using circuit theorems to calculate currents and voltage in circuits 2.2 analyse circuits including the value of circuit loads which produce maximum power
3 Understand the operation of electronic amplifier circuits used in electro-mechanical systems	3.1 analyse the operation of single- and two-stage amplifiers 3.2 evaluate the performance of single- and two-stage amplifiers 3.3 design and evaluate a single-stage transistor amplifier 3.4 compare measured results with theoretical calculations
4 Be able to design and test digital electronic circuits used in electro-mechanical systems	4.1 evaluate digital electronic device families 4.2 design combinational and sequential digital electronic circuits 4.3 test digital circuits by construction or by computer simulation

Unit 67: Further Electrical Power

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

unitlearnerthe distribution of electrical power and help them needs

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the construction and properties of overhead lines and cables	1.1 explain the construction and properties of an overhead line 1.2 compare different types of cable used in power systems 1.3 describe methods of fault location 1.4 use T and π models to evaluate performance
2 Understand symmetrical faults and protection schemes	2.1 investigate and describe the components in a protection scheme 2.2 use one-line diagrams to solve fault analysis problems 2.3 solve problems involving the use of fault-limiting reactors 2.4 identify and describe the protection scheme used in a given system
3 Be able to analyse power system transients	3.1 analyse the propagation of surges 3.2 use a Bewley lattice diagram to analyse multiple reflections 3.3 describe how surges occur and two methods used for surge control
4 Understand the synchronising and control of synchronous machines	4.1 analyse and compare two methods of synchronising 4.2 explain how the control of voltage, frequency and power factor of a synchronous machine can be achieved

Unit 68: Applications of Power Electronics

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop a technical understanding of power electronics and their application to variable speed drives.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand common configurations for controlled and uncontrolled rectification	1.1 describe standard configurations used in single and three-phase systems 1.2 calculate signal parameters of a rectified waveform 1.3 explain methods of device protection 1.4 use safe measurement techniques when measuring current and voltage in earthed systems
2 Understand the methods used for AC motor control	2.1 explain methods of speed control for a DC motor 2.2 explain methods of torque control for a DC motor 2.3 investigate an industrial DC motor controller
3 Understand the methods used for DC motor control	3.1 explain methods of frequency conversion 3.2 explain methods of control for an AC motor 3.3 investigate an industrial AC motor controller
4 Understand other applications of power electronics	4.1 compare the principles of three other applications of power electronics 4.2 investigate an area of application for each of the three applications

Unit 69: Advanced Computer-Aided Design Techniques

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

The aim of this unit is to enhance learners' skills in the use of Computer-Aided Design (CAD) and 3D modelling systems to solve a design problem.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to modify and update an existing design	1.1 load drawing files from varying sources using different formats 1.2 update the modified blocks and load into drawing 1.3 modify drawing to new requirements and record modifications 1.4 create a word-processed report with modified parts of drawing inserted 1.5 produce and print/plot report and drawing
2 Be able to generate a surface model	2.1 manipulate the user co-ordinate system (UCS) and world co-ordinate system (WCS) to suit construction requirements 2.2 produce shapes that contain the correct geometry for the required surface 2.3 create the correct surface construction 2.4 produce a surface that is compatible with processing limits 2.5 create a suitable viewing medium 2.6 produce a report describing the different methods of constructing a surface

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
3 Be able to generate a solid model	3.1 manipulate the user co-ordinate system (UCS) and world co-ordinate system (WCS) to suit construction requirements 3.2 create bounded geometry for extrusion and revolving 3.3 produce sections from solid model 3.4 demonstrate the use of construction techniques 3.5 produce file containing mass, surface area, radius of gyration and centre of gravity 3.6 produce a report detailing the uses of solid modelling in the manufacturing process

Unit 71: Combinational and Sequential Logic

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit aims to provide learners with the skills and understanding required to design and build electronic circuits that use combinational and sequential logic.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to design and build circuits using combinational logic	1.1 interpret manufacturers' data sheets to select appropriate combinational logic devices for specific purposes 1.2 compare the characteristics of similar devices using different technologies 1.3 design, construct and test combinational circuits 1.4 use computer software packages (eg Visual Spice) to simulate logic circuits
2 Be able to design and build circuits using sequential logic	2.1 describe the operation of sequential logic devices 2.2 use formal design techniques to design sequential circuits 2.3 construct and test sequential circuits 2.4 use computer simulation to verify logic designs
3 Be able to design and evaluate a digital system	3.1 design a digital system to meet a technical specification 3.2 realise, test and evaluate the design against criteria 3.3 improve the design by reducing the chip count through the use of programmable logic devices

Unit 73: Manufacturing Electronic Products

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the principles and techniques used in the production of modern electronic products.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the production and packaging of solid-state electronic devices	1.1 describe the production of solid-state devices common to the electronics industry 1.2 evaluate the different types of device packaging available
2 Understand electronic component design parameters	2.1 explain the effects of altering given design rules on microelectronic devices 2.2 describe failure modes and mechanisms for a range of microelectronic devices
3 Know the methods used for the design, simulation, manufacture and testing of printed circuit boards (PCB)	3.1 describe the design and simulation of single- and multi-layer PCBs 3.2 specify the types of equipment required for automated PCB manufacture and assembly 3.3 describe the methods of testing completed PCBs and finished electronic products 3.4 describe the methods of designing and producing casings and housings for electronic products
4 Understand the key elements of an automated PCB assembly facility	4.1 identify the key elements of an automated PCB assembly facility 4.2 evaluate the use of robots for components placement including selection criteria and associated costs

Unit 74: Vehicle Fault Diagnosis

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of vehicle fault diagnosis and will give them the practical skills needed to diagnose vehicle faults and assess serviceability.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand vehicle systems fault diagnosis criteria and techniques	1.1 identify and justify a diagnosis specification for a mechanical or an electrical or an electronic vehicle system 1.2 use, explain and record the results of at least two suitable vehicle systems diagnostic techniques 1.3 compare the factors that contribute to quick and effective diagnosis of a given vehicle system.
2 Be able to use fault diagnostic techniques and equipment to determine the performance of vehicle systems	2.1 select and use appropriate test equipment 2.2 carry out a systematic fault diagnosis 2.3 interpret faults from given symptoms and justify repair recommendations.
3 Be able to evaluate and present findings of a vehicle fault diagnostic test and produce a fault location guide.	3.1 produce a written report of the test results 3.2 interpret and justify the test results in terms of the known data for that system 3.3 create an effective fault location guide for a mechanical or an electrical or an electronic system.

Unit 75: Vehicle Systems and Technology

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of the operating principles associated with advanced vehicle systems and will give them the skills needed to carry out diagnostic procedures on these systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1. Understand vehicle electronic power steering and active suspension systems	1.1 explain the principles of operation and identify major components of an advanced power steering system 1.2 explain the principles of operation and identify major components of an active suspension and ride control system 1.3 explain service and repair procedures for an advanced power steering system and an active suspension and ride control system.
2. Understand vehicle anti-lock braking, traction control and integrated dynamic stability control systems	2.1 explain the principles of operation and identify major components of an anti-lock braking system 2.2 explain the principles of operation and identify major components of a traction control system 2.3 examine the service and repair procedures for an anti-lock braking system and a traction control system 2.4 examine the function of an integrated stability control system.
3. Understand vehicle security, environmental control and passenger protection systems	3.1 explain the operating principles and identify major components of an advanced central locking and security system 3.2 explain the operating principles and identify major components of an environmental control system 3.3 examine the operation of a passenger protection system 3.3 explain the service and repair procedures of an advanced central locking and security system 3.4 explain the service and repair procedures of an environmental control system.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
4 Be able to carry out diagnostic procedures on power steering, suspension and central body systems.	4.1 carry out fault diagnosis tests on advanced vehicle power steering, suspension and central body systems and record the results 4.2 interpret and present results from a fault diagnosis test 4.3 report on the serviceability of a system and the major components in that system.

Unit 77: Plan and Co-ordinate Vehicle Maintenance

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit aims to develop learners' knowledge and understanding of the planning, co-ordination and control of vehicle fleet maintenance.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the legal and operational implications of a vehicle maintenance contract	1.1 explain three different types of vehicle maintenance contract and evaluate their legal and operational implications 1.2 discuss the methods used to satisfy the requirements of a vehicle maintenance contract 1.3 assess the suitability of a vehicle maintenance contract to meet specific requirements.
2 Understand fleet maintenance management systems	2.1 evaluate different management systems for fleet maintenance and identify the criteria for selecting a management system 2.2 design a fleet maintenance management system to satisfy a customer's requirements.
3 Understand the legal implications relating to vehicle maintenance	3.1 explain the legal requirements when undertaking fleet maintenance 3.2 discuss the implications and processes needed to satisfy legal requirements.
4 Understand how to control the maintenance of a vehicle fleet	4.1 produce criteria for the selection of a maintenance control system 4.2 evaluate a control system for the maintenance of a vehicle fleet 4.3 explain the procedures used when planning and controlling the maintenance of a vehicle fleet.

Unit 78: Accident Investigation

QCF Level 5: BTEC Higher National

Credit value: 15

Aim

This unit gives learners an in-depth appreciation of the principles and techniques used for accident investigation and reconstruction.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Understand the forces acting on a vehicle when in motion and during a collision	1.1 carry out calculations to determine the forces acting upon a vehicle in motion 1.2 explain the effect of friction on the motion of a vehicle 1.3 evaluate the effects of a vehicle collision
2 Understand the influence of vehicle brake characteristics on the behaviour of a vehicle	2.1 analyse different types of brake circuits and explain the effect of circuit failure on brake performance when one circuit fails 2.2 explain the operation of different types of pressure valves 2.3 describe the different characteristics of brake fluid 2.4 describe the different types of brake defects 2.5 explain the legal requirements with regard to vehicle braking systems
3 Understand the influence of vehicle tyre characteristics on the behaviour of a vehicle	3.1 explain the different types of tyre markings 3.2 describe the factors affecting vehicle handling and tyre behaviour 3.3 describe the factors affecting adhesion 3.4 recognise tyre construction and determine types of tyre defects 3.5 interpret the legal requirements for tyres
4 Be able to apply accident reconstruction techniques	4.1 evaluate the relevance of vehicle debris and tyre markings at the scene of an accident 4.2 produce accident scene construction plans

Unit 79: Vehicle Electronics

QCF Level 4: BTEC Higher National

Credit value: 15

Aim

This unit will develop learners' understanding of vehicle electrical and electronic systems, circuits and components and will develop the skills needed to carry out tests, find faults and repair systems.

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
1 Be able to analyse and test vehicle electrical and electronic circuits	1.1 carry out calculations to solve problems in series and parallel automotive electrical circuits 1.2 explain the properties and characteristics of common semiconductor devices 1.3 read and interpret electrical and electronic circuit diagrams 1.4 perform systematic testing of vehicle electronic systems and record results.
2 Understand the operation of vehicle sensors, actuators and display units	2.1 explain the principles of operation and electrical characteristics of different sensors when used in vehicles 2.2 explain the principles of operation and electrical characteristics of different actuators when used in vehicles 2.3 examine the operation and relevant test procedure of a driver information display device.
3 Understand the operation of microprocessor hardware and suppression methods used in vehicle circuits	3.1 analyse microprocessor hardware operation in vehicle systems 3.2 analyse the operation of a suppression method.
4 Be able to carry out systematic fault diagnosis and repairs on vehicle electronic systems	4.1 carry out systematic test procedures on vehicle microprocessor, sensor and suppression systems and record results 4.2 evaluate the use of a vehicle self diagnosis system 4.3 identify and repair faults on a vehicle microprocessor, sensor/actuator and suppression system.