BTEC Higher Nationals in Aerospace Engineering

Core Units

This **Course Information** document outlines the core units individually by specification, unit number, description, assessment outcomes and guidance for the Edexcel BTEC Higher National qualifications in Aerospace Engineering.

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Contents

UNIT 1: BUSINESS MANAGEMENT TECHNIQUES

Unit value: 1
Unit level: H1
Unit code: 21716P

1.1 Description of unit

This unit develops students' knowledge of calculating costs associated with engineered products and services. It also introduces them to the fundamental concepts of project planning and scheduling.

1.2 Summary of outcomes

To achieve this unit a student must:

1 Select and apply **costing systems and techniques**

2 Analyse the key functions of **financial planning and control**

3 Apply basic **project planning and scheduling** methods to a specified project

1.3 Content

COSTING SYSTEMS AND TECHNIQUES

Costing systems: job costing, process costing, contract costing

Costing techniques: absorption, marginal, activity-based

Engineering business functions: design, manufacturing, engineering services

Measures and evaluation: break-even point, safety margin, profitability forecast, contribution analysis, 'what if' analysis, limiting factors, scarce resources

FINANCIAL PLANNING AND CONTROL

Financial planning process: short- medium- and long-term plans, strategic plans, operational plans, financial objectives, organisational strategy

Factors influencing decision: cash and working capital management, credit control, pricing, cost reduction, expansion and contraction, company valuation, capital investment

Budgetary planning: fixed, flexible and zero-based systems, cost, allocation, revenue, capital, control, incremental budgeting

Deviations: variance calculations for sales and costs, cash flow, causes of variance, budgetary slack, unrealistic target setting

PROJECT PLANNING AND SCHEDULING

Project resources and requirements: human and physical resource planning techniques, time and resource scheduling techniques, Gantt charts, critical path analysis, computer software packages, work breakdown structure, precedence diagrams

1.4 Outcomes and assessment criteria

Outcomes	**Assessment criteria** **To achieve each outcome a student must demonstrate the ability to:**
1 Select and apply **costing systems and techniques**	• identify and describe appropriate costing systems and techniques for specific engineering business functions • measure and evaluate the impact of changing activity levels on engineering business performance.
2 Analyse the key functions of **financial planning and control**	• explain the financial planning process • describe the factors influencing the decision-making process during financial planning • examine the budgetary planning process and its application to financial planning decisions • apply standard costing techniques and analyse deviation from planned outcomes.
3 Apply basic project **planning and scheduling** methods to a specified project	• establish the project resources and requirements • produce a plan with appropriate timescales for completing the project • identify human resource needs • identify approximate costs associated with each stage of the project.

1.5 Guidance

GENERATING EVIDENCE

Evidence of outcomes may be in the form of assignments and projects. These may be undertaken individually or as part of a wide-ranging group engineering assignment. Evidence should be provided at unit level, reflecting the links between the different outcomes.

LINKS

This unit offers opportunities for demonstrating Common Skills, particularly Applying Numeracy, Communicating, Managing Tasks and Solving Problems and Applying Technology.

Entry requirements for this unit are at the discretion of the centre. However, it is advised that students should have completed the Advanced Engineering GNVQ unit 'Engineering and Commercial Functions', or an equivalent qualification.

RESOURCES

Manual records and relevant computer software packages are needed to enable realistic project planning, resource allocation and costing assignments. Ideally, centres should establish a library of material which will simulate a range of different applications of management techniques.

DELIVERY

This unit is intended to give students an appreciation of the application of standard costing techniques, and an insight into the key functions underpinning financial planning and control. It also aims to expand students' knowledge and interest in managerial and supervisory techniques by introducing and applying the fundamental concepts of project planning and scheduling.

Learning and assessment can be across units, at unit level or at outcome level, but centres should be aware that study and assessment at outcome level can lead to an assessment overload.

It may be beneficial to complete this unit through case studies which reflect a particular engineering business or specific engineering function (eg design function, plant installation and commissioning).

In estimating costs and approximating project completion times and human resource needs, it may be necessary to provide information from a 'given data source'. However, students should be encouraged to research their own basic data requirements, ideally from local industrial attachments.

SUGGESTED READING

Maintland, Iain – *Budgeting for Non-Financial Managers* (Pitman, 1997)

Riggs J L – *Production Systems: Planning, Analysis and Control* (Wiley, 1997)

Tooly M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1998)

Wild R – *Essentials of Production and Operation Management* (Cassell, 1995)

Wilson David – *Managing Information* – 2nd Edition (Butterworth-Heinmann, 1997)

UNIT 2: ANALYTICAL METHODS FOR ENGINEERS

Unit value: 1
Unit level: H1
Unit code: 21717P

2.1 Description of unit

The primary aim of this unit is to provide the fundamental analytical knowledge and techniques needed to successfully complete the core units of Higher National Engineering programmes. It is also intended as a base for the further study of analytical methods and mathematics, needed for the more advanced option units. This unit has been designed to enable students to use fundamental algebra, trigonometry, calculus, statistics and probability, for the analysis, modelling and solution of realistic engineering problems at the Higher National level.

2.2 Summary of outcomes

To achieve this unit a student must:

1 Analyse and model engineering situations and solve problems using **algebraic methods**

2 Analyse and model engineering situations and solve problems using **trigonometric methods**

3 Analyse and model engineering situations and solve problems using **the calculus**

4 Analyse and model engineering situations and solve problems using **statistics and probability**.

2.3 Content

ALGEBRAIC METHODS

Algebraic methods: polynomial division, quotients and remainders, use of factor and remainder theorem, rules of order for partial fractions including – linear, repeated and quadratic factors, reduction of algebraic fractions to partial fractions

Exponential, trigonometric and hyperbolic functions: the nature of algebraic functions, relationship between exponential and logarithmic functions, reduction of exponential laws to linear form, solution of equations involving exponential and logarithmic expressions, relationship between trigonometric and hyperbolic identities, solution of equations involving hyperbolic functions

Arithmetic and geometric: notation for sequences, arithmetic and geometric progressions, the limit of a sequence, Sigma notation, the sum of a series, arithmetic and geometric series, Pascal's triangle and the binomial theorem
Power series: variables expressed as power series functions, standard series, Maclaurin's series, binomial series, approximate values, L'Hopital's rule

TRIGONOMETRIC METHODS

Sinusoidal functions: review of the basic trigonometric ratios, Cartesian and polar co-ordinate systems, properties of the circle, radian measure, sinusoidal functions, angular velocity, angular acceleration, centripetal force, relationship between angular velocity and frequency, amplitude and phase, production of complex waveforms by sinusoidal graphical synthesis, AC waveforms and phase shift

Trigonometric identities: relationship between trigonometric and hyperbolic identities, double angle and compound angle formulae and the conversion of products to sums and differences, solve trigonometric equations using identities, simplify complex trigonometric expressions using identities

THE CALCULUS

Introduction to the calculus: the concept of the limit and continuity, definition of the derivative, derivatives of standard functions, notion of the derivative and rates of change, differentiation of simple functions using the product, quotient and function of a function rules, introduction to the integral calculus as the calculation of area and the inverse of differentiation, the indefinite integral and the constant of integration, standard integrals and the application of algebraic and trigonometric functions, the definite integral and area under curves

Further differentiation: second order and higher derivatives, logarithmic differentiation, implicit functions, differentiation of inverse trigonometric functions, differential coefficients of inverse hyperbolic functions, partial derivatives and partial differentiation

Further integration: integration by parts, integration by substitution, integration using partial fractions, reduction formulae

Applications of the calculus: maxima and minima, points of inflexion, rates of change of temperature, distance and time, electrical capacitance, rms values, electrical circuit analysis, AC theory, electromagnetic fields, velocity and acceleration problems, complex stress and strain, engineering structures, simple harmonic motion, centroids, volumes of solids of revolution, second moments of area, moments of inertia, rules of Pappus, radius of gyration, thermodynamic work and heat energy

Engineering problems: stress and strain, torsion, motion, dynamic systems, oscillating systems, force systems, heat energy and thermodynamic systems, fluid flow, AC theory, electrical signals, information systems, transmission systems, electrical machines, electronics

STATISTICS AND PROBABILITY

Tabular and graphical form: data collection methods, histograms, bar charts, line diagrams, cumulative frequency diagrams, scatter plots

Central tendency and dispersion: introduction to the concept of central tendency and variance measurement, mean, median, mode, standard deviation, variance and interquartile range, application to engineering production

Regression, linear correlation: product moment formula for determining linear correlation coefficient, least squares regression lines, application to experimental work, batch production and quality control

Probability: interpretation of probability, probabilistic models, empirical variability, events and sets, mutually exclusive events, independent events, conditional probability, sample space and probability, addition law, product law, Baye's theorem

Probability distributions: discrete and continuous distributions, binomial, poisson and normal distributions, linear regression and confidence intervals, application to sampling, component and system reliability, batch production sampling and quality control

2.4 Outcomes and assessment criteria

Outcomes	**Assessment criteria** **To achieve each outcome a student must demonstrate the ability to:**
1 Analyse and model engineering situations and solve problems using **algebraic methods**	• determine the quotient and remainder for algebraic fractions and reduce algebraic fractions to partial fractions • derive expressions and equations for engineering situations that involve exponential, trigonometric and hyperbolic functions, and find the solution to such equations • solve scientific problems that involve arithmetic and geometric series • use power series methods to determine estimates of engineering variables, expressed in power series form.
2 Analyse and model engineering situations and solve problems using **trigonometric methods**	• use trigonometric functions to solve engineering problems that involve static forces, relative motion, frameworks, metrology, friction, electric motor torque, and electrical and mechanical energy problems • use sinusoidal functions and radian measures to solve engineering problems • use trigonometric and hyperbolic identities to solve trigonometric equations and to simplify complex trigonometric expressions.

Outcomes	Assessment criteria To achieve each outcome a student must demonstrate the ability to:
3 Analyse and model engineering situations and solve problems using **the calculus**	• differentiate algebraic and trigonometric functions using basic, product, quotient and function of function rules • determine higher order derivatives for algebraic, logarithmic, inverse trigonometric and inverse hyperbolic functions • perform implicit and partial differentiation • integrate functions using the basic rules, by parts, by substitution, reduction formulae and partial fractions • analyse engineering situations and solve engineering problems using the calculus.
4 Analyse and model engineering situations and solve problems using **statistics and probability**	• represent engineering data in tabular and graphical form • determine measures of central tendency and dispersion • use regression, linear correlation and confidence intervals to sample the quality of engineering operations • use probability theory, probability distributions and confidence intervals for estimating reliability and quality of engineering components and systems.

2.5 Guidance

GENERATING EVIDENCE

The results of tests and examinations are likely to form a significant part of the evidence of outcomes of this unit. However, it is also essential that evidence is gathered from assignments designed to apply the analytical methods to the modelling and solution of realistic engineering problems. The evidence gathered should, wherever possible, be deliberately biased to reflect the chosen engineering pathway.

LINKS

This unit is intended to underpin and link with those units which are analytical in nature. It provides the opportunity to demonstrate Common Skills particularly in Numeracy, Applying Technology and Managing Tasks and Solving Problems.

Entry requirements for this unit are at the discretion of the centre. However, it is strongly advised that students should have completed a BTEC National unit or GNVQ Engineering

units in Advanced 'Mathematics for Engineering' or their equivalent. Students who have not attained this standard will require appropriate bridging studies (see *Delivery*).

RESOURCES

The use of mathematical software packages should be strongly encouraged, wherever appropriate, to help students understand and model scientific and engineering problems.

DELIVERY

This unit may be delivered as a stand-alone unit, or integrated into other appropriate programme modules. If it is delivered in a completely integrated way, care must be taken to provide tracking of evidence for the outcomes. In delivering the unit it is vital to ensure that the analytical methods are applied to the modelling and solution of realistic engineering problems.

The aim of this unit is to provide the minimum analytical knowledge, skills and understanding needed to successfully complete a Higher National in Engineering. For some programmes this unit will prove insufficient, and it will be necessary to select further units of mathematics to underpin specific areas of engineering.

Prior to embarking on this unit all students, as a minimum standard, should be able to demonstrate proficiency in the following mathematical fundamentals:

- *algebra*: laws of algebra, evaluation and transposition of formulae, algebraic operations, factorisation, linear, simultaneous and quadratic equations, laws of indices and logarithms, common and Naperian logarithms, indicial equations, direct and inverse proportion, inequalities, functional notation and manipulation of algebraic functions
- *trigonometry*: basic trigonometric ratios and their inverses, trigonometric ratios for the four quadrants, solution of triangles, calculation of areas and volumes of solids
- *numeracy*: notation and precedence rules, vulgar fractions, lowest common multiple and highest common factor, ratios and constant of proportionality, significant figures and estimation techniques
- *calculus*: familiarity with the concept of the differential and integral calculus, differentiate simple polynomial and trigonometric functions using the basic rules, integrate simple polynomial and trigonometric functions using the standard rules.

Students not meeting the above standard need to be enrolled onto appropriate bridging studies.

SUGGESTED READING

Bird – *Higher Engineering Mathematics (*Butterworth-Heinemann, 1996)

Croft, Davis, Hargreaves – *Introduction to Engineering Mathematics* (Addison-Wesley, 1995)

James, Glyn – *Modern Engineering Mathematics* (Addison-Wesley, 1996)

Mustoe L R – *Engineering Mathematics* (Longman, 1997)

Tooly M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1998)

UNIT 3: ENGINEERING SCIENCE

Unit value: 1
Unit level: H1
Unit code: 21718P

3.1 Description of unit

The aim of this unit is to investigate a number of major scientific principles which underpin the design and operation of engineering systems. It is a broad-based unit, covering both mechanical and electrical principles. Its intention is to give an overview which will provide the basis for further study in specialist areas of engineering.

3.2 Summary of outcomes

To achieve this unit a student must:

1 Investigate **static and dynamic** engineering systems

2 Investigate **energy transfer** in thermal and fluid systems

3 Apply **single phase AC theory**

4 Investigate **information and energy control systems**.

3.3 Content

STATIC AND DYNAMIC

Bending: shear force, bending moment, stress due to bending and radius of curvature in simply supported beams subjected to concentrated and uniformly distributed loads

Torsion: shear stress, shear strain, shear modulus, theory of torsion and its assumptions, distribution of shear stress and angle of twist in solid and hollow circular section shafts

Uniform acceleration: linear and angular acceleration, Newton's laws of motion, mass moment of inertia and radius of gyration of rotating components, linear and angular kinetic energy, combined linear and angular motion, effects of friction

Mechanical oscillations: simple harmonic motion, linear and transverse systems, qualitative description of the effects of forcing and damping

ENERGY TRANSFER

Modes of heat transfer: conduction, convection, radiation

Heat transfer rates: thermal conductivity, natural and forced convection coefficients, Stephan's constant, black and grey body radiation, conduction through insulated surfaces

Viscosity: boundary layer formation, laminar and turbulent flow, viscous drag, pressure loss in pipes, effect of temperature on viscosity

Energy losses: dynamic viscosity, power loss in plain journal and thrust bearings, pipe friction coefficient, pressure loss in pipes using Darcy's formula

SINGLE PHASE AC THEORY

Non-resonant circuits: equivalent impedance and admittance for circuits containing R-L-C, when connected in series and parallel, current flow, potential difference, power factor, true, reactive and apparent power for these circuits, use of Argand diagrams to display the solutions to problems

Resonant circuits: definition of circuit resonance, circuit conditions at resonance for circuits containing a coil and capacitor connected either in series or parallel, resonant frequency, Q-factor and dynamic impedance for these circuits

Power factor correction: capacitance required to improve the overall power factor of an inductive load, benefits of this technique to the supply authorities

Complex waveforms: explanation of how complex waveforms are produced from sinusoidal waveforms, graphical synthesis of a complex waveform, recognition of waveforms containing odd-order harmonics only and even-order harmonics only (including the effects of phase shift), production of harmonics due to non-linear characteristics in electrical and electronic devices, advantages and disadvantages of selective resonance in a system

INFORMATION AND ENERGY CONTROL SYSTEMS

Information systems: block diagram representation of a typical information system, eg audio-communication, instrumentation, process monitoring, qualitative description of how electrical signals convey system information, in-depth analysis of a system (to include, where applicable, transducers as energy converters, types of transducer, transducer output and accuracy), types of amplifier, typical gain, resolution of analogue to digital and digital to analogue converters, types of oscillators and operating frequencies, effect of noise on a system, determination of system output for a given input

Energy flow control systems: block diagram representation of an energy flow control system (eg AC electric drives, DC electric drives, heating, lighting, air conditioning), in-depth analysis of a control system (to include, where applicable, the transistor as a switch, thyristor, temperature-sensing devices, humidity sensing devices, speed control elements for DC and AC machines, dimmer devices and relays), determination of system output for a given input

3.4 Outcomes and assessment criteria

Outcomes	Assessment criteria To achieve each outcome a student must demonstrate the ability to:
1 Investigate **static and dynamic** engineering systems	• determine distribution of shear force, bending moment and stress due to bending in simply supported beams • determine the distribution of shear stress and the angular deflection due to torsion in circular shafts • determine the behaviour of dynamic mechanical systems in which uniform acceleration is present • determine the behaviour of oscillating mechanical systems in which simple harmonic motion is present.
2 Investigate **energy transfer** in thermal and fluid systems	• describe the modes of heat transfer • determine heat energy transfer rates in thermal systems • describe the effects of viscosity in fluid flow systems • calculate energy losses due to viscosity in fluid flow motions.
3 Apply **single phase AC theory**	• solve problems on non-resonant and resonant circuits supplied by a constant sinusoidal voltage • describe the methods used for power factor correction and its benefits • describe the nature of complex waveforms and synthesise a complex waveform graphically • describe how electrical and electronic devices produce complex waveforms • describe the effects of complex waveforms on electrical and electronic systems.
4 Investigate **information and energy control systems**	• describe the methods by which electrical signals convey information • analyse an information system • describe the methods by which electrical signals control energy flow • analyse an energy flow control system.

3.5 Guidance

GENERATING EVIDENCE

Evidence of outcomes may be in the form of assignments, laboratory notes, solutions to applied problems or completed tests/examinations. Learning and assessment can be across units, at unit level or at outcome level. Evidence is likely to be at outcome level in order to provide maximum flexibility of delivery.

Evidence may be accumulated by students building a portfolio of activities or by a tutor-led combination of tests and assignments. In either case, the evidence must be both relevant and sufficient to justify the grade awarded.

LINKS

This unit is intended to be linked with the mathematics and other principles and applications units in the programme. It also offers opportunities for demonstrating Common Skills, particularly in Numeracy, Managing Tasks and Solving Problems and Applying Technology.

Entry requirements for this unit are at the discretion of the centre. However, it is advised that students should have completed the BTEC National unit or GNVQ Engineering Advanced unit 'Science for Engineering' or an equivalent. Knowledge of the Advanced GNVQ units 'Electrical Principles' and 'Mechanical Science' or equivalent BTEC National units would also be an advantage.

Appropriate software packages should be used wherever possible to verify solutions to problems and system behaviour. Examples might include circuit emulation and stress analysis packages.

DELIVERY

This unit may be delivered as a stand-alone package or integrated into other programme modules. If it is delivered in an integrated way, care must be taken in the tracking of evidence for the outcomes, and centres should be aware that study and assessment at outcome level could lead to an assessment overload. Wherever possible, a practical approach should be adopted. Effort should be made to identify the relevance of the principles covered to engineering applications and system design. The unit may require an industrial input, such as a visit or evidence from an external speaker.

SUGGESTED READING

Bedford A, Fowler W – *Statics* (Addison-Wesley, 1997)

Bolton W – *Mechanical Science* (Blackwell Scientific, 1993)

Denton T – *Electrical and Electronic Systems* (Edward Arnold)

Hannah J, Hillier M – *Mechanical Science* (Longman, 1991)

Hughes E – *Electrical Technology* (Longman, 1995)

Tooly M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1998)

UNIT 4: ENGINEERING DESIGN

Unit value: 1
Unit level: H1
Unit code: 21719P

4.1 Description of unit

The aim of this unit is to give students an opportunity to experience the process of carrying out a design project. It will enable them to appreciate that design involves synthesising parameters which will affect the design solution.

4.2 Summary of outcomes

To achieve this unit a student must:

1 Prepare a **design specification**

2 Prepare a **design report**

3 Use **computer technology** in the design process.

4.3 Content

DESIGN SPECIFICATION

Customer requirements: all relevant details of customer requirements (aesthetics, functions, performance, cost, production parameters) are identified and listed

Design parameters: implications of specification parameters and resource requirements are identified and matched, the level of risk associated with each significant parameter is established

Design information: all relevant information is extracted from appropriate reference sources, techniques and technologies used in similar products or processes are identified, when new technologies can be used, these are specified, relevant standards and legislation are identified and applied throughout

DESIGN REPORT

Analysis of possible design solutions: matrix analysis, brainstorming, mind mapping, forced decision making

Evaluation: costs, future development potential, value engineering concepts
Compliance check: using check-lists, design review procedures

Report: rationale for adopting proposed solution, appropriate techniques and media in presentation of report

COMPUTER TECHNOLOGY

Key features of a computer-aided design system: 3D modelling, standards, parts and material storage and retrieval, engineering calculations, PCB layouts, integrated circuit design, circuit and logic simulation (including AC, DC and transient analysis, schematic capture)

Software: parts assembly, pipework and ducting layouts, networks, planned maintenance, scheduling, planning, stress and strain, heat transfer, vibration analysis, resourcing, utilisation, plant layout, costing, circuit emulation, plant electrical services, for example, finite element analysis and printed circuit board analysis software (centres should select suitable examples from the applications listed)

Demonstration: the specification of the design problem, identification of the constraints, derivation of the functional requirements

4.4 Outcomes and assessment criteria

Outcomes	**Assessment criteria** **To achieve each outcome a student must demonstrate the ability to:**
1 Prepare a **design specification**	• establish customer requirements • determine the major design parameters • obtain design information from appropriate sources • prepare a design specification • ensure that the design specification meets requirements.
2 Prepare a **design report**	• prepare an analysis of possible design solutions • produce conceptual designs • evaluate alternative concepts • select the optimum design solution • carry out a compliance check • prepare a final report.
3 Use **computer technology** in the design process	• identify the key features of a computer-aided design system • use computer-aided design software to prepare a design drawing or scheme • evaluate software that can assist the design process • demonstrate an understanding of the principles of computer-aided design.

4.5 Guidance

GENERATING EVIDENCE

Students should prepare a design portfolio containing information required to meet the outcomes. Preferably this should be one design assignment, but it could be a series of discrete assignments.

LINKS

This unit would be suitable for delivery as part of an integrated assignment including other subject areas, such as 'Engineering Science' (Unit 3) and 'Project' (Unit 5).
Entry requirements for this unit are at the discretion of the centre. However, it is advised that students should have completed an appropriate BTEC National unit, the Advanced GNVQ unit 'Design Development' or an equivalent qualification.

RESOURCES

Suitable software packages should be used whenever possible. These could include packages for computer-aided design, assembly procedures, critical path, plant layout, planned maintenance, utilisation, material selection, standard component and matrix analysis.

DELIVERY

This unit has been written in terms of general outcomes which examine products and services. It should be delivered in the context of the discipline that the student is studying.

It can be delivered as a stand-alone unit, but it is more appropriate to incorporate it into an integrated programme of study.

If it is delivered as part of a programme of study, it must be possible to track evidence to show that students have met the outcomes of the unit.

SUGGESTED READING

Corbett J, Dooner M, Meleka J, Pym C – *Design for Manufacture* (Addison-Wesley, 1991)

Ion B – *Pugh's Total Design* (Addison-Wesley, 1998)

Hawkes B, Abinett R – The Engineering Design Process (Longman, 1988)

Syan, Menon – *Concurrent Engineering* (Chapman & Hall, 1994)

Tooly M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1998)

UNIT 5: PROJECT

Unit value: 1
Unit level: H2
Unit code: 21720P

5.1 Description of unit

This unit develops students' ability to use the knowledge and skills they develop at work and/or on an engineering programme to complete a realistic work project. It also contributes, if appropriate, to the requirements of Engineering Applications theme 2.

The unit aims to integrate the skills and knowledge developed in other units of the course within a major piece of work that reflects the type of performance expected of a higher technician at work.

It is designed to bring small groups of students together into a multi-disciplinary team, so that they can co-ordinate their individual skills and abilities. This allows them to develop the ability to work individually and with others, within a defined timescale and given constraints, to produce an acceptable and viable solution to an agreed brief.

5.2 Summary of outcomes

To achieve this unit a student must:

1 **Select a project** and agree specifications and procedures

2 **Implement the project** within agreed procedures and to specification

3 **Evaluate** the project

4 **Present a project evaluation**.

5.3 Content

SELECT A PROJECT

Project specifications: identify and record a prioritised list of technical and non-technical requirements relevant to the chosen project type –plant layout, installation, maintenance, product design, product manufacture; appropriate elements may include costs, timescales, scale of operation, standards, legislation, quality, fitness for purpose, ergonomics, processing capability, business data

Process of project selection: formulate a plan of action, appraise the feasibility of the project and carry out a critical analysis of the outline specification, for group projects agree roles and allocate responsibilities, initiate a project log book

IMPLEMENT THE PROJECT

Select option: simple comparison and decision-making methods and techniques for generating solutions for the selection from alternatives should include the use of elements such as graphical displays, statistical data, quality and resource requirements, process capability, fitness for purpose, costs, brainstorming, mind mapping

Record: maintain log book entries

EVALUATE THE PROJECT

Procedures: formulate a plan of action, appraise the feasibility of the project and carry out a critical analysis of the outline specification

Evaluation techniques: graphs, statistics, Gantt charts, sequencing, scheduling, critical path methods, networking, simple application of Project Evaluation and Review Techniques (PERT), use computer software packages where appropriate, maintain log book entries

PRESENT A PROJECT EVALUATION

Present: written report, log book record of all events, an oral presentation, use of sketches, charts, graphs, drawings and associated technical reports, use of CAD, DTP, spreadsheets, WP should form a necessary part of the presentation process wherever possible, presentation to known audiences (peer groups, tutors) and unknown audience (actual or simulated customer or client)

5.4 Outcomes and assessment criteria

Outcomes	Assessment criteria To achieve each outcome a student must demonstrate the ability to:
1 **Select a project** and agree specifications and procedures	• identify and agree a project for a given engineering application • establish and record the project specifications • identify the factors which contribute to the process of project selection.
2 **Implement the project** within agreed procedures and to specification	• identify and review alternative options • select and implement the chosen option to meet the agreed specification • record and collate relevant data.
3 **Evaluate** the project	• schedule the procedures to be adopted in order to meet the required specifications • describe and use appropriate project evaluation techniques • interpret and justify the results in terms of the original specifications.
4 **Present a project evaluation**	• produce a written report and log book record of all procedures and results • present the details of the project in a suitable format, using appropriate media.

5.5 Guidance

GENERATING EVIDENCE

Evidence of outcomes may be in the form of a written or computer-based report supported by a fully documented log book and, where appropriate, an oral presentation.

LINKS

This unit may be linked with the core unit ‘Engineering Design’ (Unit 4).

Entry requirements for this unit are at the discretion of the centre. The unit is intended to integrate skills and knowledge which are developed in many of the other units making up the total programme. Common Skills will feature strongly throughout the development,

implementation and presentation stages of the project, and students should be made aware of the significance of knowledge and experience gained from earlier work.

RESOURCES

Students should have access to a wide variety of physical resources, depending on the specific project. Many of these are listed with the individual units (and Common Skills) associated and integrated with this one. Other data sources and reprographic facilities should also be readily accessible. Centres should try to work closely with industrial organisations in order to bring realism and relevance to the project.

DELIVERY

Students may work individually or in groups of three or four, allocating responsibilities within the group and meeting at intervals to evaluate progress. Once the initial brief for the project has been clarified, the tutor's role is of a counselling rather than a directing nature. Groups might tackle different projects or several groups might elect to do similar projects. Part of the unit should be devoted to the presentation of findings, both at intermediate and final stages, so that all groups gain an insight into the thinking of others. After the final presentations, it could be useful to have a feedback/debriefing plenary so that the students can benefit from comments on good and bad practice. Involving a few employers in the presentation or plenary sessions, or both, is recommended.

SUGGESTED READING

Due to the nature of the unit, students should refer to the reading lists of other units in the programme which relate to the specific aspect they are investigating. However, the following references may be of general use.

Lock D – *Project Management* (Gower Publishing, 1996)

Smith N J – *Engineering Project Management* (Blackwell Scientific, 1995)

UNIT 6: AIRCRAFT SYSTEM PRINCIPLES

Unit value: 1
Unit level: H1
Unit code: 21723P

6.1 Description of unit

The primary aim of the unit is to apply the necessary mechanical, electrical and electronic principles to the examination of aircraft mechanical, fluid and avionic systems. In particular, these principles are applied to the construction, operation, component interfacing and performance monitoring of aircraft power supply and control systems.

6.2 Summary of outcomes

To achieve this unit a student must:

1 Determine the underlying principles and explain the components used for the **control and performance monitoring** of aircraft systems

2 Explain the operation and performance of **aircraft power supply systems**

3 Apply control system fundamentals to the analysis of **aircraft control systems**.

6.3 Content

CONTROL AND PERFORMANCE MONITORING

Basic system concepts: system definition, system state and operating environment, basic electro-mechanical system components – sensor/transducer, comparator (error detector), signal conditioner and actuation device, G notation, feedback signals, H notation, simple system transfer functions

Transducers: characteristics, operation and application, optical (photoconductive cell, photovoltic, photodiode, phototransistor), magnetic (induction, reluctance, hall-effect), heat (thermocouple, thermistor, radiation pyrometer), electro-mechanical (limit switches), potentiometers, strain gauges, differential transformers, tacho-generators, pressure sensors, gauges (flow meters), incremental and absolute encoders

Signals, signal conditioners and comparators: physical signals, digital and analogue signals, digital/analogue/digital converters, signal frequency and amplitude, error signal modification and amplification, closed loop control signal paths, introduction to feed-forward signals, mechanical amplifiers and signal conditioners, electrical amplifiers and comparators, active filters

AIRCRAFT POWER SUPPLY SYSTEMS

Power generation: comparison of aircraft pneumatic, hydraulic and electrical power generation (advantages/disadvantages), basic circuit operation, power distribution, alternative

power supplies, standby and emergency provision, circuit/system components, duplication and failsafe philosophy

Power actuation methods: comparison of fluid and electrical power actuation methods and systems, fluid motors and actuators (single, double acting, rotary, linear, reciprocating piston, spur gear), electric motors and actuators (AC/DC, induction, synchronous, stepper motor, multi-phase cage motor, linear and rotary actuators), their principle of operation, construction, control and protection

AIRCRAFT CONTROL SYSTEMS

Servomechanism control systems: control system definitions, open and closed loop control systems, servo-mechanism motion control, rate and position sensing and control synchros, remote positioning control (RPC) systems,

Response of control systems: step and ramp inputs, transient and steady state response, stability of response, overshoot and hunting

System damping: damping terms and definitions, coulomb and viscous friction damping, electrical damping, velocity feedback damping, damping methods used in aircraft systems

System control methods: proportional and derivative control, proportional and integrative control, analogue/digital hybrid control, system response to control methods

Aerospace control systems applications: guide vane control of missile, radar aerial movement, positioning of aircraft control surfaces, autopilot platform displacement, gyro compass platform positioning, inertial navigator platform stabilisation, nosewheel steering system, engine speed control, engine pressure ratio signalling and control, engine speed and temperature control, generator frequency and voltage control, hydraulic servo rate and positioning control, electric motor positioning and control, cabin temperature control, engine fuel control

6.4 Outcomes and assessment criteria

Outcomes	Assessment criteria To achieve each outcome a student must demonstrate the ability to:
1 Determine the underlying principles and examine the components used in **aircraft systems**	• represent typical aircraft systems in block diagram form • determine the purpose, operation and advantages/ disadvantages of transducers used in aircraft systems • perform simple block-diagram reduction exercises and so determine open/closed loop transfer functions, using G and H notation • identify and explain the operation of DAC/ADC and amplifier circuits used in aircraft systems.
2 Explain the operation and performance of **aircraft power supply systems**	• differentiate between mechanical, fluid and electrical methods of power generation for given aircraft usage • determine the methods used to ensure the continuing integrity and safety of aircraft power distribution, in the event of primary system failure • determine the operating principles, constructional detail, control and protection of aircraft power system components and their associated circuitry • investigate the performance parameters and aircraft applications of high horse power and fractional horse power fluid/electrically driven motors/actuators.
3 Apply control system fundamentals to the analysis of **aircraft control systems**	• explain the nature and operation of aircraft remote position control systems • determine the response of control systems to step, ramp and sinusoidal inputs • analyse the damping methods used to overcome control system overshoot and hunting • explain the derivative/integrative and proportional/ integrative control methods and apply them to the response of typical aircraft systems • select and analyse appropriate components and control methods for a given set of typical aircraft control system parameters • analyse selected aircraft servomechanism control systems.

6.5 Guidance

GENERATING EVIDENCE

Evidence of outcomes may be in the form of assignments, case studies, reports of practical activities and tests/examinations. Learning and assessment may be across units but is more likely to be at the unit and outcome level.

LINKS

This is a core unit and as such provides a link with several of the Higher National programme units. These include 'Engineering Science' (Unit 3), 'Aircraft Fluid Systems' (Unit 12), 'Automatic Flight Control Systems' (Unit 9) and other avionic units.

Entry requirements for this unit are at the discretion of the centre. However, the unit assumes that students have some prior knowledge of the electrical and mechanical fundamentals as exemplified by appropriate units at the National or Advanced GNVQ level. Ideally, students should have successfully completed GNVQ Engineering units in 'Science for Engineering' and 'Mathematics for Engineering', both at the Advanced level, or similar BTEC National/equivalent units. Students who do not meet these criteria may benefit from appropriate bridging studies.

RESOURCES

A range of electro-mechanical laboratory equipment should be made available for the practical investigations which underpin the theory. This is likely to include the equipment necessary to analyse servo-systems, transducers, electrical, fluid and mechanical machines/mechanisms, and equipment which allows for emphasis on the aerospace applications detailed in the unit.

DELIVERY

This unit has been designed to act as an introduction to aircraft systems engineering and, as such, should be taught prior to or in tandem with all programme units which require a systems input.

Emphasis should be placed on appropriate laboratory/practical work which enhances the theory. Every effort should be made to link the system principles with current operational aircraft systems. Fundamental safety principles should be stressed whenever appropriate, but particularly when relating the theory to aircraft applications.

SUGGESTED READING

Buchla D and McLachlan W – *Applied Electronic Instrumentation and Control* (Macmillan, 1992)

Chesmond C J – *Basic Control System Technology* (Arnold, 1992)

Hargreaves M – *Engineering Systems Modelling and Control* (Longman, 1996)

Middleton D H – *Avionic Systems* (Longman, 1989)

Moir I and Seabridge A – *Aircraft Systems* (Longman, 1992)

Pallett E H J and Coyle S – *Automatic Flight Control, Chapter 2* (Blackwell Science, 1995)

Pallett E H J – *Aircraft Electrical Systems* – Third Edition (Longman, 1988)

Ramsay D C – *Principles of Engineering Instrumentation* (Arnold, 1996)

Rohner – *Industrial Hydraulic Control* – Second Edition (1995)

Rolls Royce – *The Jet Engine* – Fifth Edition (1996)

Wild T W – *Transport Category Aircraft Systems* (Star Publications, 1990)