



TUDEV INSTITUTE OF MARITIME STUDIES

MARINE ENGINEERING PROGRAMME UNITS

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BTEC Higher Nationals in Marine Engineering

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Edexcel level 4 BTEC Higher Nationals in Marine

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Unit 1: Business Management Techniques

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

Description of unit

This unit develops the learner's knowledge and understanding of the functions, structures and inter-relationships of an engineering business. It then enables the learner to develop and apply the skills of costing, financial planning and control associated with engineered products or services. Finally, this is brought together with the development of the fundamental concepts of project planning and scheduling that can be applied within an engineering organisation.

Summary of learning outcomes

To achieve this unit a learner must:

- 1 **Manage work activities** to achieve organisational objectives
- 2 Select and apply **costing systems and techniques**
- 3 Analyse the key functions of **financial planning and control**
- 4 Apply **project planning and scheduling** methods to a specified project.

Content

1 Manage work activities

Engineering business functions: organisational, management and operational structures in general engineering settings (eg business planning, product/service development, design and production/delivery, quality assurance and control in relevant manufacturing, production, service or telecommunication industries, etc.)

Processes and functions: business planning (eg management, production/service planning, costing, financial planning) and organisation (eg mission, aims, objectives and culture, etc.)

Manage work activities: product and service specifications and standards; quality, time and cost objectives (eg just-in-time methods, value-added chains, statistical process control, etc.); working within organisational constraints and limitations

2 Costing systems and techniques

Costing systems: systems (eg job costing, process costing, contract costing, etc) and techniques (eg absorption, marginal, activity-based, etc.)

Business performance: measures and evaluation (eg break-even point, safety margin, profitability forecast, contribution analysis, 'what if' analysis, limiting factors, scarce resources, etc.)

3 Financial planning and control

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

Factors influencing decisions: cash and working capital management (eg credit control, pricing, cost reduction, expansion and contraction, company valuation, capital investment); budgetary planning (eg fixed, flexible and zero-based systems, cost, allocation, revenue, capital, control, incremental budgeting)

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

4 Project planning and scheduling

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

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Manage work activities to achieve organisational objectives	<ul style="list-style-type: none"> λ identify and explain engineering business functions λ explain the inter-relationships between the different processes and functions of an engineering organisation λ manage work activities to meet specification and standards.
2 Select and apply costing systems and techniques	<ul style="list-style-type: none"> λ identify and describe appropriate costing systems and techniques for specific engineering business functions λ measure and evaluate the impact of changing activity levels on engineering business performance.
3 Analyse the key functions of financial planning and control	<ul style="list-style-type: none"> • explain the financial planning process in an engineering business • examine the factors influencing the decision-making process during financial planning • apply standard costing techniques and analyse deviation from planned outcomes.
4 Apply project planning and scheduling methods to a specified project	<ul style="list-style-type: none"> • establish the project resources and requirements • produce a plan with appropriate time-scales for completing the project • identify human resource needs and costs associated with each stage of the project.

Guidance

Delivery

This unit is intended to give learners an appreciation of business organisations and the application of standard costing techniques, as well as an insight into the key functions underpinning financial planning and control. It also aims to expand learners' knowledge of

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 could lead to assessment overload.

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

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, learners should be encouraged to research their own data requirements, ideally from local industrial attachments, work-placement or employer.

Assessment

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 assignment. However, if group work is used, care must be taken to ensure that the evidence produced by each of the individuals in the group fully meets the requirements of the assessment criteria. Wherever possible evidence should be provided at unit level, reflecting the links between the different outcomes.

Links

This unit can be linked with *Quality Assurance and Management*. Entry requirements for this unit are at the discretion of the centre. However, it is advised that learners should have completed appropriate BTEC National units or equivalent.

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 that is capable of simulating a range of different applications of organisational structures and management techniques.

Support materials

Textbooks

Maitland I – *Budgeting for Non-Financial Managers* (Prentice Hall, 1997) ISBN 0273644947

Tooley M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1999) ISBN 0750646292

Wilson D – *Managing Information – 2nd Edition* (Butterworth-Heinemann, 1997) ISBN 0750633891

Unit 2: Engineering Science

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

Description of unit

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

Summary of learning outcomes

To achieve this unit a learner must:

1. Analyse **static engineering systems**
2. Analyse **dynamic engineering systems**
3. Apply **DC and AC theory**
4. Investigate **information and energy control systems**.

Content

1 Static engineering systems

Simply supported beams: determination of shear force; bending moment and stress due to bending; radius of curvature in simply supported beams subjected to concentrated and uniformly distributed loads; eccentric loading of columns; stress distribution; middle third rule

Beams and columns: elastic section modulus for beams; standard section tables for rolled steel beams; selection of standard sections (eg slenderness ratio for compression members, standard section and allowable stress tables for rolled steel columns, selection of standard sections)

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

2 Dynamic engineering systems

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

Energy transfer: gravitational potential energy; linear and angular kinetic energy; strain energy; principle of conservation of energy; work-energy transfer in systems with combine linear and angular motion; effects of impact loading

Oscillating mechanical systems: simple harmonic motion; linear and transverse systems; qualitative description of the effects of forcing and damping

3 DC and AC theory

DC electrical principles: Ohm's and Kirchoff's laws; voltage and current dividers; analogue and digital signals; review of motor and generator principles; fundamental relationships (eg resistance, inductance, capacitance; series C-R circuit, time constant, charge and discharge curves of capacitors, L-R circuits)

AC circuits: features of AC sinusoidal wave form for voltages and currents; explanation of how other more complex wave forms are produced from sinusoidal wave forms; R, L, C circuits (eg reactance of R, L and C components, equivalent impedance and admittance for R-L and R-C circuits); high or low pass filters; power factor; true and apparent power; resonance for circuits containing a coil and capacitor connected either in series or parallel; resonant frequency; Q-factor of resonant circuit

Transformers: high and low frequency; transformation ratio; current transformation; unloaded transformer; input impedance; maximum power transfer; transformer losses

4 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; function, operation and interfacing of information system components (eg transducers, transducer output and accuracy, amplifier types, 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); qualitative description of how electrical signals control energy flow; function, operation and interfacing of energy flow control system components (eg transistor, 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; selection and interfacing of appropriate energy flow control system components to perform a specified operation

Interface system components: identification of appropriate information sources; select and interface information system components or select and interface energy flow control system components, to enable that system to perform desired operation

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Analyse static engineering systems	<ul style="list-style-type: none"> λ determine distribution of shear force, bending moment and stress due to bending in simply supported beams λ select standard rolled steel sections for beams and columns to satisfy given specifications λ determine the distribution of shear stress and the angular deflection due to torsion in circular shafts.
2 Analyse dynamic engineering systems	<ul style="list-style-type: none"> λ determine the behaviour of dynamic mechanical systems in which uniform acceleration is present λ determine the effects of energy transfer in mechanical systems λ determine the behaviour of oscillating mechanical systems.
3 Apply DC and AC theory	<ul style="list-style-type: none"> λ solve problems using DC electrical principles λ recognise a variety of complex wave forms and explain how they are produced from sinusoidal wave forms λ apply AC theory to the solution of problems on single phase R, L, C circuits and components λ apply AC theory to the solution of problems on transformers.
4 Investigate information and energy control systems	<ul style="list-style-type: none"> λ describe the method by which electrical signals convey information

	<ul style="list-style-type: none"> λ describe the methods by which electrical signals control energy flow λ select and interface system components to enable chosen system to perform desired operation.
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Guidance

Delivery

This unit may be delivered as a stand-alone package or integrated with other programme modules. If it is delivered in an integrated way, care must be taken in the tracking of evidence for the outcomes. Wherever possible, a practical approach should be adopted.

Since the unit outcomes have been designed to serve as a foundation for the mechanical or electrical principles that follow, this unit should be taught in the first year or first semester of a two-year programme. To support this unit the core BTEC Higher National unit *Analytical Methods for Engineers* may usefully be taught in tandem, drawing upon the mathematical principles in a staged manner, as required.

The AC principles content of outcome 3 does not require the use of complex numbers, merely the application of vector theory and trigonometry.

Assessment

Evidence of outcomes may be in the form of assignments, laboratory notes and/or 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 to provide maximum flexibility of delivery.

Evidence may be accumulated by learners building a portfolio of activities or by 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 can be linked with the mathematics and other principles and applications units in the programme.

Entry requirements for this unit are at the discretion of the centre. However, it is advised that learners should have completed the BTEC National unit *Science for Technicians* or equivalent. Knowledge of the BTEC National units *Electrical and Electronic Principles* and/or *Mechanical Principles* or equivalent would also be an advantage.

Resources

Access to appropriate mechanical and electrical laboratory equipment for the assignment and laboratory work is considered key to enhance learner learning. Suitable software packages should be used when possible to verify solutions to problems and system behaviour.

Support materials

Textbooks

Bedford A and Fowler W – *Statics* (Addison-Wesley, 1997) ISBN 0201403404

Bolton W – *Mechanical Science* (Blackwell Science, 1998) ISBN 0632049146

Hannah J and Hillier M – *Mechanical Engineering Science* (Longman, 1995) ISBN 0582326753

Hughes E – *Electrical Technology* (Prentice Hall, 2001) ISBN 058240519X

Tooley M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1999) ISBN 0750646292

Tooley M – *Electronic Circuits Fundamentals and Applications* (Newnes, 2001) ISBN 0750653949

Unit 3: Analytical Methods for Engineers

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

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 BTEC 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 learners to use fundamental algebra, trigonometry, calculus, statistics and probability, for the analysis, modelling and solution of realistic engineering problems at BTEC Higher National level.

Summary of learning outcomes

To achieve this unit a learner 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**.

Content

1 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: expressing variables as power series functions and use series to find approximate values (eg exponential series, Maclaurin's series, binomial series)

2 Trigonometric methods

Sinusoidal functions: review of the trigonometric ratios; Cartesian and polar co-ordinate systems; properties of the circle; radian measure; sinusoidal functions

Applications such as: angular velocity; angular acceleration; centripetal force; frequency; amplitude; phase; the production of complex waveforms using 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; use of trigonometric identities to solve trigonometric equations and simplify trigonometric expressions

3 The calculus

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 functions using the product, quotient and function of a function rules; 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 for their solution; the definite integral and area under curves

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

Further integration: integration by parts; integration by substitution; integration using partial fractions

Applications of the calculus: eg 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: eg 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

4 Statistics and probability

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

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

Regression, linear correlation: determine linear correlation coefficients and regression lines and apply linear regression and product moment correlation to a variety of engineering situations

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; Bayes' theorem

Probability distributions: discrete and continuous distributions, introduction to the binomial, Poisson and normal distributions; use of the Normal distribution to estimate confidence intervals and use of these confidence intervals to estimate the reliability and quality of appropriate engineering components and systems.

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Analyse and model engineering situations and solve problems using algebraic methods	<ul style="list-style-type: none"> • determine the quotient and remainder for algebraic fractions and reduce algebraic fractions to partial fractions • solve engineering problems that involve the use and solution of exponential, trigonometric and hyperbolic functions and 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	<ul style="list-style-type: none"> • use trigonometric functions to solve engineering problems • use sinusoidal functions and radian measure to solve engineering problems • use trigonometric and hyperbolic identities to solve trigonometric equations and to simplify trigonometric expressions.
3 Analyse and model engineering situations and solve problems using the calculus	<ul style="list-style-type: none"> • differentiate algebraic and trigonometric functions using the product, quotient and function of function rules • determine higher order derivatives for algebraic, logarithmic, inverse trigonometric and inverse hyperbolic functions • integrate functions using the rules, by parts, by substitution 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	<ul style="list-style-type: none"> • represent engineering data in tabular and graphical form • determine measures of central tendency and dispersion • apply linear regression and product moment correlation to a variety of engineering situations • use the normal distribution and confidence intervals for estimating reliability and quality of engineering components and systems.

Guidance

Delivery

This unit may be delivered as a stand-alone unit, or integrated into other appropriate programme modules. If it is delivered with other units, 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 BTEC 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.

This unit has been designed to afford the lecturer choice in the delivery of the content. In that, providing the assessment criteria is met for each outcome, the content may be taught to reflect the chosen specialist pathway of the learner. For example when delivering and assessing outcome 2, the trigonometry taught to cohorts of electrical, electronic or avionic learners, would focus on the engineering applications of sinusoidal functions. Whereas the teaching and assessment for mechanical engineering learners would focus primarily on the applications concerned with angular motion and forces. This approach can be as equally well applied to the other outcomes in the unit, particularly with respect to the many applications given in outcome 3, on the calculus. In this outcome, the choice of applications for delivery and assessment are again easily separated into those required primarily by learners opting for the electrical/electronic or mechanical engineering pathways. The application of statistical techniques and probability may also be taught and assessed in a similar manner.

Prior to embarking on this unit all learners, 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: 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 polynomial and trigonometric functions using the basic rules; integrate polynomial and trigonometric functions using the standard rules.

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

Assessment

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 be 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.

Entry requirements for this unit are at the discretion of the centre. However, it is strongly advised that learners should have completed a BTEC National unit in *Mathematics for Technicians* or equivalent. Learners who have not attained this standard will require appropriate bridging studies.

Resources

The use of mathematical software packages should be strongly encouraged to help learners understand and model scientific and engineering problems. Availability of mathematics and spreadsheet packages such as Autograph, MathCad and Excel would enable realistic assignments to be set and achieved by learners.

Support materials

Textbooks

Bird, J O– *Higher Engineering Mathematics* (Butterworth-Heinemann, 1999) ISBN 075064110X

Croft, Davis and Hargreaves – *Introduction to Engineering Mathematics* (Prentice Hall, 1995) ISBN 020162447

James, G – *Modern Engineering Mathematics* (Prentice Hall, 2000) ISBN 0130183199

Mustoe, L R – *Engineering Mathematics* (Longman, 1997) ISBN 0201178036

Stroud, K A – *Engineering Mathematics* (Macmillan Press, 2001) ISBN 0333916394

Tooley M, Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1999) ISBN 0750646292

Unit 4: Project

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H2

Description of unit

This unit develops learners' 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.

Summary of learning outcomes

To achieve this unit a learner 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 project outcome.**

Content

1 Select a project

Process of project selection: formulate project plans, appraise the feasibility of the projects (eg comparison and decision-making methods and techniques for generating solutions from the selection of alternatives, brainstorming, mind mapping, etc.) and carry out an initial critical analysis of the outline specification; select chosen project option and agree roles and allocate responsibilities (individually with tutor/supervisor and within project group if appropriate); initiate a project log-book/diary; estimate costs and resource implications; identify goals and limitations

Project specifications: identify and record the technical and non-technical requirements relevant to the appropriate level of study and chosen project type (eg plant layout/ installation/ maintenance, product design, product manufacture or similar engineering-related topics); appropriate requirements may include costs, time scales, scale of operation, standards, legislation, quality, fitness-for-purpose, ergonomics, processing capability, business data, physical and human resource implications

Procedures: planning and monitoring methods; methods of working; lines of communication; structure of groups and collaborative working (eg learner groups or roles and responsibilities within a work-based project); targets and aims

2 Implement the project

Implement: proper use of resources (eg equipment, tools, materials, etc.); work within agreed time scale; use of appropriate techniques for generating solutions; maintaining and adapting project plan where appropriate; maintaining all records of development/progress

Record: maintain log-book/diary entries; prepare and collate developmental work (eg notes, sketches, drawings, meeting notes, research results, etc)

3 Evaluate

Evaluation techniques: appraisal of the feasibility/effectiveness of the project solution and a critical analysis against the project specification and planned procedures; use of graphs; statistics; Gantt charts; sequencing, scheduling; critical path methods; networking; application of Project Evaluation and Review Techniques (PERT); using computer software packages where appropriate

4 Present project outcome

Record of procedures and results: log-book/diary record of all events; record of developmental work (eg sketches, charts, graphs, drawings and associated notes); working records of planning and monitoring procedures; relevant data and results

Present: formal project report (eg written and/or oral presentation); use of appropriate media and methods (eg WP, CAD, DTP, PowerPoint, spreadsheets/databases, etc.); presentation to known audiences (peer groups, tutors) and unknown audience (actual or simulated, customer or client)

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Select a project and agree specifications and procedures	<ul style="list-style-type: none"> • establish and record possible project specifications • identify the factors that contribute to the process of project selection • identify and agree a project for an engineering application • prepare project specification and procedures.
2 Implement the project within agreed procedures and to specification	<ul style="list-style-type: none"> • implement the chosen option to meet the agreed specification • record and collate relevant data.
3 Evaluate the project	<ul style="list-style-type: none"> • describe and use appropriate project evaluation techniques • interpret and justify the results in terms of the original project specification.
4 Present project outcome	<ul style="list-style-type: none"> • produce a record of all procedures and results • present the details of the project in a suitable format, using appropriate media.

Guidance

Delivery

The unit is designed to bring small groups of learners 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. Learners may work individually or in small groups of three or four.

If the project is to be carried out as part of a team, it will be necessary to make sure that each member of the team has clear responsibilities and to ensure that everyone makes a contribution to the end result. It is important to be clear about who is responsible and accountable for each aspect of the work.

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 feedback and/or debriefing to enable learners to benefit from comments on good and bad practice. Involving employers in all the stages of the project and at least in the presentation or plenary sessions, or both, is recommended.

Assessment

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

Links

This unit may be linked with the BTEC Higher National unit *Engineering Design*.

The project unit is intended to integrate the skills and knowledge developed in many of the other units making up the total programme. Hence, the opportunity to apply the appropriate level of skills and knowledge defined by these BTEC Higher National units should be an important consideration in the selection of the project topic.

Entry requirements for this unit are at the discretion of the centre. However, it is strongly advised that learners should have completed appropriate BTEC National units or equivalent. Learners who have not attained this standard may require bridging studies.

Resources

Learners should have access to a wide variety of physical resources, depending on the specific project. Many of these are listed with the individual units 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.

Support materials

Due to the nature of the unit, learners 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.

Textbooks

Lock D – *Project Management 7th Edition* (Gower Publishing, 2000) ISBN 056608225X

Unit 5: Plant and Process Principles

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

Unit code:

Description of unit

The aim of this unit is to investigate a number of engineering principles which underpin the design and operation of plant engineering systems and equipment. The focus of the unit is to provide knowledge and understanding to support and develop a range of topics associated with plant engineering and a basis for more advanced study. It is envisaged that the content will be used as part of an integrated programme of plant engineering services and management, with the services aspect being applications orientated and developed through a knowledge of thermofluid principles.

Summary of learning outcomes

To achieve this unit a learner must:

1. Investigate **thermodynamic systems** as applied to plant engineering processes
2. Investigate **power transmission** system elements in relation to plant engineering equipment
3. Investigate **static and dynamic fluid systems** with reference to plant engineering
4. Analyse **combustion processes** associated with plant engineering.

Content

1 Thermodynamic systems

Polytropic processes: general equation $p v^n = c$; relationships between index 'n' and heat transfer during a process; constant pressure and reversible isothermal and adiabatic processes; expressions for work flow

Thermodynamic systems: closed systems; open systems; application of 1st Law to derive system energy equations; enthalpy

Properties: intensive; extensive; two-property rule

Relationship: $R = c_p - c_v$ and $\gamma = c_p / c_v$

2 Power transmission

Belt drives: flat and vee-section belts; limiting coefficient friction; limiting slack and tight side tensions; initial tension requirements; maximum power transmitted

Friction clutches: flat, single and multi-plate clutches; conical clutches; coefficient of friction; spring force requirements; maximum power transmitted by constant wear and constant pressure theories; validity of theories

Gear trains: simple, compound and epicyclic gear trains; velocity ratios; torque, speed and power relationships; efficiency; fixing torques

3 Static and dynamic fluid systems

Immersed surfaces: rectangular and circular surfaces, including retaining walls, tank sides, sluice gates, inspection covers, valve flanges; hydrostatic pressure and thrust on immersed surfaces

Centre of pressure: use of parallel axis theorem for immersed rectangular and circular surfaces

Viscosity: shear stress; shear rate; dynamic viscosity; kinematic viscosity

Head losses: head loss in pipes by Darcy's formula; Moody diagram; head loss due to sudden enlargement and contraction of pipe diameter; head loss at entrance to a pipe; head loss in valves

Reynold's number: inertia and viscous resistance forces; laminar and turbulent flow; critical velocities

Impact of a jet: power of a jet; normal thrust on a moving flat vane; thrust on a moving hemispherical cup; velocity diagrams to determine thrust on moving curved vanes; fluid friction losses; system efficiency

4 Combustion processes

Combustion chemistry: composition of air and simple hydrocarbon fuels; combustion equations; stoichiometric and actual air:fuel ratios; mixture strength; excess air

Energy of combustion: calorific values; higher and lower; thermal and boiler efficiency; practical determination of calorific value of various solid, liquid and gaseous fuels

Products of combustion: instrumentation for flue gas and exhaust products; volumetric analysis; variation of proportions of products dependent on air:fuel ratio and combustion quality

Outcomes and assessment criteria

Outcomes	Assessment criteria To achieve each outcome a learner must demonstrate the ability to:
1 Investigate thermodynamic systems as applied to plant engineering processes	<ul style="list-style-type: none"> λ evaluate polytropic processes λ define thermodynamic systems and their properties λ apply the 1st Law of Thermodynamics to thermodynamic systems λ determine the relationships between system constants for a perfect gas.
2 Investigate power transmission system elements in relation to plant engineering equipment	<ul style="list-style-type: none"> λ determine the maximum power which can be transmitted by means of a belt and by a friction clutch λ determine the torque and power transmitted through gear trains.
3 Investigate static and dynamic fluid systems with reference to plant engineering	<ul style="list-style-type: none"> λ determine the hydrostatic pressure and thrust on immersed surfaces λ determine the centre of pressure on immersed surfaces λ describe viscosity in fluids λ determine head losses in pipeline flow

	<ul style="list-style-type: none"> λ assess the impact of a jet of fluid.
4 Analyse combustion processes associated with plant engineering	<ul style="list-style-type: none"> λ describe the combustion process using terminology associated with combustion chemistry λ determine energy of combustion λ explain how products of combustion are formed.

Guidance

Delivery

A practical approach to learning should be adopted wherever possible, with tutors providing relevant examples of the application of theory in practice. Effort should be made to identify the relevance of the principles to equipment and processes. Practical work needs to be investigative in order to give learners opportunities to provide evidence for the distinction grade.

The unit could be delivered either as a stand-alone package or integrated into other programme units. If it is delivered in an integrated way, care must be taken to ensure tracking of evidence outcomes.

When delivered as part of the BTEC Higher Nationals in Marine Engineering, tutors must ensure that where reference is made to 'plant engineering' the content is contextualised to make it appropriate for the marine industry.

Assessment

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

Evidence may be accumulated by learners 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 other core units such as *Analytical Methods for Engineers* and *Engineering Science*, along with application-orientated plant engineering optional units in the programme. The unit provides a basic knowledge and understanding of thermofluids required to support the optional units *Engineering Thermodynamics*, and *Fluid Mechanics*.

Resources

If possible, laboratory facilities should be available to investigate fluid flow and the analysis of products of combustion.

Suggested reading

A number of textbooks relating to thermodynamics, fluid mechanics and power transmission have been written to cover topics in this unit and are available through the normal sources. Those listed below are given as examples and are by no means exhaustive.

Bolton W – *Mechanical Science* (Blackwell Science, 1998) ISBN 0632049146

Eastop T D, McConkey A – *Applied Thermodynamics for Engineering Technologists* (Prentice Hall, 1993) ISBN 0582215714

Massey B and Ward-Smith – *Mechanics of Fluids* (Nelson Thornes, 1998) ISBN 0748740430

Unit 6: Engineering Design

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H2

Description of unit

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

Summary of learning outcomes

To achieve this unit a learner must:

1. Prepare a **design specification**
2. Prepare a **design report**
3. Use **computer-based technology** in the design process.

Content

1 Design specification

Customer requirements: all relevant details of customer requirements (eg aesthetics, functions, performance, cost and 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; use of new technologies are specified where appropriate; relevant standards and legislation are identified and applied throughout

2 Design report

Analysis of possible design solutions: selection and use of appropriate analysis techniques to achieve a design solution (eg matrix analysis, brainstorming, mind mapping, forced decision making)

Evaluation: costs; future development potential; value engineering concepts

Compliance check: using checklists; design review procedures

Report: communicate rationale for adopting proposed solution; use of appropriate techniques and media in the presentation of the report (eg sketches, charts, graphs, drawings, spreadsheets/databases, CAD, DTP, word-processing)

3 Computer-based technology

Key features of a computer-aided design system: 2D design and 3D modelling systems (eg accessing 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: accessing and using appropriate design software (eg 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) Note: centres should select suitable examples from the applications listed

Evaluation: consideration of costs, compatibility and function

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Prepare a design specification	<ul style="list-style-type: none"> λ establish customer requirements λ determine the major design parameters λ obtain design information from appropriate sources and prepare a design specification λ ensure that the design specification meets requirements.
2 Prepare a design report	<ul style="list-style-type: none"> λ prepare an analysis of possible design solutions λ produce and evaluate conceptual designs λ select the optimum design solution λ carry out a compliance check λ prepare a final report.
3 Use computer-based technology in the design process	<ul style="list-style-type: none"> λ identify the key features of a computer-aided design system λ use computer-aided design software to prepare a design drawing or scheme λ evaluate software that can assist the design process.

Guidance

Delivery

This unit has been written in terms of general outcomes that examine products and services. It should be delivered in the context of the discipline that the learner 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 an integrated programme of study, it must be possible to track evidence to show that learners have met the outcomes of the unit.

Assessment

Learners should prepare a design portfolio containing the 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, covered by units such as *Engineering Science*, *Design for Manufacture* and *Project*.

Entry requirements for this unit are at the discretion of the centre. However, it is advised that learners should have completed an appropriate BTEC National unit such as *Engineering Design* or equivalent.

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.

Support materials

Textbooks

Corbett J, Dooner M, Meleka J and Pym C – *Design for Manufacture* (Addison-Wesley, 1991) ISBN 0201416948

Tooley M and Dingle L – *Higher National Engineering* (Butterworth-Heinemann, 1999) ISBN 075064629

Specialist Units

Unit 7: Naval Architecture (for Marine Engineers)

Learning hours: 60

NQF level 4: BTEC Higher Nationals – H2

Description of unit

This unit develops learners' knowledge and understanding of the principles of Naval Architecture as identified by the International Maritime Organisation (IMO), International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 as amended in 1995 (STCW95).

It is intended that the unit will meet the MCA requirements up to Class 1 Certificate of Competency level. The unit is also designed to satisfy the requirements of the Standards for Training, Certification and Watchkeeping of Seafarers (STCW 78 as amended to 95).

Summary of outcomes

To achieve this unit a learner must:

1. Explain and calculate the measures necessary to preserve trim and stability at small & large angles of heel.
2. Describe the **principles of watertight subdivision** and calculate and **the effects of compartment flooding** on ship trim and stability and the countermeasures to be taken.
3. Explain the principles of **ship construction**
4. Calculate the **forces on ship structures**.
5. Analyse, by calculation, the basic factors of **resistance to ship motion, propellers, powering estimates and fuel consumption estimates**.

Content

1 Trim and Stability

Stability at small angles of heel: centres of buoyancy and gravity, metacentre, Metacentric height and the criteria for stability; changes of stability due to changes of loading

Trim: changes of trim with changes of loading

Stability at large angles of heel: limitations of metacentric (small angle) theory; curves of statical stability; changes of GZ curve and angle of heel due to changes in loading; changes of GZ with shipform

2 Watertight sub-division and the effects of compartment flooding

Watertight sub-division: rules governing sub-division

Effects of compartment flooding: change of draught and stability due to bilging; heel and trim caused by bilging

3 Ship Construction

Ship construction: define ship terminology; basic ship construction and functions of structural components; the design features of different ship types

4 Forces on ship structures

Static forces: weight and buoyancy distribution; load diagram; shear force diagram; Bending Moment diagram

Dynamic Forces: difference between static and dynamic forces.

Stress in ship structures: how stress is calculated; how stress is measured; stress (strain) gauges

5 Resistance to ship motion, propellers, powering estimates and fuel consumption estimates

Ship resistance: techniques for identifying ship resistance; resistance components

Powering: power estimates; identification of power losses; fuel consumption estimates; fuel and admiralty coefficients

Propellers: basic propeller terminology; relationship between indicated power, shaft power, delivered power and thrust power.

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1. Explain and calculate the measures necessary to preserve trim and stability at small and large angles of heel	<ul style="list-style-type: none"> λ explain the mechanism of small angle ship stability λ identify stability of a ship by calculation λ calculate changes of trim when ship loading is changed λ demonstrate the use of data and calculation to identify ship stability
2. Describe the principles of watertight subdivision and calculate and the effects of compartment flooding on ship trim and stability and the countermeasures to be taken	<ul style="list-style-type: none"> λ explain the function of ship sub-division λ calculate the change of draught, trim and stability due to bilged compartment λ explain the actions taken minimise the dangers of compartment flooding λ specify statutory sub-division regulations
3. Explain the principles of ship construction	<ul style="list-style-type: none"> λ define ship terminology λ explain basic ship construction and the functions of structural components
4. Calculate the forces on ship structures	<ul style="list-style-type: none"> λ explain the distribution of buoyancy and weight on ship. λ calculate the effects of changes in loading conditions on the distribution of buoyancy and weight on the ship. λ show how stress is measured in ship hulls
5. Analyse, by calculation, the basic factors of resistance to ship motion, propellers, powering estimates and fuel consumption estimates	<ul style="list-style-type: none"> λ calculate ship resistance, propellers, power estimates and fuel consumption. λ calculate ship powering and propulsion.

Guidance

Delivery

Delivery of this unit can be facilitated through the use of learners' own experiences whilst serving on board ship and the links to other aspects of ship operation and marine engineering.

Learning will be monitored by learner response during tutorial and homework submissions. In addition assessment carried out at Learning Outcome level will establish the level of understanding of the learner.

It is expected that the Learning Outcome dealing with ship construction will be delivered by lecture and tutor guided project. The assessment of this Learning Outcome will be carried out by learners working in small groups answering a question chosen from a list posed by the Subject Team. Learners will complete a joint project with their own conclusions, then make a presentation to their class group.

Assessment

Evidence of the outcome may be in the form of assignments, projects and formal class assessments. The assignments and class assessments will be taken on an individual basis, whilst project work may be undertaken as by a small group with a presentation being given to the class group.

Links

This unit links with the *Unit 3: Analytical Methods for Engineers*. Entry requirements for this unit are at the discretion of the centre.

Resources

Library of materials relevant to naval architecture, ship design, ships construction and ship operation.

Computers networked to the Internet.

Support Materials

E A Stokoe *Naval Architecture for Marine Engineers* (Thomas Reed Publishers 1991)

D H Taylor *Merchant Ship Construction* (Institute of Marine Engineers 1992)

Unit 10: Application of Machine Tools

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

Description of unit

This unit introduces learners to the types of manually operated machine tools commonly used in industry and typical applications of such equipment. It introduces the theory of cutting tools, the practice of tool and work setting for production on manual machine tools and the checking of critical features and dimensions against specifications. Safe use of equipment will be a constant theme throughout the unit.

The unit aims to provide the learner with the skills necessary for the safe and efficient production of components on manual machine tools. It also provides the learner with a broad knowledge base upon which suitable types of machine tool and appropriate tooling may be chosen for specific sorts of work.

Summary of learning outcomes

To achieve this unit a learner must:

1. Describe the characteristics of a range of **machine tools**
2. Investigate **machining operations**
3. Investigate **material cutting and forming processes**
4. **Produce components** to specification using safe working practices.

Content

1 Machine tools

Machine tools: a range of machine tools and their applications (eg centre lathes, vertical and horizontal milling machines, cylindrical and surface grinders, centreless grinders, lapping, honing, planing and shaping machines, internal and external broaching machines, sawing machines, presses, sheet and tube bending machines); types of drives (eg for lathes, milling machines and presses); relative motion between cutting tool and workpiece

Work holding techniques: the six degrees of freedom of a rigid body with respect to work holding and jig and fixture design (eg the need for rigidity in design and build of machine tools, three and four-jaw chucks, use of centres, machine vices, worktable clamps, magnetic tables, etc.)

Tool holding: toolposts; morse taper shanks; Jacobs chucks; milling machine arbors; mounting and dressing of grinding wheels

2 Machining operations

Components and geometries: component features typically associated with lathe work, milling, sheet metal forming and broaching. For example:

- Lathe work: rotational operations - diameters and face turning, taper turning, chamfers, radii, drilled holes and internal bores, deep holes, internal and external threads, grooving, knurling, parting off, roughing and finishing cuts, the purpose and use of cutting fluids
- Milling: prismatic operations - face milling, slab milling, profiles, pockets and slots, drilling, reaming, thread tapping, thread milling, counterboring, countersinking, roughing and finishing cuts
- Press work: sheet metal forming operations - blanking, piercing, drawing, bending, notching, cropping, use of progression tooling; finishing operations
- Broaching: internal and external - square and round holes, splines, gear teeth, keyways, rifling and flat, round and irregular external surfaces

3 Material cutting and forming processes

Tooling: choice and effects of tool geometries; choice of tool material; permissible depth of cut; types and consequences of tool wear; importance of clearance in pressworking operations; calculation of expected tool life

Forces: theory of metal cutting; mechanics of chip formation; shearing mechanisms in press work; calculation of forces exerted on cutting/forming tool and workpiece during various operations; calculation of power required to perform specific operations; use of dynamometers and other condition monitoring/measuring equipment

***Speeds and feeds:* calculation of speeds and feeds for turning and milling operations on a variety of workpiece features, sizes and materials (eg aluminium alloys, mild steel, tool steels, cast metals and alloys); relationship between cutting speed and tool life – economics of metal removal**

4 Produce components

Health and safety: issues related to machine tools, workshops and the production environment in general; responsibilities of the employer and employee under the Health and Safety at Work Act and other legislation; correct and approved use and operation of systems and equipment; potential hazards for given machine tools

Principles of production: tool and work setting techniques; interpretation of specifications and engineering/production drawings; feature measurement (eg depths, diameters, screw threads, etc)

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass
	To achieve each outcome a learner must demonstrate the

	ability to:
1 Describe the characteristics of a range of machine tools	<ul style="list-style-type: none"> λ identify the typical axis conventions of given machine tools λ identify the types of drive and the axis control systems, such as hand-wheels and servo-motors, for given machine tools λ describe the six degrees of freedom of a rigid body and how they relate to work holding techniques λ describe work and tool holding devices for given machine tools.
2 Investigate machining operations	<ul style="list-style-type: none"> λ identify the types of machine tool suitable for the production of specific components and geometries λ develop the sequence of operations required to produce specific components <ul style="list-style-type: none"> • λ describe the machining and forming processes involved in the production of specific features.
3 Investigate material cutting and forming processes	<ul style="list-style-type: none"> λ select appropriate tooling for the production of specific features on specific materials λ determine the forces acting on the tool face and work piece during ideal orthogonal cutting λ calculate speeds and feeds for turning and milling operations for a variety of tool and work piece materials λ describe the mechanisms and effects of different types of tool wear and catastrophic failure λ estimate the life of given tools for specific applications.
4 Produce components to specification using safe working practices	<ul style="list-style-type: none"> • demonstrate awareness of health and safety issues related to the specific machine tools used and the workshop in general • apply the principles of production • produce given components in accordance with specifications.

Guidance

Delivery

Learners should work individually. Delivery may be achieved by formal lectures, supported by tutorial sessions focusing upon the theoretical aspects of the syllabus, and practical workshop sessions.

Assessment

Evidence of outcomes may be in the form of a written report supported by a fully documented log-book, production of an assembly or component produced with available machine tool resources and written tests based on theoretical principles.

Links

This unit may be effectively linked with the BTEC Higher National unit *Manufacturing Process*.

Entry requirements for this unit are at the discretion of the centre. However, it is strongly advised that learners should have completed an appropriate BTEC National unit or equivalent.

Resources

Learners should have access to appropriate machine tools and properly trained support staff. Institutions should try to work closely with industrial organisations in order to bring realism and relevance to the unit.

Support materials

Textbooks

Kalpakjian, S – *Manufacturing Engineering and Technology* (Addison-Wesley, 2000) ISBN 0201361310

Timings – *Manufacturing Technology: Volume 1* (Longman, 1998) ISBN 0582356938

Unit 14: Instrumentation and Control Principles

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

Description of unit

This unit is intended to give learners an appreciation of the principles of industrial instrumentation. The unit will also give learners an understanding of the techniques used in industrial process control and enable them to predict controller settings and make adjustments to achieve stability in such a control system.

Summary of learning outcomes

To achieve this unit a learner must:

- 1 Investigate the operation of modern **instrumentation systems** used in process control
- 2 Examine **process control systems and controllers**
- 3 Examine the use of **regulating units** in control system.

Content

1 Instrumentation systems

System terminology: accuracy; error; repeatability; precision; linearity; reliability
reproducibility; sensitivity; resolution; range; span; zero drift; hysteresis

Sensors/transducers: pressure (eg resistive, strain gauge, inductive, capacitive, semiconductor, ceramic, piezoelectric, LVDT); level (eg conductivity, capacitive, ultrasonic, radar, nucleonic, loadcells, radiometric, microwave, hydrostatic, sonar); flow (eg ultrasonic, Coriolis, vortex, magnetic, differential pressure); temperature (eg resistance, thermocouple, radiation pyrometers); displacement (eg diffraction grating, lasers, variable resistance signal conditioning)

Transmitters/signal converters: current to pressure; pressure to current; microprocessor based ('smart'); digital; analogue

Transmission medium: pneumatic; hydraulic; electrical; fibre-optic

Signal conditioners: operational amplifiers; voltage to voltage; voltage to current; current to voltage; charge amplifier

2 Process control systems and controllers

Need for process control: quality; safety; consistency of product; optimum plant performance; human limitations; efficiency; cost; environmental

Process controller terminology: deviation; range; span; absolute deviation; control effect; set point; process variable; manipulated variable; measured variable; bumpless transfer; process variable tracking; direct and reverse acting; offset; proportional band; gain; on-off control; two step control; cycling; proportional; proportional with integral; proportional with integral and derivative; proportional with derivative

System terminology: distance velocity lags; transfer lags; multiple transfer lags; capacity; resistance; dead time; reaction rate; inherent regulation; dead time; open loop; closed loop; load; supply; static gain; dynamic gain; stability; loop gain

Tuning techniques: Zeigler-Nichols; continuous cycling; reaction curve; ¼ decay methods; tuning for no overshoot on start-up; tuning for some overshoot on start-up

System representation: P and I diagrams; loop diagrams; wiring diagrams; constructing and using diagrams to appropriate standards

3 Regulating units

Regulating unit terminology: body; trim; plug guide and seat; valve; stem; bonnet; packing gland; yoke; actuator; motor; stroke; direct and reverse action; air fail action; repeatability; CV; turndown; flow characteristics; linear, equal percentage, quick-opening, modified parabolic, split range

Regulating units: dampers; power cylinders; louvres; valve positioners; valves (globe, ball, diaphragm, gate, double seated, 3-way, solenoid, split bodied, butterfly)

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Investigate the operation of modern instrumentation systems used in process control	<ul style="list-style-type: none"> • describe terminology used in process measurements • evaluate a range of sensors and transducers with reference to manufacturers' terminology • describe the construction and operation of modern sensors used to measure pressure, level, temperature and flow • describe typical applications for the sensors examined • describe signal conditioning and transmission.
2 Examine process control systems and controllers	<ul style="list-style-type: none"> • explain the need for process control • describe process control terminology • determine the medium required for successful transmission • name sensors, conditioners and display units for a range of specific purposes • examine several tuning techniques • describe the control actions required for different systems

	<ul style="list-style-type: none"> • represent systems using standard diagrams.
3 Examine the use of regulating units used in control systems	<ul style="list-style-type: none"> • identify the main parts of a regulating unit • evaluate a regulating unit with reference to standard terminology, including manufacturers' specifications • select the plug characteristics required for a specified process • describe the characteristics of a range of regulating units • examine the use of valve positioners • calculate the CV of a control valve from relevant data.

Guidance

Delivery

A practical hands-on approach to learning should be adopted wherever possible, with tutors providing relevant examples of theory in practice. Learners should be given an appreciation of the use of process control systems in an industrial context. Evaluation of modern sensors/transducers/transmitters should include calibration checks where possible.

Safe working practice should be followed at all times.

Assessment

Evidence of outcomes may be in the form of assignments, records of practical activities, applied examples or completed tests/examinations.

Evidence may be accumulated by learners in a portfolio containing an appropriate mix of assessment material. A number of practical activities are expected to be included in the assessment evidence. Where possible, learners should use appropriate software to explore process control models.

Links

Entry requirements for this unit are at the discretion of the centre. However, it is advised that learners should have achieved appropriate BTEC National units or equivalent.

Resources

Suitable computer packages should be available, such as spreadsheets and engineering software, appropriate to the learner's specialist discipline. Centres delivering this unit should possess or have access to a range of modern sensors, transducers, transmitters, controllers and appropriate regulating units to support practical investigations. Appropriate software packages should be used wherever possible to solve problems.

Support materials

Textbooks

Bolton W – *Instrumentation and Process Measurements* (Longman, 1991) ISBN 0582068088

O'Doebelin E – *Measurement Systems – Applications and Design* (McGraw Hill, 1990) ISBN 0070173389

Parr E A – *Industrial Control Handbook* (Butterworth-Heinemann, 1998) ISBN 0750639342

3. Steam and gas turbine

Principles of operations: impulse and reaction turbines; condensing; pass-out and back pressure turbines; single and double shaft gas turbines; regeneration and re-heat in gas turbines; combined heat and power plants

Circuit and property diagrams: circuit diagrams to show boiler/heat exchanger; superheater; turbine; condenser cooling water circuit; hot well; economiser/feedwater heater; condenser extraction and boiler feed pumps; temperature-entropy diagram of Rankine cycle

Performance characteristics: Carnot and Rankine cycle efficiencies; turbine isentropic efficiency; power output; use of property tables and enthalpy-entropy diagram for steam

4. Refrigerators and heat pumps

Reversed heat engines: reversed Carnot and Rankine cycles; vapour compression cycle; second law of thermodynamics; temperature-entropy diagrams; pressure-enthalpy diagrams; refrigeration tables and charts; refrigerant fluids; environmental effects

Refrigerators: refrigeration effect; coefficient of performance

Heat pumps: heating effect; coefficient of performance; economics of heat pumps

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass <u>To achieve each outcome a learner must demonstrate the ability to:</u>
1. Evaluate internal combustion engine performance	<ul style="list-style-type: none"> λ relate the second law of thermodynamics to the operation of heat engines λ investigate theoretical heat engine cycles λ determine the performance characteristics of internal combustion engines λ recognise how improvements may be made to the efficiencies of IC power units.
2. Investigate reciprocating air compressors	<ul style="list-style-type: none"> λ draw property diagrams for compressor cycles λ determine the performance characteristics of compressors λ apply the first law of thermodynamics to compressors λ recognise compressor faults and hazards.
3. Investigate steam and gas turbine power plant	<ul style="list-style-type: none"> λ describe the principles of operation of steam and gas turbines λ draw circuit and property diagrams to show the functioning of steam power plant λ <u>determine the performance characteristics of steam power plant.</u>
4. Analyse industrial applications of refrigerators and heat pumps	<ul style="list-style-type: none"> λ determine coefficient of performance, heating effect and refrigeration effect of reversed heat engines λ use refrigeration tables and charts λ sketch refrigerator and heat pump cycles λ discuss the economics of heat pumps

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	explain the apparent contradiction between refrigeration cycles and the second law of thermodynamics.
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Guidance

Delivery

A practical approach to learning should be adopted wherever possible, with tutors providing relevant examples of the application of theory in practice. Practical work needs to be investigative, to give learners opportunities to provide evidence for distinctive performance. Visits to industrial installations will be of value for the achievement of Outcomes 2, 3 and 4 if centre-based facilities are not available.

Assessment

Evidence of outcomes may be generated from assignments, laboratory notes, solutions to applied problems or completed tests/examinations. Evidence is likely to be at outcome level in order to provide maximum flexibility of delivery.

Evidence may be accumulated by learners 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 has links with the BTEC Higher National units *Analytical Methods for Engineers* and *Engineering Science*.

Resources

If possible, laboratory facilities should be available for the investigation of internal combustion engines, compressor and refrigerator performance and analysis of the combustion process, but they are not essential.

Support Materials

Eastop T and McConkey A - *Applied Thermodynamics for Engineering Technologists* (Prentice Hall, 1993) ISBN 0582215714

Joel R - *Basic Engineering Thermodynamics* (Prentice Hall, 1996) ISBN 0582256291

Sprackling M - *Heat and Thermodynamics* (Macmillan, 1993) ISBN 0333565134

Rogers and Mayhew - *Engineering Thermodynamics* (Longman, 1992) ISBN 0582045665

Unit 18: Marine Diesel Propulsion & Power Systems (further editing required)

Learning hours: 60

NQF level 4: BTEC Higher Nationals – H2

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Description of unit

The aim of this unit is to extend the learners' knowledge and understanding of marine diesel propulsion and power systems. The learner will consider the design and construction of diesel engines and also the impact of legislation and maintenance on the operational performance of marine diesel propulsion and power systems.

Learners choosing this unit will not be permitted to choose *Unit 21: Marine Propulsion Systems*.

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Summary of outcomes

To achieve this unit a learner must

- 1 Investigate the **design and applications** of marine diesel engines.
- 2 **Describe** constructional methods used in a marine diesel engine.
- 3 **Investigate** the operational parameters of a marine diesel engine.
- 4 **Describe** the techniques used in the maintenance of marine diesel engines

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Content

1 Design and applications

Efficiency of marine diesels: power to weight ratios, efficiencies of two and four stroke engines and their running costs, turbo-charging, waste heat recovery.

Mechanical and thermal stresses: selection and use of materials, relative sizes and dimensions, stress reversal and fatigue failure, thermal stressing (eg environmental and generated thermal conditions: exposure to both high and low temperatures).

Designs to limit atmospheric pollution: cross-head engine design and trunk piston design, fuel oil injection methods, exhaust gas re-circulation, homogenisation, direct water injection, water mist, exhaust gas scrubbers, and catalytic reduction.

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2 Constructional methods

Transmission of propulsion forces: bedplates, thrust bearings, holding down arrangements.

Crankshafts: manufacturing methods (eg forged and fabricated crankshafts), methods for crankshaft alignment and deflections, causes and effects of misalignment.

Transmission of combustion forces: construction of the engine, framing and tie bolts, running gear, cylinder liners and heads

Engine timing and combustion: camshaft drives and cams, reversing, fuel pumps, injectors and valves, air start systems.

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3 Operational Parameters

Operational data: power and draw cards, peak and compression pressures, log book trends.

Monitoring: types of lubricating oil used in diesel engines, **??in full??** (LO) testing, bearing temperature measurement, oil mist measurement, protection devices in case of abnormal operation (eg crankcase explosions, scavenge fires), engine monitoring, slow downs and Shut downs

Atmospheric Pollutants: Nox, Sox, CO₂, impact of Marpol 73/78 and US Federal and State Regulations on the design and operation of diesel engines

Operating procedures: requirements and use of SOLAS 74 Construction regulations and Classification Society regulations for marine diesel engines

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3 Maintenance of marine diesel engines

Types and need for maintenance: planned maintenance (eg based on running hours, application of maintenance schedules, use of manufacturer's guidance and manuals), expected and projected life of components, repair and breakdown maintenance.

Maintenance plans: permit to work, risk analysis, availability of human and physical resources, downtime, (COSWP)

Planned maintenance: continuous survey by classification societies, approved planned maintenance systems, coordinating maintenance with dry docking schedules and off hire periods.

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Outcomes and assessment criteria

Outcomes	Assessment criteria for pass
	To achieve each outcome a learner must demonstrate the ability to:
1 Investigate the design and applications of marine diesel engines.	<ul style="list-style-type: none"> λ identify and describe the layout and application of systems for main propulsion and electrical generation. λ describe methods used to improve the efficiency of marine diesel engines λ evaluate methods employed to limit the extent of generated mechanical and thermal stresses λ identify and describe the design considerations employed to limit atmospheric pollution.
2 Describe constructional methods used in a marine diesel engine.	<ul style="list-style-type: none"> λ identify and describe how propulsion forces are transmitted to the ships structure. λ describe methods of crankshaft manufacture and alignment. λ describe how combustion forces are transmitted to the crankshaft. λ evaluate different methods of timing the engine and how this affects the combustion process.
3 Investigate the operational parameters for a marine diesel engine.	<ul style="list-style-type: none"> λ interpret operational data and compare with accepted norms. λ describe methods of monitoring the running parameters of the engine. λ explain how the combustion of hydrocarbon fuels create atmospheric pollution. λ produce plant operating procedures that comply with the requirements of SOLAS 74 and classification societies
4 Describe the techniques used in the maintenance of marine diesel engines.	<ul style="list-style-type: none"> λ identify the types of, and need for maintenance. λ describe how the maintenance is planned and executed. λ explain how planned maintenance relates to statutory, class and owners requirements.

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Guidance

Delivery

This unit can be delivered as a stand-alone package or integrated into a programme however, a practical approach to learning should be adopted wherever possible. Case studies incorporating actual or simulated data secured from appropriate sources would be a beneficial way to support understanding.

Assessment

Evidence of outcomes may be generated through the use of activities such as, assignments, simulations, case studies and time-constrained assessments. As a general rule, these activities will be undertaken by learners on an individual basis. However, where group work is undertaken then centres must ensure that assessment evidence at an individual level. That is, group or collective evidence would not be acceptable.

Links

This unit links Unit 5: Plant and Process Principles, Unit 24: Marine Auxiliary Plant, Unit 20: Marine Engineering Mechanics and Unit 17: Marine Engineering Thermodynamics.

Learners choosing this unit will not be permitted to choose Unit 21: Marine Propulsion Systems.

Resources

Institutions delivering this unit should possess, or have access to a wide range of marine diesel plant. Learners should have access to suitable computer simulation packages to model typical marine engineering situations.

Support Materials

Textbooks

Taylor C - *The Internal Combustion Engine Theory and Practice* (MIT Press, 1984) ISBN 0262700271

Woodyard D - *Pounder's Marine Diesel Engines* (Butterworth-Heinemann, 1998) ISBN 075062583X

Unit 19: Marine Turbine Propulsion and Power Systems

Learning hours: 60

NQF level 4: BTEC Higher Nationals – H1

Description of unit

The aim of this unit is to extend the learners' knowledge and understanding of marine turbine propulsion and power systems. It also provides the opportunity for learners to investigate and evaluate the design, construction, operation and maintenance of marine turbine propulsion and power systems.

Learners choosing this unit will not be permitted to choose Unit 21: Marine Propulsion Systems.

Summary of outcomes

To achieve this unit a learner must:

- 1 Investigate the design and construction of marine boilers.
- 2 Investigate the design and construction of marine turbine plant.
- 3 Investigate the design and construction of marine power transmission systems.

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<p>2. Investigate the design and construction of marine turbines.</p>	<ul style="list-style-type: none"> λ identify and describe the design and operating principles of steam turbines. λ explore and explain the various design features that allow the efficient and safe operation of steam turbines. λ identify and describe the design and operating principles of gas turbines. λ recognise and describe the materials and techniques used in the construction of steam and gas turbines.
<p>3. Investigate the design and construction of marine power transmission systems.</p>	<ul style="list-style-type: none"> λ identify and describe the design features of of gearing arrangements. λ describe different methods of transmitting motive forces in marine power transmission systems. λ identify and compare lubrication methods. λ describe the materials and techniques used in the construction and setting up of shafting and gearing.
<p>4. Explain plant operational and maintenance parameters.</p>	<ul style="list-style-type: none"> λ describe procedures used to safely commission and maintain the operational availability of steam and gas turbine plant. λ describe how operating anomalies can be detected in steam and gas turbine plant. λ describe how operational and maintenance procedures relate to statutory, class and owner's requirements.

Guidance

Delivery

This unit can be delivered as a stand-alone package or integrated into a programme of study. A practical approach to learning should be adopted wherever possible and the unit should be delivered in the context of the discipline that the learner is studying. Centres should encourage learners to make use of any practical evidence or work-based experience that they may possess.

Assessment

Assessment evidence may be generated through a range of assignments, simulations, case studies and time-constrained assessments. As a general rule these will be undertaken by learners on an individual basis although the use of case studies incorporating actual or simulated data secured from appropriate sources would be a beneficial way to support understanding.

Links

This unit links with Unit 17: *Marine Engineering Thermodynamics*, Unit 20: *Marine Engineering Mechanics*, and Unit 24: *Marine Auxiliary Plant*. Learners choosing this unit will not be permitted to choose Unit 21: *Marine Propulsion Systems*.

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Resources

Centres delivering this unit should possess, or have access to a wide range of marine Plant (eg. the typical plant expected). Learners should also have access to suitable computer simulation packages to model typical marine engineering situations.

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Support Materials

A wide range of standard texts and journals are available as well as information booklets and project guides from manufactures of marine equipment. The books below are examples only.

British Standards Institution – *Methods for Treatment of Water for Marine Boilers*. (B.S.1170)

Cohen H, Rogers CFC & Saravanamuttoo HIH - *Gas Turbine engineering Theory*

Harman RTC - *Gas Turbine engineering*

Hunt EC - *Modern Marine Engineer's Manual* – 3rd Ed (Cornell Maritime Press, 2002)

McBirn SC – *Marine steam engines and turbines* – 4th Ed (Butterworth & Co, 1980)

Milton, JH – *Marine Steam Boilers* – 4th Ed (Butterworth & Co, 1980)

Taylor CF-*The internal Combustion Engine Theory and Practice*

Woodyard, D - *Pounder's Marine Diesel Engines* - 7th Ed (Butterwort-Heinemann, 1998)

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Delivery¶

This unit can be delivered as a stand-alone package or integrated into a programme.¶

A practical approach to learning should be adopted wherever possible with tutors providing¶ the sources of information. ¶

It should be delivered in the context of the discipline that the student is studying maximising the use of any practical evidence the student possess.¶

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Unit 22: Electronics

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H2

Description of unit

This unit further develops the understanding of analogue electronics gained through previous study. It places particular emphasis on the use of current manufacturers' data and modern circuit analysis techniques.

Summary of learning outcomes

To achieve this unit a learner must:

- 1 Investigate **signals and noise**
- 2 Investigate **types of amplifier**
- 3 Investigate **circuits with feedback**
- 4 Investigate **oscillators**.

Content

1 Signals and noise

Logarithmic units: decibels, related to power, current and voltage ratios

Reference levels: dBA; dBW; dBm

Types and sources of noise: thermal; radiated; distortion (eg clipping or cross-over); mains borne; sparking; cross-talk and consider noise reduction techniques (eg screening)

Concepts: signal-noise ratio; noise factor; noise temperature

2 Types of amplifier

Analyse: using quantitative methods; equivalent circuits; computer modelling

Types of amplifier: power; tuned; operational

Performance: frequency response; gain/bandwidth product; distortion; input and output impedance

Modify circuit designs: using manufacturers' data; circuit calculations

Revised specifications: using alternative components to achieve lower cost or to improve performance

3 Circuits with feedback

Types of feedback: voltage; current; series; shunt

Circuit performance: effect of feedback on gain, bandwidth, distortion, noise, gain stability, input and output impedance

Circuit: single-stage transistor amplifier; operational amplifier

Investigate: practical measurement; computer simulation

4 Oscillators

Circuit conditions: $1-\beta A = 0$ at only one frequency; gain-phase relationship in the circuit

Build and evaluate: using given formulae build a typical circuit configuration such as Wien Bridge, phase shift, LC coupled, transistor or operational amplifier

Specification: factors such as frequency, stability, frequency drift, distortion

Crystal Oscillator advantages: frequency accuracy and stability

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Investigate signals and noise	<ul style="list-style-type: none"> λ use logarithmic units and reference levels to express measured values of gain and attenuation λ describe the types and sources of noise in electronic systems and methods of noise reduction λ explain the concepts used to describe the effects of noise and make practical measurements.
2 Investigate types of amplifier	<ul style="list-style-type: none"> λ analyse the operation of different types of amplifier λ evaluate the actual performance of different types of amplifier λ compare the analysis with the measured results λ modify circuit designs to meet revised specifications.
3 Investigate circuits with feedback	<ul style="list-style-type: none"> λ deduce an expression for the closed loop gain of a system with feedback λ describe types of feedback and determine the effects on circuit performance when feedback is applied

	<ul style="list-style-type: none"> λ design a circuit employing negative feedback λ investigate the effects of applying feedback to single and multi-stage circuits.
4 Investigate oscillators	<ul style="list-style-type: none"> λ describe the circuit conditions and the methods used to achieve sinusoidal oscillation λ build and evaluate a sine wave oscillator to a given specification λ explain the advantages of crystal-controlled oscillator circuits.

Guidance

Delivery

A practical approach to learning should be adopted wherever possible, with tutors providing relevant examples of the application of theory in practice. The most likely way to achieve this is through a series of co-ordinated assignments covering the main topic areas. Practical work needs to be investigative, to allow opportunities for learners to provide evidence across grades.

Computer simulation and analysis of circuits should be used, where appropriate, so that practical analysis can be compared with computer-generated results for the same circuits. This helps to ensure that learners are familiar with current industrial practice.

In Outcome 2, not all of the amplifiers need to be covered to the same depth. Learners are expected to be given existing designs to analyse. They may, however, be expected to improve or change the designs to meet revised specifications. Not all methods of analysis need to be used for each circuit, although all would benefit from computer modelling.

Assessment

Much of the evidence for this unit will be achieved through assignment and project work. This may be formal and informal reports on practical activities, presentations or written assessments.

Links

This unit may be linked to *Analytical Methods for Engineers, Electrical and Electronic Principles* and *Electronic Computer-Aided Design*.

Entry requirements for this unit are at the discretion of the centre. However, it is assumed that learners have already achieved a level of learning equivalent to the BTEC National unit *Science for Technicians* or similar. This unit builds on and extends the material covered in the BTEC National units *Electronics* and *Analogue Electronics*.

Resources

This unit is intended to involve at least 50% practical work, and will require an appropriate range of electronic test equipment (eg signal generators, oscilloscopes, frequency meters, etc). Learners are expected to have ready access to a computer based circuit analysis package.

Support materials

Textbooks

Green D C – *Digital Electronics* (Longman, 1998) ISBN 0582317363

Unit 23: Operation and Maintenance of Electrical Plant

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H2

Description of Unit

The unit has been designed to cover the distribution of electrical power within a marine environment taking into account all safety features and paying particular attention to electrical equipment within a hazardous area. The learner will be required to demonstrate their ability to work safely in both low and high voltage areas and be sufficiently aware of the safety requirements to advise or supervise others in such environments.

Summary of outcomes

To achieve this unit a learner must :

1. Investigate **electrical power distribution and protection equipment**
2. Identify and describe the risks of **electrical equipment in hazardous areas**
3. Work safely in low and high voltage environments.

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Content

1 Electrical power distribution and protection equipment

Plant in use: main electrical supplies (eg distribution systems, insulated and earthed neutral systems, preferential trips, shore supply connection, emergency switchboard connection); transformers (eg as metering device, isolation device, protection requirements)

Safety protection devices in distribution systems: high rupturing capacity (HRC) fuses; isolators; circuit breakers (eg over-current, over-voltage, under-voltage, reverse power)

Emergency back-up systems: emergency power supplies (eg batteries, uninterruptible power supplies (UPS) systems, emergency generator, emergency switchboard)

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2 Electrical equipment in hazardous areas

Explosion proof (Ex) equipment and apparatus: Ex certified equipment and labelling; hazardous areas (eg combustible materials, ignition of gas/air mixtures, hazardous cargo); markings of all apparatus groups and temperature classifications

Maintenance: maintenance of equipment in a real or simulated hazardous environment (eg luminaire, junction box)

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3 Low and high voltage environments

Safety procedures: electrical safety and electric shock levels; low voltage (LV) and high voltage (HV) environments (eg generation, switchboards, distribution boards, propulsion); isolation and permit-to-work procedures

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Maintenance: routine maintenance on electrical equipment; maintenance procedures; use of manufacturers' manuals/guidelines; maintenance records

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Fault location: recognition of electrical fault types (eg open-circuit, short-circuit, earth faults); faultfinding procedures; use of test equipment (eg multimeter, voltmeter, megger, clamp meter); location of fault and rectification method

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High voltage systems: eg electric propulsion, bow-thrusters, cargo pumps, air conditioning, passenger ship distribution.

Outcomes and assessment criteria

Outcomes	Assessment criteria	
1. Investigate electrical power distribution and protection equipment	<p>To achieve each outcome a learner must demonstrate the ability to:</p> <ul style="list-style-type: none"> λ apply circuit and distribution diagrams to the plant in use λ recognise all safety protection devices and describe their function λ describe emergency back up systems 	Formatted: Bullets and Numbering
2. Identify and describe the risks of electrical equipment in hazardous areas	<ul style="list-style-type: none"> λ identify <u>and explain the function and risks associated with</u> Ex equipment <u>and</u> apparatus groups λ <u>recognise and explain markings and temperature classifications</u> λ <u>check equipment to ensure equipment conformity</u> λ carry out <u>a</u> maintenance procedure <u>within a hazardous area</u> in a safe manner. 	Formatted: Bullets and Numbering Deleted: , Deleted: ing Deleted: s
3. Work safely in low and high voltage environments	<ul style="list-style-type: none"> λ <u>identify and describe the</u> safety procedures <u>required when working in</u> low and high voltage environments λ <u>carry out a maintenance and a fault location procedure on a low voltage system in a safe manner</u> λ <u>describe</u> the safety procedures <u>required</u> when carrying out <u>a given</u> maintenance and fault location <u>procedure on</u> a high voltage system λ <u>identify the probable cause of failure and describe the necessary remedial action for a given HV system.</u> 	Deleted: a Formatted: Bullets and Numbering Deleted: apply Deleted: when Deleted: when carrying out maintenance and fault location. Deleted: ¶ Deleted: understands Deleted: Deleted: i Deleted: carry out maintenance and testing in a safe manner.

Guidance

Delivery

Delivery of this unit could be best achieved through a mixture of lectures and practical applications. This approach would help to reinforce the theoretical principles and gain the necessary maintenance and faultfinding skills.

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Assessment

It is anticipated that the majority of this unit will be demonstrated using practical methods. The assessment evidence may take a variety of forms including tutor observation of practice, short presentations to demonstrate understanding and ability in particular environments (real or simulated) and written reports of investigations. All learners will however have to demonstrate their understanding and ability to work safely, both themselves and to guide or supervise others, in normal and hazardous environments (eg where the presence of gases could cause an explosion).

Links

The unit should be linked with *Marine Electrical Systems* and *Engineering Science* and it is anticipated that the learners will study this unit together with the *Marine Electrical Systems* unit in an integrated way.

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Resources

Learners will require access to power generation and distribution equipment to enable fault diagnostics and routine maintenance to be conducted. Whenever possible, industrial visits should be made to ships, where ideally generators and distribution systems may be viewed in a marine environment.

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Suggested reading

Hall D - *Practical Marine Electrical Knowledge* (Witherby and Company, 1999) ISBN 1856091821

Hughes E - *Electrical Technology* (Prentice Hall, 2001) ISBN 058240519X

McGeorge H - *Marine Electrical Equipment and Practice* (Butterworth-Heinemann, 1993) ISBN 0750616474

Unit 24: Marine Auxiliary Plant

Learning hours: 60

NQF level 4: BTEC Higher Nationals – H1

Description of unit

The aim of this unit is to develop the learner's knowledge of the types, operation and maintenance of marine auxiliary machinery and shipboard hotel services equipment. It is expected that the learner will consider the applications of the machinery and equipment in relevant vessel types. The unit covers both the theory and application of maintenance procedures and it is expected that a practical approach will be taken throughout the unit.

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Summary of learning outcomes

To achieve this unit a learner must:

1. Investigate and describe **marine pumps and pumping systems**.
2. Examine and describe the types, possible defects and maintenance requirements for **shipboard hotel services equipment**.
3. Analyse **fire safety** in ships.
4. Establish, organise and carryout **maintenance procedures**.

Content

1 Marine pumps and pumping systems

System heads: pump suction and discharge conditions (eg suction and discharge heads, head losses, vapour pressure, net positive suction head, total head)

Types: roto-dynamic pumps (eg centrifugal pumps, both single and double entry, diffuser pumps, axial flow pumps, liquid ring air pumps, regenerative pumps, multi-stage pumps, deep-well cargo pumps); rotary and reciprocating positive displacement pumps (eg gear pumps, screw pumps, progressive cavity pumps, diaphragm pumps, rotary piston pumps, vane pumps, simplex and duplex pumps)

Applications: eg bilge, ballast and seawater systems, tanker cargo systems, water pollution prevention such as, oil-water separators, ballast exchange systems; ram and rotary steering gear systems, tubular and plate type heat exchangers, priming and air handling methods, sealing arrangements, hydraulic balancing, air vessels

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Performance characteristics: typical performance curves for roto-dynamic and positive displacement pumps (eg head, flow, power, efficiency, Net Positive Suction Head available, Net Positive Suction Head required, best efficiency point, shut-off head, pumping in parallel and series, effects of operation under off-design conditions)

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Operational difficulties: cause and identification of difficulty (eg corrosion, erosion, cavitation and vibration, impeller suction and discharge recirculation problems); routine and preventative maintenance procedures for pumps and pumping systems (eg renewal of gland sealing arrangements, checking of internal clearances, manufacturers' manuals/procedures)

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2 Shipboard hotel services equipment

Types and operation: refrigeration (eg operating cycles, storage temperatures, properties of refrigerants, system components, rotary and reciprocating compressors); air-conditioning (eg principles, comfort zone, types of air conditioning systems; zone control, double duct, and reheat systems); bacterial control methods (eg prevention of Legionella bacterium, and mould related illnesses); desalination equipment and potable water systems (eg submerged tube and plate evaporators, flash evaporators, vapour compression plant, reverse osmosis plant); potable water sterilisation and conditioning; sewage handling systems (eg holding tanks, vacuum systems, biological treatment, zero discharge systems)

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Malfunctions: identification and rectification of typical plant operational problems (eg due to component wear, mechanical breakdown and operator error)

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Maintenance procedures: appropriate routine and preventative maintenance procedures on hotel services equipment and components (eg refrigeration - leak detection, addition and removal of refrigerant, servicing driers, compressor valve overhaul, lubrication; air conditioning - monitoring air quality, maintaining plant cleanliness; desalination - scale control, using maintenance chemicals, maintaining reverse osmosis filters; domestic water sterilisation - techniques for confirming effectiveness; sewage systems - safe working practices, maintaining effluent quality standards)

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3 Fire safety

Fire protection systems: fire extinguishing and extinguishing media; portable extinguishers and, fixed installations (eg multi-cylinder and bulk CO₂, foam, automatic sprinkler, water mist and fire main systems); tanker inert gas plant; fire detection equipment (eg thermal, ionisation, flame and smoke detectors)

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Regulatory requirements: fire control plans; fire drills; international shore connection; regulatory measures (eg International Convention for the Safety of Life at Sea regulations, classification society and statutory surveys)

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Causes of fire: ignition of flammable liquid leaks and overflows; hot work; machinery fires and explosions; cargo fires

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4 Maintenance procedures

Establish resources: human and physical resource planning techniques (eg time and resource scheduling techniques, Gant charts, critical path analysis, computer software-based solutions)

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Prepare documentation: record sheets; technical reports; risk assessments; permit to work forms

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Safe working practice: Code of Safe Working Practice; isolation and permit to work procedures

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Routine and preventative maintenance: need for routine maintenance; planned maintenance procedures; recognition of faults; faultfinding procedures

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Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1. Investigate <u>and describe marine pumps and pumping systems</u> .	<ul style="list-style-type: none"> λ determine the total system head for a <u>pumping system</u> λ identify and describe the types and applications of marine pumping systems λ relate pump performance characteristics to pump operation and application λ explain the cause of operational difficulties and describe suitable maintenance strategies.
2. Examine <u>and describe the types, possible defects and maintenance requirements for shipboard hotel services equipment</u> .	<ul style="list-style-type: none"> λ describe types and operation of <u>shipboard hotel services equipment</u> λ recognise symptoms and identify the causes of malfunctions in a <u>shipboard hotel services system</u>. λ propose appropriate maintenance procedures for a <u>shipboard hotel services system</u>.
3. Analyse <u>fire safety in ships</u>	<ul style="list-style-type: none"> λ evaluate fire protection equipment and systems λ relate marine regulatory requirements to shipboard fire protection methods λ recognise causes of incidents involving fire and determine appropriate measures to reduce their occurrence.
4. Establish, organise and carryout <u>maintenance procedures</u> .	<ul style="list-style-type: none"> λ establish resources and requirements for a <u>routine and a preventative maintenance activity</u>. λ prepare documentation necessary to support <u>the maintenance activities</u>. λ select and apply safe working procedures λ undertake <u>and report on the routine and preventative maintenance activities</u>

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Guidance

Delivery

This unit can be delivered as a stand-alone package or integrated into a programme of study.

A practical approach to learning should be adopted wherever possible with tutors providing the sources of information. Aspects of the unit should be delivered in the context of the engineering discipline that the learner is studying.

Assessment

Evidence of outcomes may be generated from activities such as assignments, simulations, case studies and time-constrained assessments. Generally, these will be undertaken individually but the simulations may justify working in groups to produce the necessary evidence. However, assessment evidence must be at an individual level. That is, group or collective evidence would not be acceptable.

Links

This unit links with the BTEC Higher National units *Marine, Plant and Process Principles*, *Marine Propulsion and Power Systems*, *Marine Propulsion Systems*, *Marine Engineering Mechanics* and *Marine Engineering Thermodynamics*.

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Resources

Institutions delivering this unit should possess, or have access to a wide range of marine plant. Learners should have access to suitable computer simulation packages to model typical marine/shipboard engineering situations.

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A number of textbooks, periodicals and information booklets relating to marine auxiliary plant and maintenance practice and management are available through normal sources.

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Support materials

Textbooks

Cowley Dr. J – *MEP Series. Volume 1, Part 5 Fire Safety at Sea* (IMarEST, 2002) ISBN 1902536428

McGeorge H – *Marine Auxiliary Machinery* (Butterworth-Heinemann, 1998) ISBN 0750643986

McGeorge H – *General Engineering Knowledge* (Butterworth-Heinemann, 1991) ISBN 0750600063

Hunt E - *Modern Marine Engineer's Manual* (Cornell Maritime Press, 2001) ISBN 0870335375

Guidance

Delivery

This unit may be delivered as a stand-alone package or integrated with other programme modules. If it is delivered in an integrated way, care must be taken to track the assessment evidence for the outcomes back to the unit.

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Wherever possible, a practical approach should be adopted to reinforce the links between the topics covered and current industrial practice (e.g. use of computer based planned maintenance systems). Sections of the unit may also benefit from an industrial input. This may be achieved through guest lecturers or input from the students with specific references to their current or past company practices and procedures.

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Assessment

Evidence of outcomes may be generated through activities such as assignments, or written/oral tests or examinations. Learning and assessment can be across units, at unit level or at outcome level.

Evidence may be accumulated by students building a portfolio of their own 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 can be linked to *Unit 24: Marine Auxiliary Plant*, *Unit 18: Marine Diesel Propulsion and Power Systems* and/or *Unit 19: Marine Turbine Propulsion and Power Systems* which look at the detail and application of the legislation and systems covered in this unit.

Some topics of the unit may form the underpinning knowledge of an appropriate NVQ and it may be beneficial to deliver these topics between sea phases to assist the learner with their later onboard training.

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Resources

Appropriate software packages should be used wherever possible to demonstrate current industrial practice. Access to the Internet is essential along with access to current marine legislation applicable to the unit. Topics may also be reinforced by use of appropriate industry video material.

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Support Materials

Textbooks

Chauval A M — *Managing Safety and Quality in Shipping* (The Nautical Institute, 2000) ISBN 11870077407
Maclachlan M — *The Shipmasters Business Companion* (The Nautical Institute, 1999) ISBN 1870077458
The Nautical Institute - *The Mariner's Role in Collecting Evidence* (The Nautical Institute, 1998) ISBN 1870077059

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Other Publications

Maritime and Coastguard Agency — *Code of Safe Working Practices for Merchant Seamen* (Maritime and Coastguard Agency, 1998)

International Maritime Organisation Conventions:

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78)

International Convention for the Safety of Life at Sea (SOLAS), 1974

Standards for Training, Certification and Watch keeping of Seafarers (STCW 78 as amended in 95)

UNIT 25: Marine Law and Conventions

Unit Value: 1
Unit level: H1
Unit code:

Description of unit

This Unit is about the relationship between law, codes and other forms of guidance, and it develops an awareness of the law, codes and guidance relating to ship and crew safety and operations. It is primarily intended for candidates who intend to seek sea-going employment as a Merchant Navy Marine Engineering Officer however it could be studied by someone with an interest in the subject area.

Content

1. Law, codes and other forms of guidance, The requirements of records for commercial and legislative purposes;

International Conventions and Treaties, legislation, Codes of Practice and M Notices, an overview of UK Civil and Criminal Law, an overview of Flag and Port State Control, recording methods available; written records, automatic data recorders, requirement for

accuracy in record keeping, confidential nature of records and the access that can be afforded them: commercial, legal, personal

2. Personal and corporate penalties, for unlawful Acts or Omissions and for breaches of company regulations, The law, codes, principles and procedures and other forms of guidance of;

LSA, FFA, , ISM or relevant Codes, The fundamental principles of anti-pollution legislation, MARPOL Convention, Annexes and related legislation, Company procedures for compliance with MARPOL, Penalties for non-compliance

3. Agreements and conventions

Agreements and conventions

Certification

Loadlines

SOLAS

MARPOL

Health Regulations

Safety of Ship, passengers, crew and cargo

National legislation for implementing International agreements

Conditions for issuing, validity, extension and content of statutory certificates and documents

4. The principles and application of UK and international legislation including the principles of UK and international legislation including:

The laws of contract, tort and agency

Liens

Arbitration

UNCLOS III

Statutory and other records including the OLB and ORB

Legal responsibility of the master with respect to:

Distress

Collision

Encountering navigational hazards

Pollution

Salvage

Towage

Pilotage

The application of UK and international legislation including

Flag State Surveys

Classification and other surveys

Port State Control surveys

Record keeping and the collection of evidence

Outcomes and assessment criteria

Outcomes	Assessment criteria
1. Appreciate the relationship between law, codes and other forms of guidance	<p>To achieve each outcome a student must demonstrate the ability to:</p> <ul style="list-style-type: none"> • differentiate between laws, codes and guidance • give an overview of UK civil and criminal law, flag and port state control and penalties
2. Demonstrate an awareness of the law, codes and guidance relating to ship	<ul style="list-style-type: none"> • explain the requirement for accuracy in record keeping • demonstrate an awareness of the law, codes, principles and procedures and other forms of guidance relating to safety and

and crew safety and operations	<p>safety equipment and the organisation and management of the crew</p> <ul style="list-style-type: none"> • explain the fundamental principles of anti-pollution legislation
3. Explain the agreements and conventions to ensure safety of life at sea and the protection of the marine environment	<ul style="list-style-type: none"> • explain the agreements and conventions to ensure safety of life at sea and the protection of the marine environment
4. Explain the principles and application of UK and international legislation	<ul style="list-style-type: none"> • explain the principles of UK and international legislation • explain the application of UK and international legislation

Resources

International Conventions, Statutory Instruments, Codes and guidance

Delivery

The content of this unit forms part of the underpinning knowledge for the N/SVQ Marine Vessel Operations and reflects the content of international Standards of Training Certification and Watch-keeping (STCW) as amended in 1995

Unit 26: Managing the Work of Individuals and Teams

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H2

Description of unit

This unit is designed to develop the learner's knowledge and understanding of the issues involved in managing the work of individuals and teams employed in the engineering industries. It is intended to enhance the ability of the learner to motivate individuals and maximise the contribution that teams can make to the quality of service and improvements in the performance of a business.

Summary of learning outcomes

To achieve this unit a learner must:

1. Establish the **objectives of individuals**
2. Evaluate the **performance of individuals**
3. Establish the **roles and responsibilities of teams**
4. Review the **performance of teams**.

Content

1. Objectives of individuals

Job descriptions: analysis of jobs, behaviour, responsibilities and tasks; pay, bonus and incentives

Responsibilities: direct and indirect relationships

Performance targets: personal; financial; quantity and quality; incorporation within a job description; setting and monitoring performance targets

2. Performance of individuals

Individual appraisal systems: reasons for using performance appraisals (eg to determine salary levels and bonus payments, promotion strengths and weaknesses, training needs, communication); establishing appraisal criteria (eg production data, personnel data, judgemental data); rating methods (eg ranking, paired comparison, checklist, management by objectives)

Staff appraisal: conduct of performance reviews (eg by supervisor, peers, committee, subordinates or self-appraisal); feedback of results and resolution of conflicts; encouragement as a motivator for the achievement of performance targets

3. Roles and responsibilities of teams

Teams: management teams and peer groups (eg focus groups, task groups, project groups and panels); purpose of teams (eg long and short-term, specific project or task, view-seeking both within the company and from external sources, communication)

Team responsibilities: to superiors, subordinates, the business, each other and external groups (eg meeting performance targets; communicating results; confidentiality; deadlines)

Internal team management: hierarchical; functional

4. Performance of teams

Team appraisal systems: reasons for appraising team performance (eg team effectiveness, contribution to business, constitution of team, identifying individuals' contribution to team effort and determining the need to establish other team criteria); performance measurement criteria (eg outcome data, achieved improvements, employee morale, value added)

Team appraisal: conducting team performance reviews (eg by an individual manager, a group of managers, an outside person or team self-appraisal); feedback of results and resolution of conflicts within the team; encouragement of overall team performance as a motivator for the achievement of business objectives

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Establish the objectives of individuals	<ul style="list-style-type: none">λ analyse a job within the engineering sector and identify the essential elements of the job descriptionλ design a job description for an employee working within the engineering sectorλ determine the roles and responsibilities of individualsλ agree performance targets for an individual.
2 Evaluate the performance of	<ul style="list-style-type: none">λ explore the key factors in establishing a staff appraisal

individuals	system <ul style="list-style-type: none"> λ produce a staff appraisal form for use by a manager working in the engineering sector λ provide feedback to an individual who has undergone an appraisal λ encourage an individual to achieve performance targets.
3 Establish the roles and responsibilities of teams	<ul style="list-style-type: none"> λ identify teams suitable for a variety of purposes within the engineering sector λ determine the responsibilities of teams to different groups λ set suitable targets for teams working within the mechanical engineering sector λ compare various types of internal team management.
4 Review the performance of teams	<ul style="list-style-type: none"> λ identify the reasons for appraising team performance λ establish the criteria by which the performance of different types of teams are to be measured λ conduct a performance review of a team working within the engineering sector λ summarise the factors that are likely to motivate a team to achieve its defined objectives.

Guidance

Delivery

Learners are generally expected to work individually but may also work as teams to cover certain aspects.

Assessment

Evidence of outcomes may be in the form of assignments, projects or completed tests/examinations. Ideally, learners should be employed or have experience in an occupation which relates to the unit. Alternatively, suitable work-based experience may be appropriate. However, they will need some experience of supervision or management to fully benefit from the unit. Some assignments or projects should be work-based to relate the unit content to real-life situations.

Links

Entry requirements are at the discretion of the centre. However, it is recommended that learners should have already gained a BTEC National in Engineering or an equivalent qualification.

Resources

Learners should have access to a learning centre that has a range of textbooks relating to human resource management preferably in engineering based settings.

Additionally, suitable guest speakers might be invited to provide an overview of relevant aspects of the unit, which might include applications of personnel/human resource management, motivation, organisational structures, management and appraisal techniques.

Support materials

Textbooks

Armstrong M – *A Handbook of Human Resource Management Practice* (Kogan-Page, 2001) ISBN 0749433930

Armstrong M – *Performance Management* (Kogan-Page, 2000) ISBN 0749426284

Armstrong M – *Managing People: a Practical Guide for Line Managers* (Kogan-Page, 1999) ISBN 0749426128

Cushway B – *Human Resource Management* (Kogan-Page, 1994) ISBN 0749411724

Hunt J – *Managing People at Work* (McGraw-Hill, 1992) ISBN 007707677X

Smith D – *Developing People and Organisations* (Kogan-Page, 1998) ISBN 0749426802

Torrington, Hall and Taylor – *Human Resource Management* (Prentice Hall, 2001) ISBN 0273646397

Unit 27: Health and Safety and Risk Assessment

Learning hours: 60

NQF level 4: BTEC Higher Nationals - H1

Description of unit

This unit develops learner awareness of the principles of health and safety planning and implementation in an industrial environment (eg manufacturing, service industries, telecommunications, etc.). The unit also considers current UK and EU health and safety legislation together with the concepts of risk assessment and its evaluation when applied to any potential hazard. This is followed by the applications of risk management techniques in the context of risks to life, property and general engineering activities.

Summary of learning outcomes

To achieve this unit a learner must:

1. Select and apply **safe working procedures** to industrial operations
2. Apply **current health and safety legislation**
3. Analyse systems for the **assessment of risk**
4. Apply **risk management** to life, property and activities.

Content

1 Safe working procedures

Permit-to-work: types; HSE Guidance Notes; hot cold entry; buddy and plant identification systems

Isolations: eg lock, multi-lock, blank off, removal, electrical, peg removal, linked valve key, SDNT valves

Monitoring equipment: eg noise, dust, fumes, temperature, movement, radiation, costing

Protective clothing and equipment: eg chemical, temperatures, crush resistance, noise protection, visor, goggle usage, electrical isolation, radioactive protection

2 Current health and safety legislation

Current regulations: relevant and current UK and EU regulations (eg COSHH, noise at work, pressure systems, manual handling, personal protective equipment, control of asbestos,

Health and Safety at Work Act, management of health and safety at work, IEE wiring regulations, EMC directive) on typical engineering operations (eg engineering production and manufacture, engineering services, materials handling, telecommunications and transportation)

HSE Inspectorate: role; span of authority; right of inspection; guidance notes and booklets

Safety audits: policies; record keeping; safety surveys; training; proformas; management commitment; planning

Codes of practice: use of Applying Technology for codes and regulations; awareness of relevant codes of practice (eg HSE guidance, Occupational Exposure Standards, etc.)

3 Assessment of risk

Hazard: eg fire, noise, temperature, field of vision, fumes, moving parts, lighting, access, pressure, falling bodies, airborne debris, radiation and chemical hazards, etc.

Risk rating: matrix production (eg low risk, moderate risk, substantial risk, high risk)

Frequency: rate of occurrence (eg improbable, possible, occasional, frequent, regular, common)

Severity: definitions of consequence; level of injury (eg graded: trivial, minor, major, multiple major, death, multiple death)

Record: systems; production of proforma for each hazard; types of recording systems; employee training; company awareness

4 Risk management

Evidence: to support the likelihood of or reoccurrence of a risk; statistical data (eg fatigue charts, working hours, temperature, lighting levels, noise, incorrect procedures, working practices, time of day, etc)

Implications: eg threat to life, injuries, property, environment, need to redesign, effect on company, effect on other companies; mandatory factory closure

Information: eg data sheets on substances, factory rules, codes of practice; safe working procedures, hazard identification (eg hard hat area); training in procedures for new staff and contractors

Minimising risk: eg control of known risks, guarding, covering, screening, encasing, design-out; disaster contingency planning, etc.

Implementation: eg management policy, lines of communication, responsibility, safety committees and trade union input

Compliance: knowledge of regulations and guidelines; mandatory compliance with current and relevant regulations (eg HASAWA and HSE; Deposit of Poisonous waste Act, EMC directive, etc.), working towards company risk assessment findings

Outcomes and assessment criteria

Outcomes	Assessment criteria for pass To achieve each outcome a learner must demonstrate the ability to:
1 Select and apply safe working procedures to industrial operations	<ul style="list-style-type: none"> λ evaluate a range of permit-to-work systems and identify isolation requirements for given applications λ use monitoring equipment to ensure the promotion of a safe working environment

	<ul style="list-style-type: none"> λ select and justify choice of protective clothing and equipment to ensure personal protection in a given environment.
2 Apply current health and safety legislation	<ul style="list-style-type: none"> λ identify industrial work areas where current regulations would apply and describe the role of the HSE Inspectorate λ implement a schedule for the setting up of a safety audit system λ select the relevant codes of practice to enhance safety.
3 Analyse systems for the assessment of risk	<ul style="list-style-type: none"> λ identify a hazard and produce a risk rating λ evaluate frequency and severity of an identified hazard λ produce a hazard proforma for a given application λ analyse a recording system that tracks and highlights potential hazards.
4 Apply risk management to life, property and activities	<ul style="list-style-type: none"> λ evaluate evidence that would specify the existence of a risk or risks λ analyse the implications of the risk and the effect on life, property and activities λ obtain and use accurate information on the risk for the protection of others λ produce a report on how best to minimise the risk to people, property and activities and recommend effective methods of implementation and control λ 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.

Guidance

Delivery

A practical approach to learning should be adopted wherever possible with tutors providing the means of sources for information. The tutor should produce a series of co-ordinated assignments covering the outcomes that could be completed within the learner's work place. Feedback, role-play and discussion groups should also be included in the delivery of this unit to allow group development.

Actual safety audits and risk assessments should be undertaken, under guidance, within the college/university workplace or in conjunction with local industry.

Practical work needs to be investigative and offer creative solutions for the reduction of risk.

Assessment

Evidence of outcome may be in the form of assignments and projects. These may be undertaken individually or in small groups (eg not exceeding three). Evidence should be the work of the individual and ideally at unit level, reflecting the strong links between the four outcomes.

Assessment should be of a continuous nature with grading and feedback given at regular intervals after each assignment. Grading criteria must be indicated on each assignment. Special care should be taken with group work assessments to ensure authentic evidence. Peer group grading could be offered under tight control. A final assessment drawing together two or more outcomes should be attempted.

Links

This unit may be linked with all other units in the qualification that have aspects of workplace practice and applications.

Resources

Publications are available from HSE and other regulating bodies relevant to the industry sector. Computer-based software packages for the recording of data and proforma generation. Ideally, centres should establish a library/learning resource centre of material capable of covering all current codes of practice and regulations together with case studies and relevant articles of interest.

Support materials

Textbooks

Health and Safety Executive – *Safety Representatives and Safety Committees* (HSE, 1996) ISBN 0717612201

Health and Safety Executive – *Essentials of Health and Safety at Work* (HSE, 1994) ISBN 071760716X

Health and Safety Executive – *Successful Health and Safety Management* (HSE, 1997) ISBN 0717612767

Health and Safety Executive – *The Costs of Accidents at Work* (HSE, 1997) ISBN 0717613437

Health and Safety Executive – *Health and Safety in Engineering Workshops* (HSE, 1999) ISBN 0717617173

UNIT 29: Safety at Sea

Learning hours: 45

Unit value: 1

Unit level: H1

Unit code: College Devised (.....)

Description of unit

This unit develops themes introduced in Unit 12 Emergency Response and Communications it is about developing emergency and damage control plans to handle emergency situations and the action to take as Master in the event of emergencies at sea or in port. It is also about how to co-ordinate search and rescue operations.

Summary of outcomes

To achieve this unit a student must:

1. Develop **emergency and damage control plans**
2. Explain the **implementation of emergency and damage control procedures** in response to navigational and operational emergencies

3. Explain how to co-ordinate **search and rescue operations emergency and damage control plans**

-

- **Content**

1. Emergency and damage control plans

Prepare plans for response to emergencies, including:

Responding to distress and medical emergencies

Main engine failure

Steering gear failure

Man overboard

Fire

Dragging anchor

Imminent collision and collision

Stranding and grounding

Flooding

Passenger and cargo emergencies

Stability emergencies

Enclosed space rescues

Pollution

Parting of lines and tow ropes

Piracy, terrorist activity, armed robbery and other security issues

Port of refuge

Abandon ship

In each case the following is to be included in compliance with shipboard contingency plans, standing orders and company instructions and guidance:

Precautions for the protection and safety of persons on board

Initial actions and response

Communications and signals required

Procedures to be followed

Pollution and damage control

2. Implementing emergency and damage control procedures

- *The value of drills and other training to cope with emergencies.*

The drills, and their organisation, required to comply with current national and international legislation in respect of the situations listed in (1.) above.

The action to take as Chief Engineer/Second Engineer in the event of emergencies at sea or in port, as applicable, including the situations shown in (1.) above.

Emergency towing arrangements and procedures

Procedures for refloating a vessel with and without assistance

3. Search and rescue operations

The obligations and responsibilities for assistance at sea and the action to be taken to render assistance

IAMSAR Manual

Annual Summary of Admiralty Notices to Mariners - Notice 4

Consultation with other stations answering the distress

Legal obligations

Exemptions from answering a distress

Logbook entries

Plan and prepare a search

Categories of distress incidents: Coastal and ocean

Abbreviations, terms and definitions

Communications: internal and external
 Co-ordination of search and rescue operations
 Designation of SMC and OSC and their responsibilities
 Responsibility of other craft in the co-ordinated search
 Search patterns taking into account drift, leeway, visibility and type of assistance available
 Drift patterns of disabled vessels with relation to wind and currents
 Rendezvous
 Establish a datum point before commencing search pattern
 Contingency planning and training

Conduct a search

Proceeding to the area of distress
 On board preparation
 Action by assisting ships
 Approaching the scene, radar search
 Arrival on scene, implement search plan
 Assistance by SAR aircraft
 Homing on radio signals
 Aircraft casualties

Conduct a rescue

When survivors in the water/boats/rafts
 From ditched aircraft
 Fire
 Heavy weather
 Evacuation by helicopter

Terminate SAR operations

Care for and questioning of survivors
 Decision to terminate, factors to consider
 Reports to authorities

Outcomes and assessment criteria

Outcomes	Assessment criteria
1. Develop emergency and damage control plans	<p>To achieve each outcome a student must demonstrate the ability to:</p> <ul style="list-style-type: none"> • develop emergency and damage control plans to handle emergency situations
2. Explain the implementation of emergency and damage control procedures in response to navigation and operational emergencies	<ul style="list-style-type: none"> • effectively plan and evaluate drills to comply with current national and international legislation in respect of two samples each of incidents, procedures and emergency situations • explain the action to take as master in the event of a sample of emergencies at sea or in port • explain emergency towing arrangements and procedures
3. Explain how to co-ordinate search and rescue operations	<ul style="list-style-type: none"> • explain the obligations and responsibilities for assistance at sea and the action to be taken to render assistance • effectively plan and prepare a search • explain how to conduct an effective search and rescue, and how to terminate operations

Guidance

Generating evidence

Evidence of outcomes may be in the form of assignments case studies, 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.

All outcomes may be used to assess the higher level achievement of the Merit and Distinction grades

Links

This unit develops themes introduced in Unit 12 Emergency Response and Communications and is closely integrated with Unit 11 Navigation Watch III.

The Unit also offers opportunities for demonstrating Common Skills in Managing and Developing Self (2 &4), Communicating (8, 9 & 10 &11), Managing Tasks and Solving Problems (12, 13 & 14) and Applying Design and Creativity (17 &18)

Resources

Regulations, manuals and guidance notes

Delivery

The content of this unit forms part of the underpinning knowledge for the N/SVQ Marine Vessel Operations and reflects the content of international Standards of Training Certification and Watch-keeping (STCW) as amended in 1995

This is an optional unit and it is expected that it will be delivered during the final stages of this HND when candidates can use their sea service and experience as a watch-keeping officer to gain maximum benefit.

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Delivery

A practical approach to learning should be adopted wherever possible, with tutors providing relevant examples of the application of theory in practice. Practical work needs to be investigative, to give students opportunities to provide evidence for distinctive performance. Visits to industrial installations will be of value for the achievement of Outcomes 2,3 and 4 if College facilities are not available.

Suggested reading

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Boxer, G. - *Engineering Thermodynamics* (Macmillan, 1987)

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Work and Heat Transfer

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different types of design of

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Used In Marine Diesel Engines.

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As Applied To Marine Diesel Engines.

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. Breakdown maintenance.

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and necessary protection devices in case of abnormal operation.

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and the impact of Marpol and US Legislation on the design and operation of diesel engines.

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abnormal operating procedures

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and methods used to increase the operating efficiency.

Describe the various mountings and fittings that allow the safe operation of marine boilers.

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Evidence is likely to be at outcome level in order to provide for maximum flexibility of delivery.

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, ??air vessels??

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(e.g. ram and rotary types)

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(e.g. tubular and plate types).

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