OTHM LEVEL 3 FOUNDATION DIPLOMA IN ENGINEERING

Qualification Number: 603/7030/0

Specification | March 2023

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QUALIFICATION OBJECTIVES

The OTHM Level 3 Foundation Diploma in Engineering has been developed to allow learners to gain understanding and knowledge across a range of Engineering practices.

The qualification enables learners to develop essential knowledge in areas such as engineering principles, design technology, electricity, mechanics, statistics and mathematics.

Successful completion of this qualification will prepare learners for employment in the engineering sector or further learning.

QUALITY, STANDARDS AND RECOGNITIONS

OTHM Qualifications are approved and regulated by Ofqual (Office of Qualifications and Examinations Regulation). Visit the register of Regulated Qualifications.

OTHM has progression arrangement with several UK universities that acknowledges the ability of learners after studying relevant Level 3-7 qualifications to be considered for advanced entry into corresponding degree year/top-up and Master's/top-up programmes.

REGULATORY INFORMATION

Qualification Title	OTHM Level 3 Foundation Diploma in Engineering
Ofqual Reference Number	603/7030/0
Regulation Start Date	14/01/2021
Operational Start Date	18/01/2021
Duration	1 Year
Total Credit Value	60
Total Qualification Time (TQT)	600 Hours
Guided Learning Hours (GLH)	240 Hours
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Overall Grading Type	Pass / Fail
Assessment Methods	Coursework
Language of Assessment	English

EQUIVALENCES

OTHM qualifications at Level 3 represent practical knowledge, skills, capabilities and competences that are assessed in academic terms as being equivalent to GCE AS/A Levels.

QUALIFICATION STRUCTURE

The OTHM Level 3 Foundation Diploma in Engineering consists of 6 mandatory units for a combined total of 60 credits, 600 hours Total Qualification Time (TQT) and 240 Guided Learning Hours (GLH) for the completed qualification.

Unit Ref. No.	Unit Title	Credit	GLH	TQT
M/618/6101	Engineering Principles	10	40	100
T/618/6102	Design Technology	10	40	100
A/618/6103	Electricity	10	40	100
F/618/6104	Mechanics	10	40	100
J/618/6105	Introducing Statistics	10	40	100
L/618/6106	Mathematics	10	40	100

DEFINITIONS

Total Qualification Time (TQT) is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected to be required in order for a Learner to achieve and demonstrate the achievement of the level of attainment necessary for the award of a qualification.

Total Qualification Time is comprised of the following two elements –

a) *the number of hours which an awarding organisation has assigned to a qualification for Guided Learning, and*
b) *an estimate of the number of hours a Learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike Guided Learning, not under the Immediate Guidance or Supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.*

(Ofqual 15/5775 September 2015)

Guided Learning Hours (GLH) is defined as the hours that a teacher, lecturer or other member of staff is available to provide immediate teaching support or supervision to a student working towards a qualification.

Credit value is defined as being the number of credits that may be awarded to a Learner for the successful achievement of the learning outcomes of a unit. One credit is equal to 10 hours of TQT.

ENTRY REQUIREMENTS

OTHM Level 3 qualifications can be offered to learners from age 16.

OTHM does not specify entry requirements for these qualifications. OTHM ensures that learners admitted to the programme have sufficient capability at the right level to undertake the learning and assessment.

OTHM centres must ensure learners are recruited with integrity onto appropriate qualifications that will meet their needs, enable and facilitate learning and achievement enable progression. The qualification is offered in English.

English requirements: If a learner is not from a majority English-speaking country must provide evidence of English language competency. For more information visit English Language Expectations page

PROGRESSIONS

Successful completion of the OTHM Level 3 Foundation Diploma in Engineering provides learners with the opportunity for workplace and academic progressions to a wide range of OTHM Level 4 diplomas. For more information visit www.othm.org.uk.

DELIVERY OF OTHM QUALIFICATIONS

OTHM do not specify the mode of delivery for its qualifications, therefore OTHM Centres are free to deliver this qualification using any mode of delivery that meets the needs of their Learners. However, OTHM Centres should consider the Learners' complete learning experience when designing the delivery of programmes.

OTHM Centres must ensure that the chosen mode of delivery does not unlawfully or unfairly discriminate, whether directly or indirectly, and that equality of opportunity is promoted. Where it is reasonable and practicable to do so, it will take steps to address identified inequalities or barriers that may arise.

Guided Learning Hours (GLH) which are listed in each unit gives the Centres the number of hours of teacher-supervised or direct study time likely to be required to teach that unit.

ASSESSMENT AND VERIFICATION

All units within this qualification are internally assessed by the centre and externally verified by OTHM. The qualifications are criterion referenced, based on the achievement of all the specified learning outcomes.

To achieve a 'pass' for a unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria. Judgement that the learners have successfully fulfilled the assessment criteria is made by the Assessor.

The Assessor should provide an audit trail showing how the judgement of the learners' overall achievement has been arrived at.

Specific assessment guidance and relevant marking criteria for each unit are made available in the Assignment Brief document. These are made available to centres immediately after registration of one or more learners.

OPPORTUNITIES FOR LEARNERS TO PASS

Centres are responsible for managing learners who have not achieved a Pass for the qualification having completed the assessment. However, OTHM expects at a minimum, that centres must have in place a clear feedback mechanism to learners by which they can effectively retrain the learner in all the areas required before re-assessing the learner.

RECOGNITION OF PRIOR LEARNING AND ACHIEVEMENT

Recognition of Prior Learning (RPL) is a method of assessment that considers whether learners can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and do not need to develop through a course of learning.

RPL policies and procedures have been developed over time, which has led to the use of a number of terms to describe the process. Among the most common are:

- Accreditation of Prior Learning (APL)
- Accreditation of Prior Experiential Learning (APEL)
- Accreditation of Prior Achievement (APA)
- Accreditation of Prior Learning and Achievement (APLA)

All evidence must be evaluated with reference to the stipulated learning outcomes and assessment criteria against the respective unit(s). The assessor must be satisfied that the evidence produced by the learner meets the assessment standard established by the learning outcome and its related assessment criteria at that particular level.

Most often RPL will be used for units. It is not acceptable to claim for an entire qualification through RPL. Where evidence is assessed to be only sufficient to cover one or more learning outcomes, or to partly meet the need of a learning outcome, then additional assessment methods should be used to generate sufficient evidence to be able to award the learning outcome(s) for the whole unit. This may include a combination of units where applicable.

EQUALITY AND DIVERSITY

OTHM provides equality and diversity training to staff and consultants. This makes clear that staff and consultants must comply with the requirements of the Equality Act 2010, and all other related equality and diversity legislation, in relation to our qualifications.

We develop and revise our qualifications to avoid, where possible, any feature that might disadvantage learners because of their age, disability, gender, pregnancy or maternity, race, religion or belief, and sexual orientation.

If a specific qualification requires a feature that might disadvantage a particular group (e.g. a legal requirement regarding health and safety in the workplace), we will clarify this explicitly in the qualification specification.

UNIT SPECIFICATIONS

Engineering Principles

Unit Reference Number	M/618/6101
Unit Title	Engineering Principles
Unit Level	3
Number of Credits	10
Total Qualification Time (TQT)	100
Guided Learning Hours (GLH)	40
Mandatory / Optional	Mandatory
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Unit Grading Structure	Pass / Fail

Unit Aims

The aim of this unit is for learners to understand the principles of engineering as a broad discipline and show how engineering has developed historically. Learners will also gain an introduction to fundamental concepts leading to a study of the operation of types of engines.

Learning Outcomes, Assessment Criteria and Indicative Content

Learning Outcomes – The learner will:	Assessment Criteria – The learner can:	Indicative contents
1. Understand applications of SI units and measurement.	1.1 Discuss the historic development of the International System of Units (SI). 1.2 Create a comprehensive table for 22 derived units with special names and symbols. 1.3 Demonstrate ability to use SI units in practical context.	• The International System of Units, universally abbreviated SI (from the French Le Système International d'Unités). Modern metric system of measurement. Established in 1960 by the 11th General Conference on Weights and Measures • The seven SI base units ○ metre for length ○ kilogram for mass ○ second for time ○ ampere for electric current

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kelvin for temperature
candela for luminous intensity
mole for amount of substance

Table should have at least 5 columns - Derived quantity, Name, Symbol, Expressed in terms of other SI units, Expressed in terms of SI base units. An example is given below:

<table>
<tr><th rowspan="2">Derived quantity</th><th colspan="4">SI coherent derived unit</th></tr>
<tr><th>Name</th><th>Symbol</th><th>Expressed in terms of other SI units</th><th>Expressed in terms of SI base units</th></tr>
<tr><td>Plane angle</td><td>radian</td><td>rad</td><td>1</td><td>m/m</td></tr>
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<td>2. Know how to perform engineering calculations.</td>
<td>2.1 Express numerical solutions to a degree of accuracy that is appropriate to the value being calculated.
2.2 Use algebraic expressions.
2.3 Define moments of a force and solve related problems using formula.
2.4 Define work, power and energy and solve related problems using formula.
2.5 Define friction and solve related problems using formula.
2.6 Describe the relationship between</td>
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Degree of accuracy: correct to three significant figures, correct to two decimal places, express a decimal fraction in standard form, express tolerance in terms of limits of size
Algebraic expressions: represent numerical quantities using symbols, apply laws of precedence in the use of precedence (BODMAS)
Moments of a force: define and apply the ‘Principle of Moments’, define the meanings of the terms 'torque' & 'couple'
Solve problems: associated with levers and couples

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	temperature changes and changes in length. 2.7 Define types of heat and solve related problems using formula.	work, power and energy define work done in terms of force and distance moved • Work, power and energy: explain what is meant by energy; state that the unit of energy is the joule (J), the unit of power is the watt (W) and the unit of work is the joule (J); define power in terms of voltage/current and work done per second, perform calculations for work, power and energy • Friction: definition, explain coefficient of friction, explain how friction can be reduced, select materials that will rotate, or slide together with low frictional value, perform calculations for friction • Temperature: coefficient of expansion: when an object is heated or cooled, its length changes by an amount proportional to the original length and the change in temperature, if the object is heated or cooled and it is not free to expand or contract (it's tied down at both ends, in other words), the thermal stresses can be large enough to damage the object, or to damage whatever the object is constrained by, for example bridges have expansion joints in them to stop this. • Heat: define: specific heat capacity, specific latent heat (fusion, evaporation) solve numerical problems associated with specific heat capacity, specific latent heat of fusion, specific latent heat of evaporation
3. Know how to interpret engineering information.	3.1 Explain the relevance of engineering information. 3.2 Interpret the information that can be extracted from reference charts, tables, graphs and BS EN standards. 3.3 Interpret drawings, dimensioning and labelling.	• Engineering information: BS EN standards, instruction manuals, technical handbooks, tables, charts (including: flow, Gantt, tally), graphs (including histograms, scatter diagrams), Ishikawa diagrams (fishbone diagrams or cause-and-effect diagrams), data sheets, text books and reference materials, computer applications • Reference charts, tables, graphs and BS EN

		standards: tapping sizes and threads, feeds and speeds, cable sizing, PIN configurations, component ratings, welding symbols, machining symbols and tolerances, piping components • Drawings, dimensioning and labelling: projections (orthographic [first angle, third angle], isometric [including exploded], oblique); reference points, lines, edges and surfaces, continuous dimensions, baseline dimensions

Assessment

To achieve a 'pass' for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

Learning Outcomes to be met	Assessment criteria to be covered	Type of assessment
All 1 to 3	All AC under LO 1 to 3	Coursework – The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit.

Indicative Reading list

- Bird, J.O. (2020). *Science and mathematics for engineering*. Abingdon, Oxon ; New York, Ny: Routledge
- Taylor, B.N. (2002). *The international system of units (SI)*. Gaithersburg, Md: U.S. Dept. Of Commerce, Technology Administration, National Institute of Standards and Technology.

Design Technology

Unit Reference Number	T/618/6102
Unit Title	Design Technology
Unit Level	3
Number of Credits	10
Total Qualification Time (TQT)	100
Guided Learning Hours (GLH)	40
Mandatory / Optional	Mandatory
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Unit Grading Structure	Pass / Fail

Unit Aims

The aim of this unit is for learners to understand the development of approaches for solving design problems and the selection of appropriate materials. This unit also enables the learner to develop the skills and knowledge in computer aided design (CAD), in terms of producing 2D drawings.

Learning Outcomes, Assessment Criteria and Indicative Content

Learning Outcomes – The learner will:	Assessment Criteria – The learner can:	Indicative contents
1. Demonstrate knowledge and understanding of engineering products and design.	1.1 Discuss the triggers that stimulate engineering design activity. 1.2 Evaluate commercial, regulatory or public policy-based trends that challenge current technology or design. 1.3 Discuss sustainability issues in product design process.	• The triggers that stimulate engineering design activity, including: ○ market pull/technology push (product and process) ○ demand ○ profitability ○ innovation ○ market research ○ product/process performance issues ○ sustainability (carbon footprint) ○ designing out risk.

		• Design challenges
		  ○ reduction of energy wasted during design of an engineered product
		  ○ reduction of energy wasted during operation of an engineered product
		  ○ reduction of physical dimensions
		  ○ reduction of product mass
		  ○ increase in component efficiency
		  ○ energy recovery features
		  ○ reduced product life cycle costs
		  ○ integration of different power sources for vehicles
		  ○ reduced use of resources in high-value manufacturing
		  ○ designing out risk (for individual employees and customers).
		• Sustainability issues throughout the product life cycle (raw materials, manufacture, packaging and distribution, use and reuse, end of life)

2. Understand how to apply a systems approach to electrical design.	2.1 Explain with examples the systems approach to electrical and electronic design.
	2.2 Explain the applications, function and operation of a range of input and a range of output devices.
		• How to apply a systems approach to electrical design i.e.
		  ○ open and closed loop
		  ○ input, process and output
		  ○ feedback
		  ○ development of system block diagrams
		• Function, application and operation of input devices i.e.
		  ○ switches (i.e. latched and momentary action)
		  ○ photodiode
		  ○ phototransistor
		  ○ LDR
		  ○ NTC thermistor

		◦ microphone • Function, application and operation of output devices, i.e. ◦ piezo-electric buzzers/sounders ◦ lamp ◦ Light Emitting Diode (LED) ◦ LED 7 segment display ◦ Dot matrix display ◦ Liquid Crystal Display (LCD) display module ◦ solenoid ◦ relay ◦ speaker
3. Be able to produce 2D CAD drawings.	3.1 Set drawing parameters on the CAD system. 3.2 Explain the reasons for using structured layers and how they are created. 3.3 Explain the function of the commands used in producing 2D CAD drawings. 3.4 Produce 2D CAD drawings that contain essential technical information.	• Parameters: limits to suit component dimensions and paper size, drawing aids to draw entities accurately (grid spacing, snap interval, object snap mode, orthogonal mode, units benefits and limitations of using the drawing aids) • Layers: apply meaningful names, assign line types, assign colours, control the visibility of layers • Commands: line, polyline, circle, arc, polygon, rectangle, ellipse, doughnut, erase (single entities, multiple entities) • Technical information: projection type (pictorial: isometric, oblique; orthographic: first angle, third angle) units, scale, shape, size including tolerance, surface finish, number off, material requirements, special treatment • Conventions: BS 8888, types of line representation of common features

Assessment

To achieve a ‘pass’ for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

Learning Outcomes to be met	Assessment criteria to be covered	Type of assessment
All 1 to 3	All AC under LO 1 to 3	Coursework – The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit.

Indicative Reading list

- Gindis, E. and Kaebisch, R.C. (2021). *Up and running with AutoCAD 2021: 2D and 3D drawing, design, and modeling*. London, United Kingdom: Academic Press, An Imprint of Elsevier.
- Hamilton, S. (2007). *An analog electronics companion: basic circuit design for engineers and scientists and introduction to SPICE simulation*. Cambridge: Cambridge University Press.

Electricity

Unit Reference Number	A/618/6103
Unit Title	Electricity
Unit Level	3
Number of Credits	10
Total Qualification Time (TQT)	100
Guided Learning Hours (GLH)	40
Mandatory / Optional	Mandatory
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Unit Grading Structure	Pass / Fail

Unit Aims

The aim of this unit is for learners to develop the ability to be able to apply knowledge of AC and DC circuit theory to circuit design. Learners will also understand the fundamental principles of electricity and electromagnetic radiation.

Learning Outcomes, Assessment Criteria and Indicative Content

Learning Outcomes – The learner will:	Assessment Criteria – The learner can:	Indicative contents
1. Understand the functions of basic electrical components within circuits.	1.1 Describe different circuit topography and their effects on components. 1.2 Identify a range of common electrical components and their conventional symbols. 1.3 Describe electrical current and potential difference.	• Topography: form taken by the network of interconnections of the circuit components : Series and parallel circuits: Series parallel, Y, Delta, T • Components and their symbols: Resistors, Capacitors, Light Emitting Diode (LED), Transistors, Inductors, Integrated Circuit (IC) • Electricity flow conventions: Conventional Current Direction, Current versus Drift Speed, The Nature of Charge Flow • Current and potential difference - The potential

		difference (or voltage) of a supply is a measure of the energy given to the charge carriers in a circuit. Units = volts (V). This is the voltage between two points that makes an electric current flow between them. • Current–voltage characteristic or I–V curve (current–voltage curve)
2. Be able to apply AC and DC circuit theory to circuit design.	2.1 Design DC circuits. 2.2 Describe Ohm's law and identify I/V characteristics. 2.3 Calculate total resistance and total current for a circuit that is a combination of resistors connected in series and parallel. 2.4 Explain Kirchhoff's voltage and current laws. 2.5 Discuss how to apply circuit protection.	• Electrical circuits are connected in series or in parallel. Circuit components are shown as symbols. • Circuit layout (e.g. DC power source, resistors in series, resistors in parallel, series and parallel combinations, potential divider) • Application of Ohm's law – discovered by German scientist Georg Simon Ohm: voltage or potential difference between two points is directly proportional to the current or electricity passing through the resistance, and directly proportional to the resistance of the circuit. The formula for Ohm's law is V=IR. • Power calculations : V = IR, P =IV, P = I2R • Application of Kirchhoff's voltage and current laws: • Kirchhoff's current law: the algebraic sum of currents in a network of conductors meeting at a point is zero. • Kirchhoff's voltage law/ Second Law: • The directed sum of the potential differences (voltages) around any closed loop is zero. • Apply circuit protection i.e. fuse, diode, resettable thermal fuse, circuit breaker (e.g. over current and earth leakage types)
3. Understand power supplies and	3.1 Explain an alternating current (AC) supply.	○ Alternating current (AC) - changes direction

power system protection.	3.2 Explain a direct current (DC) supply. 3.3 Draw a labelled block diagram of a stabilised power supply.	periodically. Voltage level also reverses along with the current. AC is used to deliver power to houses, office buildings, etc. ○ Direct current (DC) only flows in one direction, found in electrical cells or batteries ○ Stabilised power supply showing: ○ AC input ○ transformer ○ rectifier ○ smoothing circuit ○ stabilising circuit ○ DC output

Assessment

To achieve a 'pass' for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

Learning Outcomes to be met	Assessment criteria to be covered	Type of assessment
All 1 to 3	All AC under LO 1 to 3	Coursework – The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit.

Indicative Reading list

- Ryan, C. (1986) *Basic electricity: a self-teaching guide*. 2nd ed. John Wiley
- Gussow, M (2011) *Basic Electricity Revised*. Schaum's Outlines
- Cooke, E. et al (2010) *BTEC Level 3 National Engineering Student Book*. Pearson

Mechanics

Unit Reference Number	F/618/6104
Unit Title	Mechanics
Unit Level	3
Number of Credits	10
Total Qualification Time (TQT)	100
Guided Learning Hours (GLH)	40
Mandatory / Optional	Mandatory
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Unit Grading Structure	Pass / Fail

Unit Aims

The aim of this unit is for learners to investigate the motion of particles and objects under the influence of interacting forces. They will also learn about sources of energy and conservation of energy.

Learning Outcomes, Assessment Criteria and Indicative Content

Learning Outcomes – The learner will:	Assessment Criteria – The learner can:	Indicative contents
1. Understand the motion of objects in mathematical terms.	1.1 Explain the relationships between displacement, velocity and acceleration. 1.2 Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs. 1.3 Discuss Newton's Three Laws of Motion with examples.	• Relationships between displacement, velocity, and acceleration ○ Distance is how far an object moves. Distance does not involve direction. Distance is a scalar quantity. ○ Displacement includes both the distance an object moves, measured in a straight line from the start point to the finish point and the direction of that straight line. Displacement is a vector quantity. ○ Displacement in terms of both the magnitude and direction.

		◦ The velocity of an object is its speed in a given direction. Velocity is a vector quantity. ◦ Vector–scalar distinction as it applies to displacement, distance, velocity and speed. ◦ Qualitatively: motion in a circle involves constant speed but changing velocity. ◦ The acceleration of an object can be calculated from the gradient of a velocity–time graph. ◦ Estimate the magnitude of everyday accelerations. • Distance–time graphs: A horizontal line on a distance-time graph shows that the object is stationary (not moving because the distance does not change) A sloping line on a distance-time graph shows that the object is moving. • Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, translating information between graphical and numerical form. • Determine speed from a distance–time graph. • Apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes. • Apply Newton's Second Law to estimate the speed, accelerations and forces involved in large accelerations for everyday road transport. • Apply Newton's Third Law to examples of equilibrium situations.
2. Understand energy changes in a	2.1 Explain the ways energy is stored before and after such changes.	• A system is an object or group of objects. There are changes in the way energy is stored when a

system.	2.2 Calculate the changes in energy involved when a system is changed by: • heating • work done by forces • work done when a current flow 2.3 Calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.	system changes. • Changes involved in the way energy is stored when a system changes, for common situations. For example: ○ an object projected upwards ○ a moving object hitting an obstacle ○ an object accelerated by a constant force ○ a vehicle slowing down ○ bringing water to a boil in an electric kettle. • Calculate the changes in energy involved when a system is changed by: ○ heating ○ work done by forces ○ work done when a current flow • The kinetic energy (K.E.) of a body is the energy a body has as a result of its motion. A body which is not moving will have zero kinetic energy, therefore. • K.E. = ½ mv^2 • **<u>Conservation of Energy</u>** • If gravity is the only external force which does work on a body, then the total energy of the body will remain the same, a property known as the conservation of energy. • Therefore, providing no work is done: Initial (PE + KE) = final (PE + KE) • **<u>Power</u>** Power is the rate at which work is done (measured in watts (W)), in other words

		the work done per second. • It turns out that: Power = Force × Velocity • Calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level. • The kinetic energy of a moving object can be calculated using the equation: *kinetic energy* =0.5 ×*mass* × *speed* ^{2}
3. Understand energy transfer, forces and elasticity.	3.1 Calculate the energy transfer involved when work is done. 3.2 Convert between newton-metres and joules. 3.3 Give examples of the forces involved in stretching, bending or compressing an object. 3.4 Describe the difference between elastic deformation and inelastic deformation caused by stretching forces.	• The work done by a force on an object can be calculated using the equation: work done = force × distance (moved along the line of action of the force) $W = Fs$ work done, W, in joules, J force, F, in newtons, N distance, s, in metres • One joule of work is done when a force of one newton causes a displacement of one metre. 1 joule = 1 newton-metre Students should be able to describe the energy transfer involved when work is done. • The extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded. *force* =*spring constant* ×*extension* $F=ke$

		force, *F*, in newtons, N spring constant, *k*, in newtons per metre, N/m extension, *e*, in metres, m • This relationship also applies to the compression of an elastic object, where '*e*' would be the compression of the object. • A force that stretches (or compresses) a spring does work and elastic potential energy is stored in the spring. Provided the spring is not inelastically deformed, the work done on the spring and the elastic potential energy stored are equal.

Assessment

To achieve a 'pass' for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

Learning Outcomes to be met	Assessment criteria to be covered	Type of assessment
All 1 to 3	All AC under LO 1 to 3	Coursework – The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit.

Indicative Reading list

- Hibbeler, R. (2016) *Engineering Mechanics: statics and dynamics*. 14th ed. Prentice Hall
- Meriam, J. & Krasige, L. (2016) *Engineering Mechanics: dynamics*. 8th ed. John Wile

Introducing Statistics

Unit Reference Number	J/618/6105
Unit Title	Introducing Statistics
Unit Level	3
Number of Credits	10
Total Qualification Time (TQT)	100
Guided Learning Hours (GLH)	40
Mandatory / Optional	Mandatory
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Unit Grading Structure	Pass / Fail

Unit Aims

This unit aims to introduce basic statistical concepts and fundamentals of statistical analysis, as well as build confidence in applying mathematical and statistical thinking and reasoning in a range of new and unfamiliar contexts to solve real-life problems.

Learning Outcomes, Assessment Criteria and Indicative Content

Learning Outcomes – The learner will:	Assessment Criteria – The learner can:	Indicative contents
1. Understand the underpinning concepts relating to the analysis of statistics.	1.1 Discuss language and symbols associated with set theory in the context of probability. 1.2 Represent and interpret probabilities using tree diagrams, Venn diagrams and two-way tables.	• Statistical vocabulary • Definitions and basic concepts • Tree diagrams, Venn diagrams and Two-way tables.
2. Understand a range of data types and their representation.	2.1 Explain characteristics of different data types. Interpret sample data in terms of possible properties of the parent population. 2.2 Discuss variability of data and the main features of a distribution.	• Primary, secondary; categorical, numerical; continuous, discrete. • Sample mean as an estimate of population mean. • Includes understanding that the average from a

		sample will generally be different from the population average. The main features include the central tendency (average) and spread.
3. Be able to calculate and interpret statistical diagrams and measures.	3.1 Create and discuss a range of statistical diagrams appropriate to a variety of types of data. 3.2 Calculate and interpret appropriate measures of central tendency. 3.3 Calculate and interpret appropriate measures of spread.	• Diagrams include: box and whisker plots, dot plots, scatter diagrams, bar charts, pie charts, histograms, frequency charts, cumulative frequency diagrams. • Mean, median, mode. Includes grouped data and calculation or estimation for data in a statistical diagram. • Calculate range, inter-quartile range, semi inter-quartile range. Includes grouped data and calculation or estimation for data in a statistical diagram. *Learners are expected to calculate standard deviation.

Assessment

To achieve a ‘pass’ for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

Learning Outcomes to be met	Assessment criteria to be covered	Type of assessment
All 1 to 3	All AC under LO 1 to 3	Coursework – The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit.

Indicative Reading list

- Johnson, R. & Bhattacharyya, G. (2014) *Statistics: principles and methods*. 7th ed. John Wiley
- Rowntree, D. (2018) *Statistics without Tears: an introduction for non-mathematicians*. Penguin

Mathematics

Unit Reference Number	L/618/6106
Unit Title	Mathematics
Unit Level	3
Number of Credits	10
Total Qualification Time (TQT)	100
Guided Learning Hours (GLH)	40
Mandatory / Optional	Mandatory
Sector Subject Area (SSA)	14.1 Foundations for learning and life
Unit Grading Structure	Pass / Fail

Unit Aims

This unit will develop learners' knowledge and understanding of the mathematical techniques commonly used to solve a range of engineering problems. Learners will be able to use mathematical formulas to solve practical problems commonly found within engineering studies.

Learning Outcomes, Assessment Criteria and Indicative Content

Learning Outcomes – The learner will:	Assessment Criteria – The learner can:	Indicative contents
1. Understand the application of algebra relevant to engineering problems.	1.1 Demonstrate application of algebra i.e. • binomial expansion • factorisation • using the principle of the lowest common multiple (LCM) 1.2 Simplify and solve algebraic equations. 1.3 Demonstrate how to solve linear simultaneous equations with two unknowns using graphical interpretation and algebraic method: elimination method, substitution method. 1.4 Demonstrate how to solve quadratic equations i.e.	• Learners should understand the rules of algebra to simplify and solve mathematical problems for example: • algebraic division • the remainder and factor theorems • $(x+3)(x+2)=x^2+5x+6$ • $(a+b)^4=a^4+4a^3b+6a^2b^2+4ab^3+b^4$ • $bx+by=b(x+y)$ • $\frac{x+2}{5}+\frac{x+4}{3}=\frac{8x+26}{15}$

	sketching of quadratic graphs using the formula
	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
		Using an LCM of 15
		
		• Learners should be taught to simplify and solve equations for example: $5(x-3)-7(6-x)=12-3(8-x)$ leading to a solution that $x=5$
		• Engineering problems are often described using simultaneous equations. Learners should be taught to solve simultaneous equations graphically and by calculation for example:
		    o electrical engineering problems using Kirchhoff's laws forces in a mechanical system using $0.7F_1 + 0.5F_2 = 9$ and $0.3F_1 + 0.4F_2 = 5$, state that when two equations contain two unknowns
		    o such as $3x+7y=10$and $x+4y=6$, such that only one value of x and y exist that will satisfy both equations, are called simultaneous equations
		• Engineering problems can often be described using quadratic equations. Learners should be taught to solve quadratic equations for example:
		    o bending moment (M) of beams $M = 0.4x^2 + 0.47x - 3.2$
		    o fabrication of steel boxes when the volume of the box is, $2(x - 4)(x - 4)$ where "x" is a required dimension
		    o equations of motion
		    $v = u + at$
		    $v^2 = u^2 + 2as$

2. Be able to use geometry and graphs in the context of engineering problems.	2.1 Demonstrate how to use co-ordinate geometry including straight line equations and curve sketching.	• Straight line equations i.e.
		    o equation of a line through two points
		    o gradient of parallel lines

	2.2 Demonstrate graphical transformation.	o gradient of perpendicular lines o mid-point of a line o distance between two points • curve sketching i.e. o graphs of $y = kx^n$ o graphical solution of cubic functions • The behaviour of engineering systems can be described using straight line equations. Learners should be taught how to solve problems using straight line equations for example: o force vs displacement for a linear spring or spring buffer o electrical problems using Ohm's law o Learners should be taught to sketch mathematical functions in order to visualise (and sometimes to solve) problems for example: $y = -3x^2$ $f(x) = x(x-1)(2x+1)$ $m(x) = (2-x)^3$ *Learners can be taught to use spreadsheets to plot and solve cubic functions using trend lines. o Graphical transformations i.e. o translation by addition o transformation by multiplication o Learners should be taught graphical transformations for example: o translation in the *y* direction by adding a whole number to the whole function o translation in the *x* direction by adding a whole number to *x* o multiplying the whole function by a whole

		number ○ multiplying x by a whole number
3. Understand exponentials, logarithms and trigonometry related to engineering problems.	3.1 Demonstrate problem solving using exponentials and logarithms. 3.2 Demonstrate problem solving with arcs, circles and sectors. 3.3 Demonstrate problem solving involving right-angled triangles.	• Many engineering systems and devices can be characterised, and problems solved using exponentials and logarithms for example: • Voltage and current growth in capacitor circuits (RC circuits) • Voltage and current decay in capacitor circuits (RC circuits) • Stress-strain curves for certain engineering materials • Learners should be taught how to solve problems involving exponential growth and decay including use of the exponential and logarithmic functions and the log laws. ○ $y = e^{ax}$ ○ $y = e^{-ax}$ ○ $e^{y} = x$ ○ $\ln x = y$ • Learners should be taught both how to produce and interpret sketch graphs showing exponential growth and decay. • Problem solving with arcs, circles and sectors i.e. ○ the formula for the length of an arc of a circle ○ the formula for the area of a sector of a circle ○ the co-ordinate equation of a circle $(x - a)^2 + (y - b)^2 = r^2$ to determine: centre of the circle

		o radius of the circle
		
		• Problem solving involving right-angled triangles i.e.
		  ○ what is meant by the term "solution of a triangle"
		  ○ Pythagoras' Theorem
		  ○ use of sine, cosine and tangent rule for right-angled triangles
		  ○ the formulae for the area of a right-angled triangle

4. Understand calculus relevant to engineering problems	4.1 Demonstrate problem solving involving differentiation.
	4.2 Differentiate functions of the form:
	
	• $y = x^n$
	• $y = \sin ax$
	• $y = \cos ax$
	• $y = \tan ax$
		• Problem solving involving differentiation i.e.
		  ○ determine gradients of a simple curve using graphical methods
		  ○ the rule to differentiate simple algebraic functions
		  ○ determine the maximum and minimum turning points and the co-ordinates of the turning points by differentiating the equation twice
		• Learners should be taught to solve problems involving differentiation for example:
		  ○ given that an alternating voltage $v = 20\sin 50t$ where v is in volts and t in seconds, calculate the rate of change of voltage at a given time
		  ○ differentiate displacement to get velocity
		  ○ differentiate velocity to get acceleration, where possible problems should be presented in an engineering context.

Assessment

To achieve a 'pass' for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

Learning Outcomes to be met	Assessment criteria to be covered	Type of assessment
All 1 to 3	All AC under LO 1 to 3	Coursework – The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit.

Indicative Reading list

- Croft, A. & Davison, R. (2015) *Mathematics for Engineers*. 4th ed. Prentice Hall
- Attwood, G. et al (2017) *Edexcel AS and A-level Pure Mathematics*. Pearson Education
- Beveridge, C. (2016) *AS and A-level Maths for Dummies*. John Wiley

IMPORTANT NOTE

Whilst we make every effort to keep the information contained in programme specification up to date, some changes to procedures, regulations, fees matter, timetables, etc may occur during the course of your studies. You should, therefore, recognise that this booklet serves only as a useful guide to your learning experience. For updated information please visit our website www.othm.org.uk.