Programme	Matriculation to HND in Electrical and Electronic Engineering and Mechanical Engineering
Course Title	**Fundamentals of Mathematics**
Guided Learning Hours	**48**

Aims

This unit aims to give learners a strong foundation in mathematical skills which will allow them to successfully complete many of the other units within the qualification. Some of the topics learners will be introduced to include indices, algebraic formulas, quadratic equations, radian measure, trigonometry, areas and volumes, statistics and calculus.

Learning Outcomes

On completing this course successfully learners will be able to:

1. Use algebraic methods to solve engineering problems
2. Perform calculations involving trigonometry and standard formulae to determine areas and volumes
3. Perform calculations involving statistics
4. Use calculus to solve engineering problems

Indicative Content

1. Use algebraic methods to solve engineering problems

Indices: Simplify and evaluate algebraic expressions involving negative indices; Evaluate algebraic expressions involving fractional indices expressed in both numerator/denominator and decimal form; Simplify and evaluate algebraic expressions involving whole number indices; Simplify and evaluate algebraic expressions involving negative number indices; Solve algebraic problems involving transposition of terms with indices.

Logarithms: Laws of logarithms ($\log A + \log B = \log AB$, $\log A^n = n \log A$, $\log A - \log B = \log A/B$); Define common logarithms (base 10), natural logarithms (base e); Solve problems using logarithms such as for exponential growth and decay

Linear equations and straight line graphs: Approximate the gradient of a non-linear graph by defining the slope of a secant line between two points on the curve; Understand the accuracy of the above approximation improves when the two points are brought closer together; Approximate areas under non-linear graphs and the x-axis by splitting the region into uniform trapeziums (Non-linear graphs: parabolas, Cubic's, logarithmic, sinusoidal); Understand the accuracy of the above approximation improves as the number of trapeziums within the defined region is increased. Recognize the characteristic graphical and algebraic form of linear functions, (y = mx + c); Sketch graphs of linear functions and identify slopes and intercepts and determine the corresponding linear laws; Solve graphically a pair of simultaneous equations in two unknowns; Identify polynomial functions of order 2 or more results in a non-linear graph; Sketch graphs of simple quadratic functions, identify the intercept and where appropriate the roots; Identify that an odd-degree polynomial possesses at least one real root.

Factorization and quadratics: Multiply expressions in brackets by a number, symbol or by another expression in a bracket; Factorize expressions by extraction of a common factor or by grouping; Solve quadratic expressions of the form $ax^2 = bx + c$ by factorization and by using the quadratic formula.

2. Perform calculations involving trigonometry and standard formulae to determine areas and volumes

Trigonometry: Define trigonometric functions of an acute angle (sine, cosine, tangent); Obtain values for the three trigonometric functions for angles of any magnitude from tables and from a calculator; Determine an acute angle given a trigonometric function value; Determine angles obtained from $\sin^{-1}\theta$; $\cos^{-1}\theta$; $\tan^{-1}\theta$; State the relationships: $\cos\theta = \sin(90° - \theta)$ and $\sin\theta = \cos(90° - \theta)$ for values of θ from 0^o to 90°; Solve practical problems e.g. calculation of the Phasor sum of two alternating currents, resolution of forces for a vector diagram.

Radian Measure: Express angular rotations in multiples of radians (One rotation is 2π radians, (n) rotations is $2\pi n$ radians); Solve problems involving areas and angles measured in radians; length of arc of a circle ($s = r\theta^c$); area of a sector ($A = \frac{1}{2} r^2\theta$).

Mensuration: Use standard formulae to solve surface areas and volumes of regular solids.

3. Perform calculations involving statistics

Definitions: Distinguish between discrete and continuous data, sample and population, frequency and relative frequency, standard deviation and variance.

Representation of data: Determine the range and approximate density of the data and use this information to form appropriate groups (equal and unequal) to cover the set of data; Identify the data using either the frequencies or relative frequencies by suitable fully labelled diagrams (bar charts,

component bar charts, pie charts, pictograms); Use a labelled histogram and frequency polygon to represent a given set of data; Calculate cumulative frequencies and draw an ogive.

Statistical Calculations: Determine from data given the mean, median and mode for ungroup data; Determine from data given the Standard deviation and Variance for both group and ungrouped data; Describe the need to measure the dispersion of data.

4. Use calculus to solve engineering problems

Differentiation: Determination of the differential coefficient; gradient of a curve y = f(x); rate of change; Leibniz notation (dy/dx); differentiation of simple polynomial functions, exponential functions and sinusoidal functions; apply differentiation to problems such as velocity and acceleration; perform calculations involving maxima and minima.

Integration: Define integration as inverse of differentiation; State the importance of the constant of integration; Determine the indefinite integrals $\int y\,dx$ for $y = ax^n$, $y = \sin x$, $y = e^{kx}$; Define $\int_a^b y\,dx$ as the area under the graph between ordinates x = a and x = b; Determine the areas under graphs of simple functions.

Learning Outcomes

Candidates will be able to:

1. Use algebraic methods to solve engineering problems

1.1 Simplify algebraic expressions using the laws of indices
1.2 Simplify and solve common engineering problems using the laws of logarithms.
1.3 Sketch linear and non-linear graphs.
1.4 Determine the area under non-linear graphs using the trapezium rule.
1.5 Solve quadratic equations either by factorization or by the use of the quadratic formula.

2. Perform calculations involving trigonometry and standard formulae to determine areas and volumes

2.1 Solve problems involving trigonometric identities.
2.2 Sketch each of the three trigonometric functions over a complete cycle.
2.3 Solve problems in involving radian measure and the determination of area of a sector and length of an arc.
2.4 Solve problems involving surface areas and volumes of regular solids.

3. Perform calculations involving statistics

3.1 Distinguish between discrete and continuous data.
3.2 Distinguish between sample and population
3.3 Represent ungroup data graphically (bar charts, pie charts)
3.4 Represent grouped data graphically (Cumulative frequency curve, histogram)
3.5 Determine mean, median mode for both grouped and ungrouped data
3.6 Determine standard deviation and variance for both group and ungrouped data.

4. Use calculus to solve engineering problems

4.1 Differentiation simple polynomial, exponential and trigonometric functions.
4.2 Apply differentiation to solve problems involving velocity and acceleration and will as the determination of stationary points.
4.3 Determine the indefinite and definite integrals for simple polynomial, exponential and trigonometric functions
4.4 Determine the area under graphs of simple functions.

Outline Learning Plan:

The outline learning plan has been included in this unit as guidance. It demonstrates one way of planning the delivery and assessment of this unit.

Topic and suggested assignments/Activities	Hours
Tutor led introduction to unit and programme of learning.	0.5
Tutor led demonstration involving the laws of indices and their application using worked examples.	1
Learners complete practice problem solving exercises involving indices.	1.5
Tutor led demonstration involving the laws of logarithms using worked examples. Emphasis is placed on the conversion of indicial to logarithmic expressions to solve problems. Tutor explains how to calculate the value of logarithmic expressions using a calculator.	1.5
Learners complete practice problem solving exercises involving logarithms.	1.5
Tutor led demonstration involving transformation of formulae. Emphasis is placed on students being able to transpose equations involving fractions, powers and roots.	1.5
Learners complete practice problem solving exercises involving transposition.	1.5
Tutor led demonstration involving the procedure for solving simultaneous equations involving two unknowns. Methods discussed are elimination and substitution.	1.5
Learners complete practice problem solving exercises involving simultaneous equations.	1.5
Tutor led demonstration involving the procedure for solving quadratic equations by factorization (extraction of a common factor, grouping) and by using the quadratic formula.	1.5
Learners complete practice problem solving exercises involving quadratic equations	1.5
Tutor led demonstration involving the procedure for solving linear equations and graph sketching. Emphasis is placed on distinguishing between linear and non- linear equations. Demonstrate that all linear equations produce straight line graphs. Using worked examples to calculate the gradient y –intercept of straight line graphs and plotting straight line graphs. Solving simultaneous equations graphically	1.5
Learners complete practice problem solving exercises involving linear equations, graph sketching and the graphical solution of simultaneous equations	1.5
Tutor led demonstration involving the sketching of quadratic and polynomial equation. Determination of the roots of a quadratics equation graphically.	1.5
Learners complete practice problem solving exercises involving the sketching of quadratic and polynomial equations	1.5
Tutor led demonstration involving the use of the trapezium formula to determine the approximate area under non-linear graphs	1.5
Learners complete practice problem solving exercises involving the use of the trapezium rule	1.5
Tutor led demonstration involving the use of trigonometric identities to solve problems. Using worked examples the tutor will demonstrate how to determine the angle and/or length of a	1.5

side of a right angled triangle using simple trigonometric rations (sine, cosine, tangent). Further advanced problems problem would also be consider such as those involving irregular shaped triangles where the Sine rule and Cosine rule must be used.	
Learners complete practice problem solving exercises involving the use of the trigonometric identities to solve various problems such as calculating the Phasor sum of alternating currents or determining the resolution of forces of a vector diagram.	1.5
Tutor led demonstration involving radian measure using worked examples. Emphasis is placed on the conversion of radians to degrees and solving problems involving areas and angles measured in radians.	1.5
Learners complete practice problem solving exercises involving the use of radian measure.	1.5
Tutor led demonstration involving the presentation of data (grouped and ungrouped) graphically. Tutor will explain with the use of examples how to distinguish between discrete and continuous data as well as how to recognize group and ungrouped data. Sample sketches will be presented to guide students in the construction of bar charts, component bar charts, pie charts, pictograms, histograms and cumulative frequency curves.	1.5
Learners complete practice problem solving exercises involving the determination of continuous and discrete data as well as the sketching of bar charts, histograms and cumulative frequency curves.	1.5
Tutor will explain and demonstrate using worked examples how mean, median, mode, standard deviation and variance can be evaluated for grouped and ungrouped data.	1.5
Learners complete practice problem solving exercises involving the calculation of mean, median, mode, standard deviation and variance for grouped and ungrouped data.	1.5
Tutor introduces differentiation as a measure for determining the gradient of a curve or calculating rate of change. Worked examples are used to demonstrate how to determine the differential of simple polynomial, exponential and sinusoidal functions	1.5
Learners complete practice problem solving exercises involving the differentiation of simple algebraic, exponential and sinusoidal functions	1.5
Tutor introduces more advanced problems involving the determination of gradients, velocity and acceleration as well as calculations involving stationary points (maximum and minimum)	1.5
Learners complete practice problem solving exercises involving the use of differentiation to determine gradient, velocity, acceleration and stationary points.	1.5
Tutor introduces integration as the reverse of integration and explains the basic rules for integration placing emphasis on the determination of the indefinite integral and the constant of integration. Worked examples are used to demonstrate how to integrate simple polynomial, exponential and trigonometric functions	1.5
Learners complete practice problem solving exercises involving the integration of simple algebraic, exponential and trigonometric functions	1.5
Tutor lead demonstration involving the determination of the definite integral and determining the areas under graphs.	1.5
TOTAL LEARNING CONTACT HOURS	**48**

Assessment Details

Methods of Assessment	Mid-term Examination	End of Term Examination
Grading Mode	Numeric	Numeric
Weighting %	40	60
Pass Mark%	50 overall	
Outline Details	Two hour unseen closed book examination. (6) structured questions	Three hour unseen closed book examination. (10) structured questions

Essential Learning Resources:

Learners will be given access to a wide range of publications relating to Mathematics from our library facility as well as access to the online EBSCO database.

Textbooks and Manuals

1. Bird J – Engineering Mathematics (Elsevier Science & Technology, 2007)
   ISBN 9780750685559

Websites

1. https://www.khanacademy.org/
2. http://www.mathhelp.com/