7.1.0 ENGINEERING MATHEMATICS I

7.1.01 INTRODUCTION

This module unit is designed to equip the trainee with the knowledge, skills and attitudes to apply Mathematical skills in their trade area.
The trainee is expected to use Advanced Mathematical tables and a non-programmable scientific calculator.

7.1.02 GENERAL OBJECTIVES

At the end of this module unit, the trainee should be able to:

a) understand mathematical concepts relevant to electrical engineering
b) apply mathematical concepts in design work and problem solving in electrical engineering
c) enhance his understanding of analytical concepts in the trade and in life

7.1.03 MODULE UNIT SUMMARY AND TIME ALLOCATION

ENGINEERING MATHEMATICS I

Code	Sub-Module Unit	Content	Time Hrs
7.1.1	Indices and Logarithms	• Indices • Logarithms	4
7.1.2	Algebra	• Simultaneous Equations • Quadratic Equations	4
7.1.3	Trigonometry	• Trigonometric ratios • Factor formulae • Solution of triangles • Trigonometric Equations	8
7.1.4	Hyperbolic functions	• Hyperbolic function	4
7.1.5	Inverse function	• Inverse functions	6
7.1.6	Complex Numbers	• Introduction • Argand Diagram • Operations of Complex Numbers • De Moivre's theorem	6

7.1.7	Coordinate Geometry	• Polar equations • Cartesian equation • Graphs of polar equations • Normals and tangents	6
7.1.8	Permutations and Combinations	• Definition of permutation • Definition of combination • The factorial notation • Expressions involving permutations and combinations • Solution of problems involving permutations and combinations	6
7.1.9	Binomial Expansion	• Binomial theorem Power series using binomial theorem • Roots of numbers using binomial theorem • Estimation of errors of small changes using binomial theorem	6
7.1.10	Calculus I	• Differentiation • Applications of Differentiation	8
7.1.11	Calculus II	• Methods of integration • Application of integration	8
Total Time			**66**

7.1.1 INDICES AND LOGARITHMS

7.1.1T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

a) define the terms base and index.
b) state the laws of indices.
c) perform simple operations of indices
d) define the term logarithm
e) state the laws of logarithms
f) change of bases of logarithms
g) evaluate given expressions using the laws of logarithms
h) apply the laws of logarithms in solving problems.

Content

7.1.1T Definition of base and index
i) a^n where a is the base and n is the index

7.1.1T2 Statement of Laws of indices

i) $(am)(an) = am+n$

ii) $\frac{a^m}{a^n} = am\text{-}n$

iii) $(am)n = amn$

iv) $a0$

7.1.1T3 Operation of indices 1

7.1.1T4 Definition of logarithms

i) $logaP = x$
ii) $P = ax$
iii) $ln\ M = r$
iv) $m = er$

7.1.1T5 Laws of logarithms

i) $log\ AB = -log\ A + log\ B$

ii)

iii) $log\ \frac{A}{B} = log\ A - log\ B$

iv) $log\ Pn = nlog\ P$

v) $logaa = 1$

vi) $loga1 = 0$

7.1.1T 6 Change of bases

i) $log\ aP = \frac{\log_{10} P}{\log_{10} a}$

7.1.1T7 Evaluation of expression using the laws of logarithms

7.1.1T8 Application of the laws of logarithm in solving problems
i) Roots
ii) Powers
iii) Bases

7.1.1C Competence

The trainee should have the ability to: work with logarithms in solving electrical problem

7.1.2 ALGEBRA

Theory

7.1.2T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

a) solve linear simultaneous equations in 3-unknowns
b) solve quadratic equations

c) reduce equations to quadratic equations
d) solve equations reduced to quadratic equations
e) state and use the binomial theorem
f) apply binomial theorem to estimate errors of small changes.
g) solution of linear simultaneous equations

Content

7.1.2T1 Reduction of equations to quadratic equations

7.1.2T2 Quadratic equation

$$3e^{2x}+7e^{x}+3=0$$

$$e^{x}+e^{-x}=2$$

7.1.2T3 Solution of equations reduced to quadratic equations

7.1.2T4 Statement of the Binomial theorem

$$(1+x)^{n}=1+nC_1x+nC_2x^2+.....$$

7.1.2T5 Use the Binomial theorem to derive series of the form $(a+b)^n$ and e^x

7.1.2T6 Application of Binomial theorem to errors

7.1.2T7 Solution of linear problems
i) Small changes
ii) Errors

7.1.3 TRIGONOMETRY

Theory

7.1.3T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

a) define trigonometric ratios, compound angles, double angles and factor formulae
b) Solve triangles, trigonometric equations
c) Define hyperbolic ratios, chx, shx, thx, cosechx, cothx, sechx and their corresponding functions (odd and even)
d) State Osborne's rule and use it to solve hyperbolic equations.

Content

7.1.3T1 Definition of trigonometric equations
i) Compound angles and its derivation
ii) Double angle formulae and its derivation
iii) Factor formulae and its derivation

7.1.3T2 Solve given trigonometric equations
i) Solution of trigonometric equations
ii) Solution of triangles

7.1.3T3 Definition of Hyperbolic ratios

7.1.3T4 Osbome's rule

7.1.3C Competence

The trainee should have the ability to: use simultaneous equations in solving problems in circuit parameters

7.1.4 HYPERBOLIC FUNCTIONS

Theory

7.1.4T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

a) define coshx, thx, sechx, cosechx, cothx.
b) sketch the graphs of chi, shx, sechx, cosechx, and coth.
c) deduce properties such as chi 0-1, chi is even, shx and thx odd functions.
d) evaluate hyperbolic functions for given arguments.
e) verify, simple relationships.
f) state Osborne's rules
g) use Osborne's rule to translate trigonometric identities into hyperbolic identities.
h) solve equations of the form achx, + achx = c.
i) derive series expansions for chx and shx.

Content

7.1.4T1 Definition of chx, shx, sechx, cosechx, cothx.
7.1.4T2 Sketches of chx, sechx, cosechx, cothx.
7.1.4T3 Deduction of properties such as ch x , chx even and shx and thx odd.
7.1.4T4 Evaluation of hyperbolic functions for given arguments ch4, sh3, ch.7s.
7.1.4T5 Verification of the relationships

$$ch^2 x - sh^2 x = 1$$

$$shx - chx = e^x$$

7.1.4T6 Statement of Osborne's rules.
7.1.4T7 Use of Osborne's rules
7.1.4T8 Solution of equations of the form
a ch x + bchx = c
7.1.4T9 Derivation of the series expansion of chx, shx.

7.1.5 INVERSE FUNCTONS

Theory

7.1.5T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to;

a) identify a new-to-one function
b) define a pair of inverse functions where there is one-to-one relationship.
c) identify simple functions of inverse functions.
d) define the inverse functions arcchx, arcshx, and arc tahnx.
e) deduce, the graphs of arcchx, arcshx, and arc tahnx.
f) describe the many value nature of functions
g) define the "principal value" of the inverse trigonometric functions.
h) define the inverse hyperbolic functions.

Content

7.1.5T1 Identification of one-to-one functions.
(f x) = x, f(x) = x f(x) = x3

7.1.5T2 Definition of pair of inverse functions where there is a one-to-one relationship

ex-ex =½ ln 1 + x...ee + ex 1- x

7.1.5T3 Identification of simple functions of inverse functions

7.1.5T4 Definition of inverse functions arc cosx, arcsinx, arc tanx

7.1.5T5 Deduction of the graphs of d above.

$y^2 = x$ (ii) $y^2 + x^2 = 1$

7.1.5T6 Description of the many value nature of functions

7.1.5T7 Definition of the Principal value of inverse trigonometric functions.

7.1.5T8 Definition of the inverse hyperbolic functions arc-chx, arcshx, and arcthx

7.1.6 COMPLEX NUMBERS

7.1.6T *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

a) define a complex number
b) define the conjugate, argument, modulus of a complex number
c) state the complex number in its three forms.
d) represent the complex number on the Argand diagram
e) perform arithmetic operations on complex numbers
f) state and apply de Moivre's theorem
g) apply complex numbers to engineering problems.

Content

7.1.6T1 Definition of complex number

7.1.6T2 Definition of conjugate, argument, modulus of a complex number

7.1.6T3 Statement of complex number in its three forms: - Cartesian, polar, exponent.

7.1.6T4 Representation of complex number on the Argand diagram.

7.1.6T5 Performing of arithmetic operations
i) Addition and subtraction
ii) Multiplication and division

7.1.6T6 Statement and application of De Moivre's theorem
i) Roots of numbers
ii) Derivation of trigonometric identities

7.1.6T7 Application of complex numbers to engineering problems
i) Impedances
ii) Forces
iii) Loci
iv) Zero of functions

7.1.6C Competence

The trainee should have the ability to: solve engineering problems using complex numbers

7.1.7 COORDINATE GEOMETRY

Theory

7.1.7T0 *Specific Objectives*
By the end of the sub module unit, unit the trainee should be able to:
a) Convert polar equations to Cartesian equation
b) Convert Cartesian equation to polar equations
c) Plot graphs of polar equations
d) Determine normals and tangents using co-ordinate geometry.

Content
7.1.7T1 Polar equations
7.1.7T2 Cartesian equation
7.1.7T3 Graphs of polar equations
7.1.7T4 Normals and tangents

7.1.7C Competence
The trainee should have the ability to: work out problems in coordinate geometry.

Suggested Learning Resources
i) Charts
ii) Squared grid-board
iii) Calculators

7.1.8 PERMUTATIOONS AND COMBINATIONS

Theory

7.1.8T0 *Specific Objectives*
By the end of the sub module unit, unit the trainee should be able to:
a) define the term permutation
b) define the term combination
c) express numbers in factorial notation
d) simplify expressions involving permutations and combinations
e) solve problems involving permutation and combination.

Content
7.1.8T1 Definition of permutation
7.1.8T2 Definition of combination
7.1.8T3 The factorial notation
7.1.8T4 Expressions involving permutations and combinations
7.1.8T5 Solution of problems involving permutations and combinations

7.1.8C Competence
The trainee should have the ability to: solve problems in permutations and combinations.

Suggested Learning Resources
- Charts
- Real life situations

7.1.9 BINOMIAL XPANSION

Theory

7.1.9T0 *Specific Objectives*
By the end of the sub module unit, unit the trainee should be able to:
a) state the binomial theorem
b) apply the binomial theorem in deriving

power series of simple functions

c) apply binomial theorem to estimate errors of small changes
d) apply binomial theorem to estimate roots of numbers

Content

7.1.9T1 Binomial theorem
7.1.9T2 Power series using binomial theorem
7.1.9T3 Roots of numbers using binomial theorem
7.1.9T4 Estimation of errors of small changes using binomial theorem

7.1.9C Competence

The trainee should have the ability to: apply binomial theorem to estimating errors

Suggested Learning Resources

- Charts

7.1.10 CALCULUS I

Theory

7.1.10T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

a) define the derivative of function
b) differentiate a function from the first principles
c) refer to the table of derivatives of common functions
d) state and use rules of differentiation
e) determine higher derivatives
f) apply differentiation
g) define partial derivatives of a function of two variables
h) differentiate a function of two variables or more
i) solve problems involving small changes or errors using partial derivatives
j) determine stationary points of functions of two variables

Content

7.1.10T1 Definition of the derivative of a function.
7.1.10T2 Differentiation from the first principles of common functions
{x^n, Sin x, Cosx, e^x, ln x }
7.1.10T3 Reference to tables of derivatives of common functions
7.1.10T4 Statement and use of rules of differentiation
i) Sum
ii) Product
iii) Quotient
iv) Chain
v) Parametric
vi) Implicit
7.1.10T5 Determination of higher derivatives
7.1.10T6 Application of differentiation
i) Stationary points
ii) Curve sketching
iii) Ratios of change
iv) Small errors
7.1.6T7 Derivative of a function of two variables
7.1.6T8 problem solving involving small changes or errors

7.1.6T9 Determination of stationary points of functions of two variables

7.1.11 CALCULUS II

Theory

7.1.11T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

a) define integration as the reverse process of differentiation
b) state the two types of integrals
c) refer to table of indefinite integrals of common functions
d) use methods of integration
e) apply integration.

Content

7.1.11T1 Definition of integration

7.1.11T2 Types of integrals.
i) Definite
ii) Indefinite

7.1.11T3 Reference of table of integrals of common functions

7.1.11T4 Use of methods of integration
i) Substitution
ii) Polynomials, trigonometric, inverse trigonometric, logarithmic, hyperbolic.
iii) Reduction formulae
iv) Partial fractions
v) Integration by parts
vi) Use of complex numbers

7.1.11T5 Application of integration
i) Area
ii) Volume
iii) Mean values
iv) 1st and 2nd moments
v) Centre of mass
vi) Centroids of area and volumes
vii) R.M.S value
viii) Arc length
ix) Time constants
x) R-L-E and R-C-E circuits
xi) Energy of inductor and capacitor

Suggested Learning Resources

- Charts
- Mathematical tables
- Calculators

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests