

Unit 101

Mathematical techniques for engineering applications

Unit summary

This unit is about the understanding and application of fundamental mathematical techniques involved in the analysis of engineering systems.

Aims

The unit aims to equip the candidate with the fundamental mathematics needed to analyse and solve a range of engineering problems.

Prerequisites

Real Numbers, Functions and Algebra: polynomial, logarithmic and exponential functions and their graphs, solutions of systems of linear algebraic equations, graphical and algebraic treatment of inequalities, the binomial theorem with integer exponent.

Trigonometry: the sine and cosine rules and simple trigonometric equations.

Geometry: the Euclidean geometry of the triangle, simple polygons, the circle and elementary solids, geometry of the straight line, the circle in Cartesian co-ordinates and conic sections.

Introduction to differential and integral calculus of one variable.

Learning outcomes

There are **four** outcomes to this unit. The candidate will be able to:

- Use advanced calculus for the mathematical solution of engineering problems
- Solve engineering problems using linear algebra
- Use discrete mathematics for engineering analysis
- Apply probability and statistical principles in engineering applications

Guided learning hours

It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills

This unit contributes towards the Key Skills in the following areas:

N4.1

Develop a strategy for using application of number skills over an extended period of time.

N4.2

Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving:

- deductive and inferential reasoning;
- algebraic manipulation.

N4.3

Evaluate your overall strategy and present the outcomes from your work, including use of charts, diagrams and graphs to illustrate complex data.

Occupational Standards

This unit has been mapped to the following National Occupational Standards:

- 1.1.1 Identify the requirements of clients for engineering products or processes
- 1.4.4 Evaluate designs for engineering products or processes
- 4.2.2 Solve operational problems with engineering solutions
- 6.2.1 Assure the quality of engineering products or processes
- 8.1.1 Maintain and develop own engineering expertise

Unit 101

Mathematical techniques for engineering applications

Outcome 1

Use advanced calculus for the mathematical solution of engineering problems

Knowledge requirements

The candidate knows how to:

- 1 use and apply sequences and series including Taylor's series
 - a general geometric series
 - b infinite series
 - c convergent and divergent sequences and series
 - d power series
 - e binomial series
 - f Taylor's Theorem and series
- 2 apply functions of two or more variables to problem solving
 - a products
 - b quotients
 - c implicit functions
 - d parametric equations
 - e partial differentiation
- 3 apply complex numbers to problem solving using
 - a graphical representation
 - b Cartesian, polar and exponential forms
 - c DeMoivre's theorem
- 4 use vector algebra techniques for solving 3-D spatial problems
 - a components of vectors, scalar and vector products
 - b equations of lines and planes
- 5 use differential and integral calculus of functions of one variable
 - a curvature
 - b maxima, minima and points of inflection
 - c inverse trigonometric functions

- 6 solve ordinary differential equations of first order
 - a by separation of variables
 - b using integrating factor (linear equations)
 - c using trial solutions (linear equations with constant coefficients)
 - d using Complementary Function and Particular Integral
- 7 solve higher-order linear differential equations with constant coefficients
 - a identify Complementary Function and Particular Integral
 - b use of trial functions for CF and PI
 - c use Laplace Transforms
- 8 find coefficients of Fourier series arising in engineering problems
 - a formulae for sine and cosine coefficients
 - b identify even and odd functions

Unit 101

Mathematical techniques for engineering applications

Outcome 2

Solve engineering problems using linear algebra

Knowledge requirements

The candidate knows how to:

- 1 perform matrix algebra operations
 - a product of matrices
 - b determinants
 - c calculate the inverse matrix
 - d row reduction
 - e determine rank of a matrix
- 2 solve linear simultaneous equations relevant to engineering systems
 - a systematic elimination of variables
 - b row reduction of augmented matrix
 - c inconsistency, unique and multiple solutions related to matrix rank
- 3 solve eigenproblems arising from engineering applications
 - a find eigenvalues by solving the characteristic equation
 - b find eigenvectors for known eigenvalues

Unit 101

Mathematical techniques for engineering applications

Outcome 3

Use discrete mathematics for engineering analysis

Knowledge requirements

The candidate knows how to:

- 1 manipulate and simplify Boolean expressions arising from switching circuitry etc.
 - a truth tables
 - b de Morgan's rules

Unit 101

Mathematical techniques for engineering applications

Outcome 4

Apply probability and statistical principles in engineering applications

Knowledge requirements

The candidate knows how to:

- 1 determine mean, standard deviation and variance of discrete and continuous probability distributions
- 2 calculate sample statistics arising from engineering production inspection
- 3 linear regression
- 4 calculate conditional probabilities
- 5 relate the binomial distribution to expansions and calculate probabilities, mean and variance
- 6 relate distributions to histogram representation
- 7 calculate probabilities for a Poisson distribution
- 8 calculate probabilities from the Normal distribution

Unit 101

Mathematical techniques for engineering applications

Recommended reading list

Core texts	Author	Publisher	ISBN
Advanced Modern Engineering Mathematics	James	Addison-Wesley	0130454257
Mathematics for Engineers	Croft, Davison	Pearson	013120193X
Modern Engineering Mathematics	James	Prentice Hall	0130183199
Advanced Engineering Mathematics	Bajpai, Mustoe, Walker	John Wiley	0471925950 o/p
Other useful texts			
Engineering Mathematics	KA Stroud	Palgrave	0333919394