Unit 2: Engineering Maths

Unit code M/615/1476
Unit type Core
Unit level 4
Credit value 15

Introduction

The mathematics that is delivered in this unit is that which is directly applicable to the engineering industry, and it will help to increase students’ knowledge of the broad underlying principles within this discipline.

The aim of this unit is to develop students’ skills in the mathematical principles and theories that underpin the engineering curriculum. Students will be introduced to mathematical methods and statistical techniques in order to analyse and solve problems within an engineering context.

On successful completion of this unit students will be able to employ mathematical methods within a variety of contextualised examples, interpret data using statistical techniques, and use analytical and computational methods to evaluate and solve engineering problems.

Learning Outcomes

By the end of this unit students will be able to:

1. Identify the relevance of mathematical methods to a variety of conceptualised engineering examples.

2. Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages.

3. Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering applications.

4. Examine how differential and integral calculus can be used to solve engineering problems.
Essential Content

LO1  Identify the relevance of mathematical methods to a variety of conceptualised engineering examples

Mathematical concepts:
Dimensional analysis
Arithmetic and geometric progressions

Functions:
Exponential, logarithmic, circular and hyperbolic functions

LO2  Investigate applications of statistical techniques to interpret, organise and present data, by using appropriate computer software packages

Summary of data:
Mean and standard deviation of grouped data
Pearson’s correlation coefficient
Linear regression

Probability theory:
Binomial and normal distribution

LO3  Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering application.

Sinusoidal waves:
Sine waves and their applications
Trigonometric and hyperbolic identities

Vector functions:
Vector notation and properties
Representing quantities in vector form
Vectors in three dimensions
LO4  **Examine how differential and integral calculus can be used to solve engineering problems**

*Differential calculus:*
Definitions and concepts
Definition of a function and of a derivative, graphical representation of a function, notation of derivatives, limits and continuity, derivatives; rates of change, increasing and decreasing functions and turning points
Differentiation of functions
Differentiation of functions including:
  - standard functions/results
  - using the chain, product and quotient rules
  - second order and higher derivatives
Types of function: polynomial, logarithmic, exponential and trigonometric (sine, cosine and tangent), inverse trigonometric and hyperbolic functions

*Integral calculus:*
Definite and indefinite integration
Integrating to determine area
Integration of common/standard functions and by substitution and parts
Exponential growth and decay
Types of function: algebraic including partial fractions and trigonometric (sine, cosine and tangent) functions

*Engineering problems involving calculus:*
Including: 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
<table>
<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LO1</strong> Identify the relevance of mathematical methods to a variety of conceptualised engineering examples</td>
<td><strong>P1</strong> Apply dimensional analysis techniques to solve complex problems</td>
<td><strong>M1</strong> Use dimensional analysis to derive equations</td>
</tr>
<tr>
<td><strong>P2</strong> Generate answers from contextualised arithmetic and geometric progressions</td>
<td><strong>M2</strong> Interpret the results of a statistical hypothesis test conducted from a given scenario</td>
<td><strong>LO1 &amp; 2</strong> &amp; <strong>D1</strong> Present statistical data in a method that can be understood by a non-technical audience</td>
</tr>
<tr>
<td><strong>P3</strong> Determine solutions of equations using exponential, trigonometric and hyperbolic functions</td>
<td><strong>P4</strong> Summarise data by calculating mean and standard deviation, and simplify data into graphical form</td>
<td><strong>D2</strong> Model the combination of sine waves graphically and analyse the variation in results between graphical and analytical methods</td>
</tr>
<tr>
<td><strong>LO2</strong> Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages</td>
<td><strong>P5</strong> Calculate probabilities within both binomially distributed and normally distributed random variables</td>
<td><strong>P6</strong> Solve engineering problems relating to sinusoidal functions</td>
</tr>
<tr>
<td><strong>P7</strong> Represent engineering quantities in vector form, and use appropriate methodology to determine engineering parameters</td>
<td><strong>M3</strong> Use compound angle identities to separate waves into distinct component waves</td>
<td><strong>LO3</strong> Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering application</td>
</tr>
<tr>
<td>Pass</td>
<td>Merit</td>
<td>Distinction</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>LO4</strong> Examine how differential and integral calculus can be used to solve engineering problems</td>
<td><strong>P8</strong> Determine rates of change for algebraic, logarithmic and circular functions</td>
<td><strong>D3</strong> Analyse maxima and minima of increasing and decreasing functions using higher order derivatives</td>
</tr>
<tr>
<td><strong>P9</strong> Use integral calculus to solve practical problems relating to engineering</td>
<td><strong>M4</strong> Formulate predictions of exponential growth and decay models using integration methods</td>
<td></td>
</tr>
</tbody>
</table>
Recommended Resources

Textbooks

Websites
http://www.mathcentre.ac.uk/ Maths Centre (Tutorials)
http://www.mathtutor.ac.uk/ Maths Tutor (Tutorials)

Links
This unit links to the following related units:
*Unit 39: Further Mathematics*