Unit 8: Mathematics for Construction

Level: 4

Credits: 15

Ofqual Code: K/618/8087

Introduction

The aim of this unit is to develop students' knowledge and understanding of the mathematical principles and theories that underpin many aspects of construction technology, structures and materials. Students will be introduced to mathematical methods and statistical techniques so that they can analyse and solve problems in a construction engineering context.

Topics included in this unit are: trigonometry and algebraic mathematical techniques; matrices; statistical techniques; differential and integral calculus; binomial and normal distribution; dimensional analysis; arithmetic progressions; vector analysis.

On successful completion of this unit, students will be able to employ mathematical methods in a variety of contextualised examples; use analytical and computational methods to evaluate and solve engineering construction problems; interpret data using statistical techniques and apply calculus techniques. Students will gain crucial employability skills such as critical thinking, problem solving, analysis, reasoning and data interpretation.

Learning Outcomes

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

LO1 Use analytical and computational methods to solve construction-related problems

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

LO3 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus

LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems.

Essential Content

LO1 Use analytical and computational methods to solve construction-related problems

Analytical methods

Trigonometry

Irregular areas and volumes

Sine rule

Cosine rule

Area of triangles applications

Trigonometry

Coordinate systems

Basic trigonometric ratios and their inverses

Trigonometric ratios for the four quadrants

Solution of triangles

Areas and volumes of regular solids

Algebra

Linear

Simultaneous and quadratic equations (graphical or algebraic solving)

Matrices

Multiplication

Transposition

Inversion (up to 2 × 2)

Application to construction problems

Analysis and design issues

Processes and operations

Resource issues e.g., labour, finance

Project planning

Levelling, contouring

Triangulation, traversing, cut and fill, setting out

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

Statistical methods

Presentation of data (histograms, frequency graphs, cumulative frequency graphs)

Central tendency and dispersion

Dispersion (standard deviation, variance, interquartile range)

Distribution theory: normal distribution

Measures of dispersion (range, variance, standard deviation, quartiles, deciles and percentiles)

Grouped and ungrouped data

Probability theory, binomial and normal distribution

Applications

Presentation of data

Estimation

Prediction

Quality control

LO3 **Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus**

Differential calculus

Basic differentiation techniques applied to algebraic, trigonometric and logarithmic functions

Products and quotients

Function of a function

Second order derivatives

The location of stationary values

Integral calculus

Indefinite and definite integration techniques applied to algebraic, trigonometric and exponential functions

Practical construction problems

Solution of problems involving maxima and minima

Growth and decay

Centroids

Moments of inertia

Areas under curves and volumes of revolution

Use in electrical theory, structural mechanics, fluid mechanics as appropriate

LO4 **Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems**

Trigonometrical techniques

Vector analysis (e.g., static forces, relative motion, frameworks)

Arithmetic progressions

Dimensional analysis

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Use analytical and computational methods to solve construction-related problems</td><td rowspan="4">D1 Evaluate analytical and statistical findings from construction problems completed and justify the techniques adopted to solve such problems.</td></tr>
<tr><td>P1 Solve construction problems using trigonometry techniques.
P2 Solve construction problems using algebraic techniques.</td><td>M1 Apply the use of matrices to solve problems.</td></tr>
<tr><td colspan="2">LO2 Investigate applications of statistical techniques to interpret, organise and present data by using appropriate computer software packages</td></tr>
<tr><td>P3 Apply statistical methods, including the calculation of the mean and standard deviation, to produce accurate and appropriate solutions to construction engineering problems.
P4 Calculate probabilities within both binomially distributed and normally distributed random variables.</td><td>M2 Interpret the results of a statistical hypothesis test conducted from a given scenario.</td></tr>
<tr><td colspan="2">LO3 Illustrate the wide-ranging uses of calculus within different construction disciplines by solving problems of differential and integral calculus</td><td rowspan="2">D2 Analyse differential calculus techniques in the determination of maxima and minima in construction-related problems.</td></tr>
<tr><td>P5 Use differential calculus techniques to solve functions which incorporate: axn, sine ax, cosine ax, loge x, eax and methods including function of a function.
P6 Use integral calculus techniques to determine indefinite and definite integrals of functions involving axn, sine ax, cosine ax, 1/x and eax.</td><td>M3 Apply the rules of integral calculus to determine solutions for complex construction-related problems.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Use mathematical methods to solve vector analysis, arithmetic progression and dimensional analysis problems		
P7 Apply dimensional analysis to solve problems. **P8** Generalise answers from a contextualised arithmetic progression problems.	**M4** Solve construction problems using vector analysis.	**D3** Evaluate the effectiveness and relevance, to the solving of complex construction problems, of the mathematical technique of vector analysis.

Recommended Resources

Print resources

LEVY, S. (2011), *Construction Calculations Manual*, Butterworth-Heinemann

SINGH, K. (2011), *Engineering Mathematics Through Applications*, Macmillan International Higher Education

STROUD, K., BOOTH, D. (2001), *Engineering Mathematics*, Industrial Press Inc.

VIRDI, S., BAKER, R., VIRDI, N. (2014), *Construction Mathematics*, Routledge

Links

This unit links to the following related units:

- Unit 9: Principles of Heating, Ventilation and Air Conditioning
- Unit 16: Principles of Public Health Engineering
- Unit 17: Civil Engineering Technology
- Unit 18: Principles of Electrical Design & Installation
- Unit 19: Principles of Structural Design
- Unit 31: Advanced Structural Design
- Unit 34: Further Mathematics for Construction
- Unit 37: Advanced Heating, Ventilation and Air Conditioning Design & Installation
- Unit 42: Hydraulics
- Unit 49: Advanced Electrical Design & Installation.

Unit 9: Principles of Heating, Ventilation and Air Conditioning

Level: 4

Credits: 15

Ofqual Code: M/618/8088

Introduction

The buildings we use in everyday life – to work, study, socialise and live in – can be increasingly complex in their design, as well as being subject to more stringent environmental targets for emissions. The heating, ventilation and air conditioning systems in buildings play a major role in maintaining the comfort of the occupants and managing environmental impact.

This unit introduces students to the principles of the design and installation of heating, ventilation and air conditioning systems for non-domestic buildings.

In this unit, students will develop an understanding of the components and systems that may be integrated into a building services installation, including key calculations, sizing and specification of non-domestic heating, ventilation and air conditioning systems and components.

Learning Outcomes

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

LO1 Prepare the pre-design information required for a non-domestic heating, ventilation and air conditioning installation

LO2 Analyse the heating and cooling loads for a non-domestic building

LO3 Present a design proposal for a heating, ventilation and air conditioning system for a given non-domestic building type

LO4 Justify the selection of non-domestic heating, ventilation and air conditioning system components for a proposed installation.