

Liverpool John Moores University

Title: BUILDING SERVICES ENGINEERING MATHEMATICS & APPLIED MECHANICAL SCIENCE
Status: Definitive
Code: **5505BEFDL** (118287)
Version Start Date: 01-08-2011
Owning School/Faculty: Built Environment
Teaching School/Faculty: Built Environment

Team	Leader
Derek King	

Academic Level: FHEQ5 **Credit Value:** 24.00 **Total Delivered Hours:** 111.00
Total Learning Hours: 240 **Private Study:** 129

Delivery Options

Course typically offered: Standard Year Long

Component	Contact Hours
Lecture	72.000
Practical	12.000
Tutorial	24.000

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Exam	Exam		80.0	3.00
Report	Lab report		20.0	

Aims

This module aims to provide students with the fundamental mathematical and scientific knowledge and analytical techniques to support the mathematical and analytical functions required in other modules of the programme. This module is further intended to enable students studying the mechanical pathway of the Building Services programme to apply the mathematical and analytical techniques associated with the principles of fluid flow, heat transfer and thermodynamic cycles to real

situations.

Learning Outcomes

After completing the module the student should be able to:

- 1 Construct differential equations for the purpose of solving building services engineering problems.
- 2 Demonstrate a knowledge of the properties of trigonometrical functions and relate these to the characteristics of wave forms.
- 3 Analyse and solve problems using statistics and probability.
- 4 Analyse modes of heat and vapour transfer and apply the principles to building services engineering.
- 5 Investigate the performance of heat exchangers commonly found with building services plant and installations.
- 6 Investigate thermodynamic cycles and how these relate to refrigeration plant and components.
- 7 Apply the principles of dimensional analysis to fundamental and empirical formulae.

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

Exam	1	2	3	4	7
Lab based reports	5	6			

Outline Syllabus

Differential Equations: General and particular solutions. Boundary condition.

Differential equation models in building services engineering.

Trigonometrical Functions: Properties of waves: Amplitude, wavelength, frequency, phase difference, etc

Graphs: $\sin \theta$, $\cos \theta$, $\sin 2\theta$, $\sin \theta/2$ etc.

Trigonometrical identities: $\sin \theta/\cos \theta = \tan \theta$, $\sin^2 \theta + \cos^2 \theta = 1$, compound angle formula, etc

Addition of wave-forms: $a \sin \theta + b \cos \theta = R \sin (\theta \pm \alpha)$

Statistics and Probability: Mutually exclusive and independent events. Binomial, Poisson and normal distributions.

Matrices: Multiplication, transposition and inversion, applications.

Convection: use of bulk, arithmetic mean temperature difference (AMTD) and log mean temperature difference (LMTD) in free and forced convection processes.

Grashoff, Nusselt, Reynolds, Prandtl dimensionless groups. Heat transfer coefficients and heat flux.

Radiation: Reflectivity, transmissivity, absorptivity, emissivity for different surfaces.

Wave characteristics and parameters associated with electromagnetic radiation.

Variation of black body emissive power. Use of form factors to determine radiant heat exchange. Applications of radiant heat transfer in building services. Plane

radiant temperature, vector radiant temperature, discomfort due to asymmetric radiation. Causes of discomfort asymmetry.

Vapour transfer: principles of vapour transfer. Moisture transfer through composite structures. Problems associated with condensation and its prevention. Vapour mass transfer within building services applications.

Heat exchangers: Identification of modes of heat transfer within building services equipment and applications. heat exchanger construction, characteristics, fluid flow paths, pressure drop, design, types and classification. (e.g. Shell and Tube, Shell and

Coil, Tube in Tube and Plate etc). Thermal transmittance through the heat exchanger boundary wall, solid boundary and boundary layers.

Resistances and factors, effectiveness and loss of performance. Rate of heat exchange in parallel flow and counterflow. Performance using Effectiveness, Capacity Ratio, Number of Transfer Units (NTU) and LMTD for parallel flow and counterflow. Cross flow heat exchangers. Performance of heat exchangers for evaporating and condensing fluids in single and two-phase fluid condition.

Thermodynamic cycles: Use of T-S and p-H diagrams to construct heating and cooling refrigeration cycles. Thermodynamic processes in refrigeration cycles, heat pumps and heat engines. Comparison between practical refrigeration/heat pump cycle and the Carnot Cycle. Performance analysis of refrigeration/heat pumps in cooling and heating modes. Mass flow rates, input power, capacity, efficiencies, temperature and COP for theoretical and actual cycle arrangements.

Dimensional analysis: units and dimensions in commonly used terms and parameters, Checking rational formulae. Identify dimensionless groups in rational and empirical formulae eg Reynolds Number, Grashof Number, Nusselt Number and Prandtl Number etc.

Application of dimensional analysis: Derivation of appropriate rational and empirical building services formulae from known variables. Application of dimensional analysis to solve appropriate problems related to building services applications.

Learning Activities

Lectures, tutorials, laboratory practical work.

References

Course Material	Book
Author	Greer, A. & Taylor, G.
Publishing Year	2004
Title	Mathematics for Technicians
Subtitle	
Edition	
Publisher	Nelson & Thorns
ISBN	928-0-7487-7949-9

Course Material	Book
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Author	Bird, J.
Publishing Year	2009
Title	Basic Engineering Mathematics
Subtitle	
Edition	5th
Publisher	Newnes
ISBN	0-7506-6575-0

Course Material	Book
Author	Moss, K.
Publishing Year	1998
Title	Heat and Mass Transfer in Building Services Design
Subtitle	
Edition	
Publisher	Spon Press
ISBN	419-22650-8

Course Material	Book
Author	Moss, K.
Publishing Year	2003
Title	Heating and Water Services Design in Buildings
Subtitle	
Edition	2nd
Publisher	Spon Press
ISBN	0-415-29185-2

Course Material	Book
Author	Beggs, C.
Publishing Year	2002
Title	Energy
Subtitle	Management, Supply and Conservation
Edition	
Publisher	Butterworth-Heinemann
ISBN	0-7506-5096-6

Course Material	Book
Author	Cengel, A.Y. Boles, M.A.
Publishing Year	2002
Title	Thermodynamics
Subtitle	An Engineering Approach
Edition	4th
Publisher	McGraw-Hill
ISBN	0-07-115071-4

Notes

This module is a specialist module for students pursuing the mechanical building services pathway. It aims to support and contextualise mathematical and analytical techniques, and other specialist scientific knowledge, such as principles of fluid flow, heat transfer and thermodynamic cycles to realistic applications.