

## Liverpool John Moores University

Title: MATHEMATICS & SCIENCE FOR BUILDING SERVICES APPLICATIONS  
Status: Definitive  
Code: **4500BEFDL** (118276)  
Version Start Date: 01-08-2011  
Owning School/Faculty: Built Environment  
Teaching School/Faculty: Built Environment

| Team       | Leader |
|------------|--------|
| Derek King |        |

**Academic Level:** FHEQ4      **Credit Value:** 24.00      **Total Delivered Hours:** 121.00  
**Total Learning Hours:** 240      **Private Study:** 119

### Delivery Options

Course typically offered: Standard Year Long

| Component | Contact Hours |
|-----------|---------------|
| Lecture   | 84.000        |
| Practical | 10.000        |
| Tutorial  | 24.000        |

**Grading Basis:** 40 %

### Assessment Details

| Category | Short Description | Description                          | Weighting (%) | Exam Duration |
|----------|-------------------|--------------------------------------|---------------|---------------|
| Exam     | Exam              | Formal examination                   | 60.0          | 3.00          |
| Report   | Report            | Report based on practical activities | 40.0          |               |

### Aims

*To provide the students with an understanding of the fundamental principles and concepts used in a wide range building services applications and the range of mathematical techniques needed to solve related problems. The module aims to provide a fundamental understanding of both the mathematical techniques and scientific principles essential to allow the various Building Services specialists to integrate and communicate effectively and a basis from which the more specialised*

*services applications can be developed. The module explores core fundamental principles of thermal comfort, fluid flow, heat transfer, sound & acoustics and alternating electrical quantities.*

*The knowledge and skills acquired in this module underpin most other modules in the Building Services Engineering HNC and FD programmes.*

## **Learning Outcomes**

After completing the module the student should be able to:

- 1 Use the laws of indices and logarithms in the solution of building services engineering problems.
- 2 Apply complex numbers, using 'j' notation in the solution of building services applications.
- 3 Apply the techniques of differentiation and integration to the solution of building services engineering problems.
- 4 Use mathematical and computer techniques to compare statistical data and solutions obtained from building services and construction problems.
- 5 Apply deterministic and adaptive models of thermal comfort and the basic principles of heat transfer in the design of building services thermal systems.
- 6 Apply the basic principles of fluid mechanics to solve problems in the flow of fluids in pipe and duct networks.
- 7 Apply the basic principles of resonant and non-resonant single phase electrical circuits to the design of electrical services systems.
- 8 Apply the basic principles of light and lighting to the design of the visual environment.
- 9 Apply the basic principles of sound, vibration and acoustics to the design of the aural environment.

## **Learning Outcomes of Assessments**

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

|                        |   |   |   |   |   |
|------------------------|---|---|---|---|---|
| Exam                   | 1 | 2 | 3 | 4 | 7 |
| Practical based report | 5 | 6 | 8 | 9 |   |

## **Outline Syllabus**

*Laws of Indices and Logarithms: laws of indices, exponential functions, logarithms, indicial equations.*

*Complex Numbers: vector representation, cartesian and polar Forms, 'j' notation, adding, subtracting, multiplying and dividing complex numbers*

*Differential calculus: basic principles, gradients of straight lines and curves, differentiating algebraic, trigonometrical, exponential and logarithmic expressions, the second derivative, velocity and acceleration, maxima & minima, method of least squares.*

*Integral calculus: basic principles defining integration, integrating algebraic and trigonometrical functions, the definite integral, calculating areas under graph curves,*

*numerical integration.*

*Statistics: Application statistics to construction problems, tables & graphs, data collection & presentation, central tendency, dispersion.*

*Thermal comfort in humans: factors affecting humans, types and application of thermal indices. Methods of predicting thermal comfort and the reliability of design criteria.*

*Heat transfer rates: basic principles of heat transfer by conduction, radiation and convection. Measurement of the thermal comfort environment. Natural and forced convection. Rates of radiant heat transfer for black and grey body radiation. Thermal and permeability properties of materials. Conduction transfer through homogeneous and multi-layered and thermally bridged structures. Heat conduction rates using star and delta thermal resistance networks. Heat transfer through insulated surfaces, economic insulation thickness. Effect of Humidity in the internal environment. Temperature gradients and interstitial condensation risk in structures.*

*Fluid flow: principles of uniform, steady, and continuity of flow.*

*Energy in flowing fluids: Conservation of energy in a moving fluid, Bernoulli's equation. Measurement using venturi, orifice plate and pitot-static tubes.*

*Reynolds number: laminar and turbulent fluid flow, boundary separation and transition.*

*Energy losses in flowing fluids: principles and applications of frictional losses in pipe and duct networks including fittings. Principles of static regain in ductwork systems.*

*Electrical networks: non-resonant single phase ac circuits, quantities in series, parallel and combined R.L.C networks. Power factor, true, reactive and apparent power. Heating and magnetic effects.*

*Resonant ac circuits: circuit resonance, circuit conditions at resonance for various arrangements of induction coil and capacitor, resonant frequency and dynamic frequency. Power factor correction: capacitance required to improve the overall power factor, reasons for power factor correction.*

*Fundamentals of light: terminology and units of light, inverse square law, cosine law, colour temperature*

*Visual effects of lighting: lighting levels, glare, illumination for task performance, appearance, colour rendering, revealing form, measurement of light and the visual environment.*

*Sound: decibel scales, measurement of sound, equivalent continuous noise levels, sound power level (SPL), sound intensity level (SIL). Sound power/frequency spectra. Propagation of acoustic energy, sound insulation and attenuation.*

*Noise control: attenuation characteristics of materials, components and systems associated with building services. Acoustic enclosures. Noise control solutions for building services plant and applications.*

*Room acoustics: room characteristics, background and total sound levels, and reverberation time*

*Noise criteria and effect: noise rating/criteria curves and their application in acoustic design. Privacy criteria. Speech intelligibility. Evaluation of sound and vibration effects. Design criteria in building services.*

*Vibration: simple harmonic motion, modes of vibration, characteristics of springs, static and dynamic modulus of materials and natural frequency. Vibration isolation.*

## **Learning Activities**

Lectures, tutorials & laboratory practical sessions.

## References

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

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

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|------------------------|---------------------------|
| <b>Course Material</b> | Book                      |
| <b>Author</b>          | Croft, A. & Davidson, R.  |
| <b>Publishing Year</b> | 2004                      |
| <b>Title</b>           | Mathematics For Engineers |
| <b>Subtitle</b>        |                           |
| <b>Edition</b>         |                           |
| <b>Publisher</b>       | Pearson                   |
| <b>ISBN</b>            | 0-131-20193-X             |

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|------------------------|-------------------------|
| <b>Course Material</b> | Book                    |
| <b>Author</b>          | Stroud, K.A.            |
| <b>Publishing Year</b> | 2007                    |
| <b>Title</b>           | Engineering Mathematics |
| <b>Subtitle</b>        |                         |
| <b>Edition</b>         | 6th                     |
| <b>Publisher</b>       | Palgrave Macmillan      |
| <b>ISBN</b>            | 1-4039-4246-3           |

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|------------------------|-----------------------------|
| <b>Course Material</b> | British Standards           |
| <b>Author</b>          | British Standards Institute |
| <b>Publishing Year</b> | 2006                        |
| <b>Title</b>           | BS ISO 7730:2005            |

|                  |  |
|------------------|--|
| <b>Subtitle</b>  | Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria |
| <b>Edition</b>   |  |
| <b>Publisher</b> | BSI, London  |
| <b>ISBN</b>      |  |

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|------------------------|--|
| <b>Course Material</b> | Reports  |
| <b>Author</b>          | Chartered Institute of Building Services Engineers |
| <b>Publishing Year</b> | 2006   |
| <b>Title</b>           | TM40   |
| <b>Subtitle</b>        | Health issues in building services                 |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | CIBSE, London                                      |
| <b>ISBN</b>            | 9781903287651                                      |

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|------------------------|--|
| <b>Course Material</b> | Reports  |
| <b>Author</b>          | Chartered Institute of Building Services Engineers |
| <b>Publishing Year</b> | 2006   |
| <b>Title</b>           | KS6  |
| <b>Subtitle</b>        | Comfort  |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | CIBSE, London                                      |
| <b>ISBN</b>            | 9781903287675                                      |

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| <b>Course Material</b> | Book   |
| <b>Author</b>          | Chartered Institute of Building Services Engineers |
| <b>Publishing Year</b> | 2007   |
| <b>Title</b>           | Guide A  |
| <b>Subtitle</b>        | Environmental Design                               |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | CIBSE, London                                      |
| <b>ISBN</b>            | 9781903287668                                      |

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|------------------------|--|
| <b>Course Material</b> | British Standards  |
| <b>Author</b>          | British Standards Institute  |
| <b>Publishing Year</b> | 1998   |
| <b>Title</b>           | BS EN ISO12241:1998  |
| <b>Subtitle</b>        | Thermal insulation for building equipment and industrial installations — Calculation Rules |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | BSI, London  |
| <b>ISBN</b>            |  |

|                        |            |
|------------------------|------------|
| <b>Course Material</b> | Book       |
| <b>Author</b>          | Lewis, M.L |

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|------------------------|--|
| <b>Publishing Year</b> | 1990   |
| <b>Title</b>           | Electrical Installation Technology 2         |
| <b>Subtitle</b>        | Science and Calculations                     |
| <b>Edition</b>         | 3rd  |
| <b>Publisher</b>       | Stanley Thornes (Publishers) Ltd, Cheltenham |
| <b>ISBN</b>            |  |

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|------------------------|--|
| <b>Course Material</b> | Book   |
| <b>Author</b>          | Morris, N.M.                                   |
| <b>Publishing Year</b> | 1994   |
| <b>Title</b>           | Electrical & Electronic Engineering Principles |
| <b>Subtitle</b>        |  |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | Pearson Education Ltd, Harlow                  |
| <b>ISBN</b>            |  |

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|------------------------|--|
| <b>Course Material</b> | Book   |
| <b>Author</b>          | Moss, K.   |
| <b>Publishing Year</b> | 2007   |
| <b>Title</b>           | Heat and Mass Transfer in Building Services Design |
| <b>Subtitle</b>        |  |
| <b>Edition</b>         |  |
| <b>Publisher</b>       | Taylor & Francis Ltd.                              |
| <b>ISBN</b>            | 9780415409087                                      |

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

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|------------------------|----------------------------------|
| <b>Course Material</b> | Book                             |
| <b>Author</b>          | Smith, B.J. Peters, R.J. Owen,S. |
| <b>Publishing Year</b> | 1996                             |
| <b>Title</b>           | Acoustics and Noise Control      |
| <b>Subtitle</b>        |                                  |
| <b>Edition</b>         |                                  |
| <b>Publisher</b>       | Longman                          |
| <b>ISBN</b>            | 0-582-08804-6                    |

## Notes

This module provides fundamental understanding of key mathematical and scientific

concepts and the application of these to solve building services engineering problems.