Engineering Tripos Part IIA, 3A6: Heat and Mass Transfer, 2018-19

Module Leader

Prof W N Dawes [1]

Lecturers

Prof W N Dawes and Dr N Atkins

Lab Leaders

Dr Liping Xu [2]

Timing and Structure

Lent term. Conduction and radiation (Dr N R Atkins), convection and mass transfer (Prof. W N Dawes); 16 lectures.

Aims

The aims of the course are to:

- Provide an understanding of the fundamentals of heat and mass transfer processes in engineering systems.
- Provide methods for analysis and solution of problems involving heat and mass transfer using fundamental differential analysis.
- Guide the process of scaling analysis and finding solutions by analogy.

Objectives

As specific objectives, by the end of the course students should be able to:

- Understand the principles of conduction, radiation and convection and apply them to the design and analysis of engineering systems and problems
- Understand the analogy between heat, mass and momentum transfer
- Understand the origin and use of non-dimensional groups and their analogues in heat, mass and momentum transfer
- Understand the principles of phase change
- Understand the process of mass diffusion in gases, liquids and solids
- Develop an intuition for scaling and magnitudes in heat transfer
- Develop an understanding of numerical and expeirmental methods for solving practical problems

Content

Multidimensional conduction (3L)

- Heat equation
- Multi-dimensional steady-state conduction in solids
- Transient conduction: Biot and Fourier numbers, lumped capacitance
- Numerical methods

Radiation heat transfer (3L)

- Spectral radiation
- Spectral absorptivity, emissivity, transmissivity
- Form factor calculations and approximations
- Numerical methods

Convective Heat Transfer (7L)

- Principles of convection
- Forced convection
- Free convection
- Heat exchangers
- Numerical methods and examples

Mass transfer (3L)

- Conservation laws and constitutive relations
- Diffusive and convective fluxes
- Mass and heat transfer analogies

Coursework

Laboratory experiment: short or full report

Impinging flow experiment

Learning objectives:

- Measure temperatures across a metal plate
- Determine the power delivered to a test plate
- Determine the local Nusselt number for flow over an impinging plate
- Correlate the Nusselt number to the relevant flow parameters, and compare to theory

Practical information:

- Sessions will take place in Hopkinson Laborator, during week(s) [TBA]
- This activity does not involve preliminary work

Full Technical Report:

Students will have the option to submit a Full Technical Report.

Booklists

Please see the Booklist for Part IIA Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

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