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 A. Boies), convection and mass transfer (Dr J Sidey); 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 different modes of heat transfer, and their physics, and apply their knowledge to design and analysis of heat transfer problems
- Understand the principles of conduction, radiation and convection, and apply these principles to solve engineering 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 experimental 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].