Engineering Tripos Part IIA, 3A6: Heat and Mass Transfer, 2022-23

Module Leader

Prof S Hochgreb [1]

Lecturers

Prof S Hochgreb and Prof A Boies

Lab Leader

Prof A Boies [2]

Timing and Structure

Lent term. Conduction and radiation (Prof A Boies), convection and mass transfer (Prof. S Hochgreb); 16 lectures total.

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 evaporation and 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

Temperature measurements using infrared (IR) camera

Learning objectives:

- Understand the principles of infrared radiation detection and temperature measurement
- Acquire temperature information from a surface using IR
- Calculate the expected temperature distribution in a physical conduction situation
- Compare experiments to theory
- Understand the effects of convection on heat transfer

Practical information:

- Sessions will take place in Hopkinson Laboratory 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 refer to the Booklist for Part IIA Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

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