

## **Engineering Tripos Part IIA, 3A6: Heat and Mass Transfer, 2019-20**

### **Module Leader**

[Prof W N Dawes](#) [1]

### **Lecturers**

Prof W N Dawes and Dr A Boies

### **Lab Leaders**

[Dr LP Xu](#) [2]

### **Timing and Structure**

Lent term. Conduction and radiation (Dr A Boies), 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 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 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 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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**Links**

[1] <mailto:wnd1000@cam.ac.uk>

[2] <mailto:lp1@cam.ac.uk>

[3] <https://www.vle.cam.ac.uk/mod/book/view.php?id=364091&chapterid=46251>

[4] <https://teaching.eng.cam.ac.uk/content/form-conduct-examinations>