Engineering Tripos Part IIA, 3C1: Materials Processing & Design, 2017-18

Module Leader

Dr H Shercliff [1]

Lecturers

Dr H Shercliff, Dr C Barlow and Dr G McShane

Lab Leader

Dr J Durrell

Timing and Structure

Michaelmas term. 16 lectures.

Aims

The aims of the course are to:

- Provide an understanding of materials processing technology for the manufacture of products.
- Consider the integrated nature of design, material and processing in the manufacture of products.
- Illustrate the processing factors that influence selection in design.
- Relate processing to microstructure evolution and product failure.

Objectives

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

- Have a broad appreciation of the different materials processing methods used for metals, ceramics, polymers and composites.
- Understand the main interactions between process and material in design and process selection, for each of the main classes of material.
- Understand the factors which control the design of shaped castings, their microstructures, and properties.
- Know the main classes of polymers and composites, and understand the processing considerations in component design with these materials.
- Know the main deformation processes for wrought alloys, and be able to conduct simple plastic analyses.
- Know the microstructural characteristics of wrought alloys, and the reasons for alloying and heat treatment.
- Understand hardenability of steels, using CCT diagrams to select steels and heat treatments for a given component specification.
- Understand the processes and issues in the manufacture of powder metallurgy and ceramic products.
- Understand the importance of surface treatments and joining technologies, and know the main factors to consider in process selection.
- Be able to apply their knowledge of materials processing, microstructure evolution, and the mechanisms of material degradation to analyse failures and to improve product design.

Content
Introduction (1L, Dr H Shercliff)

- Classification of manufacturing processes.
- Process selection criteria in design.
- Coupled problems in design and manufacturing: the interaction between material, process and design parameters.

Metal Casting (2L, Dr HR Shercliff)

- Ingot and shaped casting technology.
- Application of phase diagrams and transformations to solidification: casting alloys and microstructures.
- Casting defects and design of shaped castings.

Deformation Processing of Wrought Alloys, Heat treatment (2L, Dr H Shercliff; 3L Dr G McShane)

- Revision of phase diagrams, phase transformations and TTT diagrams.
- CCT diagrams and hardenability for steels.
- Wrought alloy processing and microstructure evolution.
- Simple modelling of plastic forming processes (stress analysis, and upper bound method).
- Application to rolling, forging, extrusion, machining of metals; case studies.

Powder Processing, Processing of Polymers and Composites (3L, Dr CY Barlow)

- Sintering, HIPing and other processing technologies for powder metals and ceramics.
- Polymer and composite processing technology.
- Design, material and process selection for polymers and composites.

Surface Engineering, Welding and Joining (2L, Dr HR Shercliff)

- Surface engineering processes and their selection in design.
- Welding technology (fusion, friction, laser, ultrasonic), and other joining processes (mechanical, adhesives).
- Selection of joining process in design.

Design against Failure (3L, Dr CY Barlow)

- Processing as the origin of defects and failures (microstructure, damage, residual stress).
- Environmental factors in failure of materials.
- Analysis and case studies of failures.

Further notes

This module also runs in the MANUFACTURING ENGINEERING TRIPOS PART IIA - Module 3P1: Materials into Products.

Examples papers

0. Revision (Phase Diagrams etc)
1. Metal Casting, Heat Treatment of Steels, Microstructure in Wrought Alloy Processing
2. Modelling of Wrought Alloy Processing
3. Powder Processing, Polymers, Polymer Composites, Joining and Welding, Surface Engineering, Design against Failure

Coursework

Full Technical Report: weldability of steels, and correlation with hardenability
Jominy end-quench test for hardenability

Learning objectives:

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Practical information:

- Sessions will take place in [Location], during week(s) [xxx].
- This activity [involves/doesn't involve] preliminary work ([estimated duration]).

Full Technical Report:

Students [will/won't] have the option to submit a Full Technical Report.

Booklists

Please see the Booklist for Part IIA Courses [2] for references for this module.

Examination Guidelines

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

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

Last modified: 03/08/2017 15:19

Source URL (modified on 03-08-17): http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iiia-3c1-materials-processing-design-2017-18

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