Engineering Tripos Part IIB, 4C9: Continuum Mechanics, 2017-18

Module Leader

Dr G McShane

Lecturers

Prof VS Deshpande and Dr GJ McShane

Timing and Structure

Lent term. 16 lectures (including examples classes). Assessment: 100% exam

Prerequisites

3C7 assumed; 3D7 useful

Aims

The aims of the course are to:

- develop a more in-depth understanding of analytical techniques employed in continuum solid mechanics with particular emphasis on the response of elastic, visco-elastic and plastic bodies.

Objectives

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

- show a working knowledge of Cartesian tensor notation
- use the method of minimum potential energy to solve problems in linear elasticity
- understand how to solve viscoelastic problems in 1D and 3D for arbitrary loading time-histories
- know Drucker's stability postulate and understand the implications of convexity and normality
- understand the difference between deformation and flow theories of plasticity
- able to apply slip line field theory as well as upper and lower bound theorems for perfectly plastic solids

Content

This is an advanced course in continuum solid mechanics building on material covered in the Part IIA course 3C7. The aim of the course is to develop a more in-depth understanding of analytical techniques employed in continuum solid mechanics with particular emphasis on the response of elastic and plastic bodies.

Preliminaries (3L, Dr GJ McShane)

- Introduction to indicial notation
- Vectors, tensors and their manipulation
- Stress and equilibrium, strain and compatibility, constitutive relationships

Elasticity and Viscoelasticity (5L, Dr GJ McShane)
Method of minimum potential energy
• Examples: application to elastic beams and plates in bending
• Deriving constitutive equations for linear viscoelasticity
• Solving viscoelastic problems in 1D for arbitrary loading time-histories
• Viscoelastic analysis in 3D

Plasticity (8L, Prof VS Deshpande)
• Constitutive relationships - Drucker’s stability postulate, normality and convexity conditions, yield criteria, flow rules, strain-hardening materials, flow and deformation theories of plasticity;
• Limit analysis theorems;
• Slip-line field theory; the solution of boundary value problems - metal forming, contact problems, cracked bodies.

Examples papers
• Paper 1 - Preliminaries
• Paper 2 - Elastic and viscoelastic analysis
• Paper 3 - Plasticity 1
• Paper 4 - Plasticity 2

Booklists

Please see the Booklist for Group C 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: 31/05/2017 09:12

Source URL (modified on 31-05-17): http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4c9-continuum-mechanics-2017-18

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[1] mailto:gjm31@cam.ac.uk