Engineering Tripos Part IIB, 4C9: Continuum Mechanics, 2019-20

Module Leader
Dr G McShane [1]

Lecturers
Prof GN Wells and Dr GJ McShane [2]

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 continuum solid mechanics, with particular emphasis on the distinction between linearised (i.e. infinitesimal strain) and nonlinear continuum mechanics;
- understand appropriate solution methods for particular boundary value problems, with a focus on elastic and visco-elastic materials.

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

- show a working knowledge of tensor notation
- understand how to define deformation, stress and constitutive relationships, in both linear and nonlinear continuum mechanics
- use energy approaches to define constitutive relationships and solve problems in linear and nonlinear elasticity
- solve linear viscoelastic problems for arbitrary loading time-histories
- understand numerical solution methods for nonlinear continuum mechanics problems.

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 the techniques employed in continuum solid mechanics, for both small and large deformations, with particular emphasis on the response of elastic and visco-elastic bodies.

Preliminaries (2L, Dr GJ McShane)
• Introduction to indicial notation.
• Vectors, tensors and their manipulation.

Linearised Continuum Mechanics (6L, Dr GJ McShane)

• Kinematics: infinitesimal strains, compatibility.
• Conservation laws; stress and equilibrium.
• Linear elasticity: method of stationary potential energy.
• Linear viscoelasticity: constitutive equations; solving viscoelastic problems in 1D for arbitrary loading time-histories; viscoelastic analysis in 3D.

Nonlinear Continuum Mechanics (8L, Prof GN Wells)

• Nonlinear kinematics.
• Strain rates and stress measures.
• Nonlinear elasticity: stationary potential energy and hyper-elasticity.
• Numerical solution methods.
• Note that this part of the 4C9 course is new for 2018-19.

Examples papers

• Papers 1-2 - Preliminaries and linearised continuum mechanics.
• Papers 3-4 - Nonlinear continuum mechanics

Booklists

Please see the Booklist for Group C Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [5] 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 [6] which sets out the standard for degree accreditation.

The Output Standards Matrices [7] 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: 24/05/2019 14:18

Source URL (modified on 24-05-19): http://teaching.eng.cam.ac.uk/content/engineering-tripos-part-iib-4c9-continuum-mechanics-2019-20

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