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

This syllabus contributes to the following areas of the UK-SPEC [5] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

IA2

Demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US2

A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.

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Links
[1] mailto:gjm31@cam.ac.uk
[2] mailto:gjm31@cam.ac.uk, gnw20@cam.ac.uk
[3] https://www.vle.cam.ac.uk/mod/book/view.php?id=364101&chapterid=51741
[4] https://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[5] https://teaching.eng.cam.ac.uk/content/uk-spec