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

Module Leader

Dr G McShane [1]

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

This syllabus contributes to the following areas of the UK-SPEC [4] 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.

Last modified: 31/05/2017 09:12

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