Engineering Tripos Part IIB, 4C2: Designing with Composites, 2019-20

Module Leader

Prof MPF Sutcliffe [1]

Lecturer

Prof MPF Sutcliffe and Dr AE Markaki [2]

Timing and Structure

Michaelmas term. 13 lectures + 1 examples class + 10 hours coursework. Assessment: 75% exam / 25% coursework

Aims

The aims of the course are to:

- develop a systematic approach to design with composites based on mechanical properties and to understand the practical considerations associated with design, manufacture and service requirements.

Objectives

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

- be familiar with the range of composite systems in use.
- derive and use formulae to bound composite material properties.
- perform simple laminate analysis by hand, and more complex analysis with the help of appropriate software.
- be familiar with the use of carpet plots to choose laminates based on stiffness.
- understand the detailed mechanisms of lamina and laminate failure.
- use strength models of failure for lamina and laminates.
- describe design processes commonly used for composite structures.
- be familiar with the manufacturing routes for composites.
- use selection charts to select an appropriate manufacturing route.
- understand the practical requirements associated with joining, manufacture and service use.

Content

Introduction and processing (1L, Prof MPF Sutcliffe)

- Introduction
- Fabrication technology

Elastic deformation of laminates (5L, Dr AE Markaki)

- Elastic deformation of composites (stiffness bounds) and material property charts.
- On and off-axis elastic constants of laminates.
- Elastic deformation of laminates.

Designing against failure (4L, Prof. MPF Sutcliffe)

- Underlying mechanisms of yield and failure for laminate. Strength of a single ply.
- Failure of laminates. Strength models. Splitting and delamination. Composite toughness.
- Testing methods.

Practical Laminate Design (3L, Prof. MPF Sutcliffe)

- Laminate design methods. Carpet plots. Case studies.
- Composite Compressive Strength Modeller software.

Further notes

Examples papers

Examples Paper 1: Elastic deformation

Examples Paper 2: Strength

Examples Paper 3: Practical considerations

Coursework

Coursework	Format	Due date & marks
Case Study: Establish design criteria for a simple structure (10 hours) Learning objective: • Apply design methods to select a laminate using a specialist computer package (Composite Compressive Strength Modeller). • Consider practical aspects to outline a detailed design.	Individual Report anonymously marked	Coursework handed in by week 1 (Lent [15/60]

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.

D1

Wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.

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.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

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.

US4

An awareness of developing technologies related to own specialisation.

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