Engineering Tripos Part IIB, 4C2: Designing with Composites, 2021-22

Module Leader
Dr AE Markaki

Lecturer
Prof MPF Sutcliffe and Dr AE Markaki

Lab leader
Dr AE Markaki

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**

<table>
<thead>
<tr>
<th>Coursework</th>
<th>Format</th>
<th>Due date &amp; marks</th>
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<tr>
<td>Case Study: Establish design criteria for a simple structure (10 hours)</td>
<td>Individual Report anonymously marked</td>
<td>Coursework is handed in via preliminary report by 4pm 25 Nov, final report by 4pm on Thu week 1 (Lent Term)</td>
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**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.

**Booklists**

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

**Examination Guidelines**

Please refer to Form & conduct of the examinations [2].

**UK-SPEC**

The [UK Standard for Professional Engineering Competence (UK-SPEC) [3] 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 [4] which sets out the standard for degree accreditation.

The Output Standards Matrices [5] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links
[1] mailto:am253@cam.ac.uk