Engineering Tripos Part IIA, 3C9: Fracture Mechanics of Materials & Structures, 2018-19

Module Leader

Prof V Deshpande [1]

Lecturers

Prof V Despande and Prof N Fleck

Lab Leader

Dr G McShane

Timing and Structure

Lent term. 16 lectures + coursework

Prerequisites

3C7 assumed

Aims

The aims of the course are to:

- Explain the physical processes underlying fracture from a single dominant crack and from a distribution of cracks.
- Describe the main concepts of fracture mechanics in terms of stress analysis, failure mechanisms and design methods.
- Discuss both linear elastic fracture mechanics (LEFM) and ductile fracture.
- Apply the methods to a wide range of engineering applications from thin film design in electronics to fatigue life assessment of nuclear pressure vessels and damage mechanics of concrete.

Content

Introduction: lessons learned from the history of engineering disasters

Elastic stress analysis (7L) Prof Deshpande

- Williams solution using the Airy stress function
- LEFM and interfacial fracture
- Energy appraoch to fracture
- Practical K-calibrations and use of superposition
- Fracture of thin films and of weldments
- Prediction of fracture toughness

Small Scale Yielding (2L) Prof Deshpande

- plastic zone size and crack tip opening displacement
- R-curves: the tear resistance of metals, composites and biological tissues

Large Scale Yielding (3L) Prof Deshpande

- Dugdale model for a large plastic zone from a crack tip, and transition to bulk plasticity
- Application to adhesive joints and crazing of polymers, and to pressure vessels
- Void nucleation and growth in a plastic field

Fatigue crack growth (4L) Prof Deshpande

- Threshold, Paris law, variable amplitude loading for aircraft
- S-N curves for fatigue crack initiation and growth

Possible additional topics: stress corrosion cracking, creep crack growth?

REFERENCES

Fracture Mechanics: fundamentals and applications, T.L.Anderson,Taylor Francis,2005.

Coursework

Measurement of toughness of polymers as used in underground pipelines, and to assess their safety in service.

[Coursework Title]

Learning objectives:

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Practical information:

- Sessions will take place in [Location], during week(s) [xxx].
- This activity [involves/doesn't involve] preliminary work ([estimated duration]).
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Full Technical Report:

Students will have the option to submit a Full Technical Report.

Booklists

Please see the Booklist for Part IIA Courses **[2]** for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] 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 [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] 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: 13/09/2018 14:37

Links
[1] mailto:vsd20@eng.cam.ac.uk
[2] https://www.vle.cam.ac.uk/mod/book/view.php?id=364091&chapterid=46481
[3] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[4] http://www.engc.org.uk/ukspec.aspx
[5] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[6] http://teaching.eng.cam.ac.uk/content/output-standards-matrices