4B2 FORENSIC MATERIALS ENGINEERING

Lecturers:  Professor David Taylor (dtaylor@tcd.ie)
Ms Sarah Reid

Semester:  2

Module Organisation
The module runs for 12 weeks of the academic year and comprises three lectures and one tutorial per week (except the study week). Total contact time is 44 hours.

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<th>Start Week</th>
<th>End Week</th>
<th>Lectures per week</th>
<th>Lectures total</th>
<th>Tutorials per week</th>
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<td>1</td>
<td>12</td>
<td>3</td>
<td>33</td>
<td>1</td>
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Module Description
This module aims to advance the student’s knowledge of the mechanical properties of materials, especially in respect of the principal modes of failure of engineering components, in the context of forensic investigations. The module will be taught through a series of real-life legal cases involving material failure, giving the student experience of failure analysis and of the related methods of design and material selection as well as legal and ethical aspects relating to the preparation of reports and the giving of evidence in court.

Learning Outcomes
On successful completion of this module, students will be able to:

1. List and describe the various types of mechanical failure which occur in components, explaining the appearance of fracture surfaces and other relevant evidence which allows the mechanism to be diagnosed.

2. List the various common causes of failure in engineering components and explain how components are designed so as to prevent failure.

3. Conduct a failure investigation, as part of a team, to determine the mechanism and cause of a failure; write an appropriate report with recommendations and give evidence in court.

4. Determine the stress intensity of a cracked body under load and use this information to predict brittle fracture and fatigue. Estimate the fatigue strength of a structure given results from stress analysis (such as finite element or photoelastic analysis) and other relevant information. Use damage mechanics to predict failure under creep and creep/fatigue situations.

5. Understand the importance of legal and ethical aspects of engineering failures, the significance of codes of practice and standards, the need for safe working practices and the responsibilities of the forensic engineer.
Module Content

- Mechanisms of failure
- Causes of failure
- Examination of fracture surfaces
- Case 1: failure of a freight container
- Case 2: failure of a pressure vessel
- Case 3: the Markham Colliery disaster
- Case 4: failure of plastic piping
- Stress analysis, finite element methods
- Brittle fracture; fracture mechanics; stress intensity
- Brittle fracture, fracture mechanics, stress intensity
- Fatigue from stress concentrations, notch factors, stress and stress-intensity approaches
- Creep, damage mechanics
- Ethical and legal issues
- Preparation of court reports and giving evidence

Module Notes

Web pages

Teaching Strategies
This part of the module is taught through a series of four case studies presented via the internet, each of which describes an industrial failure. The students are given a description of the failure and appropriate background information, including data on this particular case and background theory. They are asked to put themselves in the position of the engineer assigned to the failure analysis. There are no formal lectures, instead the lecturer meets with the class, either as a whole or in small groups, to monitor progress and give hints. Necessary theory is covered in an on-line textbook and via tutorial classes. Students write up one of the case studies as a report.

Assessment Modes
Written Exam (70%), assignment (15%) and lab report (15%).

Recommended Texts
- How Components Fail, Wulpi (ASM)

Laboratory
Strength and toughness