MATS4004
Fracture Mechanics and Failure Analysis

Course Outline
Session 1, 2015
# Table of Contents

Course staff ................................................................. 2  
Timetable ........................................................................ 2  
Your Course at a Glance .................................................. 3  
Course Outline ............................................................... 3  
Assessment ..................................................................... 4  
References ..................................................................... 4  
Learning and teaching philosophy underpinning the course .... 4  
Course Information ......................................................... 5  
Academic honesty and plagiarism .................................... 6  
Continual course improvement ...................................... 6  
Administrative Matters ................................................ 7  
Rules for Exams ........................................................... 7  

## Course staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Room, School of Materials Science and Engineering (Building E10)</th>
<th>Phone</th>
<th>Consultation hours:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr John Daniels</td>
<td>Room 342, School of Materials Science and Engineering (Building E10)</td>
<td>9385 4509 <a href="mailto:j.daniels@unsw.edu.au">j.daniels@unsw.edu.au</a></td>
<td>by appointment</td>
</tr>
<tr>
<td>Prof Alan Crosky</td>
<td>Room 241, School of Materials Science and Engineering (Building E10)</td>
<td>9385 4424 <a href="mailto:a.crosky@unsw.edu.au">a.crosky@unsw.edu.au</a></td>
<td>by appointment</td>
</tr>
</tbody>
</table>

## Timetable

### Lectures and Labs

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>16:00-18:00</td>
<td>Tyree Energy Technologies (K-H6-LG07)</td>
</tr>
<tr>
<td>Friday</td>
<td>9:00-11:00</td>
<td>The Michael Hintze Theatre (K-H6-LG03)</td>
</tr>
</tbody>
</table>
## Your Course at a Glance

<table>
<thead>
<tr>
<th>Topic</th>
<th>Assessment Task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fracture Mechanics Dr John Daniels</strong></td>
<td></td>
</tr>
<tr>
<td>1 Revision and clarification of basic concepts: Griffith criterion, $K=Y\sqrt{a}$, $K=K_{IC}$, ductile and brittle fracture, cyclic fatigue, environmentally assisted crack growth.</td>
<td>Assignment</td>
</tr>
<tr>
<td>2 Linear Elastic Analysis Airy stress function, crack tip stresses, finite size effects, crack opening displacement.</td>
<td>Assignment</td>
</tr>
<tr>
<td>3 Plastic Analysis Hydrostatic stress, deviatoric stress, yield criteria.</td>
<td></td>
</tr>
<tr>
<td>4 Elastic-Plastic Analysis</td>
<td></td>
</tr>
<tr>
<td>5 Fracture toughness testing</td>
<td></td>
</tr>
<tr>
<td>6 Crack Growth Resistance - R-curves</td>
<td></td>
</tr>
<tr>
<td>7 Fracture mechanics of composites</td>
<td>Assignment</td>
</tr>
<tr>
<td>8 Fracture of interfaces</td>
<td></td>
</tr>
<tr>
<td>9 Fracture of nanomaterials</td>
<td></td>
</tr>
<tr>
<td><strong>Fractographic Analysis Prof Alan Crosky</strong></td>
<td></td>
</tr>
<tr>
<td>10 General practice in failure analysis</td>
<td>Laboratory</td>
</tr>
<tr>
<td>11 Ductile and brittle failure mechanisms</td>
<td></td>
</tr>
<tr>
<td>12 Cyclic fatigue failure mechanism</td>
<td></td>
</tr>
<tr>
<td>13 Stress corrosion cracking and hydrogen assisted failure mechanisms</td>
<td></td>
</tr>
<tr>
<td>14 Effect of defects on failure</td>
<td></td>
</tr>
<tr>
<td><strong>Final exam</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Course Outline

Fracture mechanics, remnant life assessment, general practice in failure analysis, fractographic analysis, ductile and brittle fracture, fatigue, stress corrosion cracking, hydrogen embrittlement, fracture criteria in design, fracture toughness and fatigue testing.
Assessment

10%  Assignment 1 (hard copy submission)
10%  Assignment 2 (hard copy submission)
20%  Laboratory Report d (online submission)
60%  Final exam during exam period

References

• D. Broek, "Elementary Fracture Mechanics".
• J. F. Knott, "Fundamental of Fracture Mechanics".
• R. W. Hertzberg, "Deformation and fracture mechanics of engineering materials".
• G. Atkins & Y.-W. Mai, "Elastic and Plastic Fracture".
• Practical Failure Analysis (journal) ASM International
• Engineering Failure Analysis (journal) Pergamon

Learning and teaching philosophy underpinning the course
Based on UNSW Learning Guidelines

The course is designed for students to actively engage in the learning process and analyse and synthesise the content in a real world environment.

• Students are engaged actively in the learning process.
  It is expected that, in addition to attending classes, students will read, write, discuss, and engage in analysing the course content.

• Effective learning is supported by a climate of inquiry, where students feel appropriately challenged.
  Students are expected to be challenged by the course content and to challenge their own preconceptions, knowledge, and understanding by questioning information, concepts, and approaches during class and study.

• Learning is more effective when students’ prior experience and knowledge are recognised and built on.
  Coursework, tutorials, assignments, laboratories, examinations, and other forms of learning and assessment are intended to provide students with the opportunity to cross-reference these activities in a meaningful way with their own experience and knowledge.

• Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts.
  The course content is designed to incorporate both theoretical and practical concepts, where the latter is intended to be applicable to real-world situations and contexts.
# Course Information

<table>
<thead>
<tr>
<th>Units of credit</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How the course relates to other course offerings and overall program(s) in the discipline</strong></td>
<td>The first part of the course applies mechanics concepts to engineering design. Mechanical and structural knowledge associated with materials is called upon. This is followed by an examination of the mechanisms of failure in materials and their characteristic features, a knowledge of which is required by materials engineers in order to establish the cause of service failures so that appropriate remedial action can be taken.</td>
</tr>
<tr>
<td><strong>Course aims</strong></td>
<td>To develop an understanding of fracture mechanics, and the common failure mechanisms and their distinguishing features, so as to be capable of incorporating fracture criteria into design and undertaking failure analysis of engineering structures.</td>
</tr>
</tbody>
</table>
| **Graduate attributes which will be gained through the course** | Ability to communicate effectively  
Capacity for creativity and innovation  
Ability to manage information and documentation  
Understanding of professional and ethical responsibilities, and commitment to them  
Ability to function effectively as an individual  
Ability to work effectively in multidisciplinary and multicultural teams  
Capacity for lifelong learning and professional development  
Professional attitudes |
| **Expected learning outcomes** | **In doing this course, you will learn to:**  
Predict the onset of failure.  
Identify the distinguishing features of different types of service failure.  
Identify the materials and processing features responsible for failure.  
Make informed decisions in recommending remedial action.  
**You will also learn to:**  
Think critically in decision making and problem-solving  
Communicate with correct terminology  
Conduct online research  
Work effectively in a team to solve problems |
| **Teaching strategies** | Core concepts, theories and approaches will be covered in lectures.  
These concepts will be synthesised in a practical context in the laboratory sessions.  
Extensive use will be made of case studies to exemplify fracture  
Problem design and solution will be learnt through assignments  
Teaching material, including course outline, notes, problems, assignments, case studies and course announcements are available on the Course Moodle website. |

---

1 Based on the professional attributes given in *Engineers Australia National Generic Competency Standards - Stage 1 Competency Standard for Professional Engineers* and *UNSW Graduate Attributes*. 

---

5
Academic honesty and plagiarism

What is Plagiarism?
Plagiarism is the presentation of the thoughts or work of another as one’s own.* Examples include:

• direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, website, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
• paraphrasing another person’s work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
• piecing together sections of the work of others into a new whole;
• presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
• claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

• correct referencing practices;
• paraphrasing, summarising, essay writing, and time management;
• appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne.

Continual course improvement

• Students will be asked to provide evaluative feedback through the UNSW's Course and Teaching Evaluation and Improvement (CATEI) process at the end of the course
• Students are encouraged to address any problems regarding teaching of this course at the annual staff-student meeting

• Student comments on teaching during the session are welcome and will be appreciated
   At times students may be asked to answer a short questionnaire for feedback on the course

**Administrative Matters**

• Students should attend at least 80% of all classes.

• Students unable to submit assignments on time or attend the mid-session quizzes or final exams on health grounds should make a request for special consideration. Information on this process can be found here (https://my.unsw.edu.au/student/atoz/SpecialConsideration.html). Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.

• Assignments/lab reports submitted after the deadline will receive a 10% of maximum grade penalty for every day late, or part thereof.

• Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (www.studentequity.unsw.edu.au). Early notification is essential to enable any necessary adjustments to be made.

**Rules for Exams**

Rules governing conduct during exams are given at: https://my.unsw.edu.au/student/academiclife/assessment/examinations/examinationrules.html - Rulesfortheconductofexaminations

---

Note that the use of mobile phones or music players in an exam room will constitute Academic Misconduct.