Fracture Mechanics and Failure Analysis

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Course Staff

<table>
<thead>
<tr>
<th>A/Prof John Daniels</th>
<th>Room 338, School of Materials Science and Engineering (Building E10)</th>
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<tbody>
<tr>
<td>Lecturer and Course Coordinator</td>
<td>Phone: 9385 5607</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:j.daniels@unsw.edu.au">j.daniels@unsw.edu.au</a></td>
</tr>
</tbody>
</table>

Consultation hours: by appointment

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

### Lectures and Labs

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
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<tbody>
<tr>
<td>Tuesday</td>
<td>11:00-13:00</td>
<td>Tyree Energy Technologies (K-H6-LG05)</td>
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<tr>
<td>Thursday</td>
<td>09:00-11:00</td>
<td>Tyree Energy Technologies (K-H6-LG05)</td>
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## Your Course at a Glance

<table>
<thead>
<tr>
<th>Topic</th>
<th>Assessment Task</th>
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<tbody>
<tr>
<td><strong>Fracture Mechanics Dr John Daniels</strong></td>
<td></td>
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<tr>
<td>1. Revision and clarification of basic concepts: Griffith criterion, K=Yσ√a, K=KIC, ductile and brittle fracture, cyclic fatigue, environmentally assisted crack growth.</td>
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<tr>
<td>2. Linear Elastic Analysis Airy stress function, crack tip stresses, finite size effects, crack opening displacement.</td>
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<tr>
<td>3. Plastic Analysis Hydrostatic stress, deviatoric stress, yield criteria.</td>
<td>Assignment 1</td>
</tr>
<tr>
<td>4. Elastic-Plastic Analysis</td>
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<tr>
<td>5. Fracture toughness testing</td>
<td></td>
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<tr>
<td>6. Crack Growth Resistance - R-curves</td>
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<tr>
<td>7. Fracture mechanics of composites</td>
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<td>8. Fracture of interfaces</td>
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<tr>
<td>9. Fracture of nanomaterials</td>
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**Midsession Exam – Thursday Week 7 (13th April)**

| **Fractographic Analysis Prof Alan Crosby**                             |                                                                                 |
| 10. General practice in failure analysis                                |                                                                                 |
| 11. Ductile and brittle failure mechanisms                              |                                                                                 |
| 12. Cyclic fatigue failure mechanism                                    |                                                                                 |
| 13. Stress corrosion cracking and hydrogen assisted failure mechanisms   |                                                                                 |
| 14. Effect of defects on failure                                        |                                                                                 |

**Laboratory**

**Final exam**
Course Description

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

20% Assignment 1 (online submission)
30% Midsession exam (final exam for fracture mechanics strand)
20% Laboratory Report (online submission)
30% Final exam during exam period

References

• Practical Failure Analysis (journal) ASM International
• Engineering Failure Analysis (journal) Pergamon

Learning and Teaching Philosophy Underpinning the Course

(based on UNSW Learning Guidelines)

• Students are actively engaged in the learning process.
  It is expected that, in addition to attending classes, students read, write, discuss, and are engaged in solving problems.
  Effective learning is supported by a climate of inquiry where students feel appropriately challenged.
• Learning is more effective when students’ prior experience and knowledge are recognised and built on.
  This course is built on prior courses in materials, mathematics, physics and chemistry.
• Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts
  Real world examples of fracture mechanics in design and failure will be provided at every opportunity.
## Course Information

<table>
<thead>
<tr>
<th>Units of credit</th>
<th>6</th>
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<tbody>
<tr>
<td>How the course relates to other course offerings and overall program(s) in the discipline</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>Course aims</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>
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| Graduate attributes which will be gained through the course\(^1\) | • 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 |

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

## Academic Honesty and Plagiarism

### What is Plagiarism?

All details regarding plagiarism can be found here: [https://student.unsw.edu.au/plagiarism](https://student.unsw.edu.au/plagiarism)

It is important to understand what plagiarism is. The general concept is plagiarism is using the words or ideas of others and passing them off as your own. Examples of plagiarism, including self-plagiarism, are:
• **Copying**
  Using the same or very similar words to the original text or idea without acknowledging the source or using quotation marks. This includes copying materials, ideas or concepts from a book, article, report or other written document, presentation, composition, artwork, design, drawing, circuitry, computer program or software, website, internet, other electronic resource, or another person's assignment, without appropriate acknowledgement.

• **Inappropriate paraphrasing**
  Changing a few words and phrases while mostly retaining the original structure and/or progression of ideas of the original, and information without acknowledgement.

  This also applies in presentations where someone paraphrases another’s ideas or words without credit and to piecing together quotes and paraphrases into a new whole, without appropriate referencing.

• **Collusion**
  Presenting work as independent work when it has been produced in whole or part in collusion with other people. Collusion includes,

  o students providing their work to another student before the due date, or for the purpose of them plagiarising at any time
  o paying another person to perform an academic task and passing it off as your own
  o stealing or acquiring another person’s academic work and copying it
  o offering to complete another person’s work or seeking payment for completing academic work.

  This should not be confused with academic collaboration.

• **Inappropriate citation**
  Citing sources which have not been read, without acknowledging the 'secondary' source from which knowledge of them has been obtained.

• **Self-plagiarism**
  ‘Self-plagiarism’ occurs where an author republishes their own previously written work and presents it as new findings without referencing the earlier work, either in its entirety or partially.

  Self-plagiarism is also referred to as 'recycling', 'duplication', or 'multiple submissions of research findings' without disclosure. In the student context, self-plagiarism includes re-using parts of, or all of, a body of work that has already been submitted for assessment without proper citation.

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

  o correct referencing practices;
  o paraphrasing, summarising, essay writing, and time management;
  o 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.
Continual Course Improvement

- At the end of the course, students will be asked to provide evaluative feedback through myExperience, the University’s course and teaching evaluation and improvement process
- 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://student.unsw.edu.au/special-consideration. Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.
- Unless otherwise specified in the task criteria, all assignments must be uploaded via Moodle prior to the due date for submission.
- Assignments/lab reports submitted after the due date for submission 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: https://student.unsw.edu.au/disability. Early notification is essential to enable any necessary adjustments to be made.

Rules for Exams

Rules governing conduct during exams are given at: https://student.unsw.edu.au/exam-rules