Course Outline

MATS4004

Fracture Mechanics and Failure Analysis

Materials Science and Engineering

Science

T2, 2020

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	A/Prof John Daniels	j.daniels@unsw.edu.au	Room 338, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 5607
Lecturer	Dr Caitlin Healy	caitlin.healy@unsw.edu.au	Room 401, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 4509

2. Course information

Units of credit: 6

Pre-requisite(s): None

Timetabling website: TBA

Teaching times and locations:

	Lecture	Lecture	Lecture
Day	Monday	Tuesday	Thursday
Location	Online	Online	Online
Time	09:00 – 11:00	12:00-14:00	12:00-14:00
Weeks	1-5, 7-10	v1-5, 7-10	1, 3, 5, 7, 9

2.1 Course summary

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

2.2 Course aims

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.

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Predict the onset of failure
2. Identify the distinguishing features of different types of service failure
3. Identify the materials and processing features responsible for failure
4. Make informed decisions in recommending remedial action

2.4 Relationship between course and program learning outcomes and assessments

Course Learning Outcome (CLO)	LO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Predict…	1.1, 1.2, 1.3 & 3.4	1 & 4
CLO 2	Identify…	1.1, 1.2, 1.3 & 3.4	1, 2, 3 & 4
CLO 3	Identify…	1.3, 2.1, 2.2 & 3.4	1, 3, & 4
CLO 4	Make…	1.1, 1.2, 1.3 & 3.4	2 & 4

3. Strategies and approaches to learning

3.1 Learning and teaching activities

(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.

Lectures: The core concepts will be taught in lectures, students will have access to the lectures notes before class for annotation during the lecture. Students will be engaged in the learning process through class discussions and problem-solving questions independently and working together with partners and groups.

3.2 Expectations of students

- Students must attend at least 80% of all classes with the expectation that students only miss classes due to illness or unforeseen circumstances
- Students must read through lecture notes and lab sheets prior to class
- During class, students are expected to engage actively in class discussions
- Students should work through lecture, tutorial and textbook questions
- Students should read through the relevant chapters of the prescribed textbook.
- Students should complete all assessment tasks and submit them on time.
- Students are expected to participate in online discussions through the Moodle page

4. Course schedule and structure

This course consists of 50 hours of class contact hours. You are expected to take an additional 100 hours of non-class contact hours to complete assessments, readings and exam preparation spread over the term.

Week	Topics	Activity
1	Revision and clarification of basic concepts: Linear Elastic Analysis Airy stress function Plastic Analysis Hydrostatic stress, deviatoric stress, yield criteria	
2	Elastic-Plastic Analysis	Assignment start
3	Fracture toughness testing Crack Growth Resistance - R-curves	Formative in-class quiz
4	Crack Growth Resistance - R-curves Fracture mechanics of composites	
5	Fracture mechanics of composites Fracture of interfaces	Assignment due
6	*Mid-term study week*	
7	General practice in failure analysis	Mid-term exam
8	Ductile and brittle failure mechanisms	
9	Cyclic fatigue failure mechanism Stress corrosion cracking and hydrogen assisted failure mechanisms	
10	Stress corrosion cracking and hydrogen assisted failure mechanisms Effect of defects on failure	Laboratory reports

5. Assessment

5.1 Assessment tasks

Assessment task	Description	Weight	Due date
Assignment:	Materials failure case study. Students will research and reports on a historic materials failure that caused a major industrial disruption and resulted in legal proceedings. They will prepare a reports and short presentation summarising the case study.	30%	Week 5
Mid-term exam:	The mid-term exam will be held in class timevand cover the lecture topics taught in weeks 1-6	20%	Week 7
Laboratory Report:	Detailed investigation of fracture surfaces. Students will use laboratory methods to investigate the fracture surface of a material failure to understand its origins and write a detailed report.	30%	Week 10
Final exam:	The final exam will be held in the final exam period and cover the lecture topics taught in weeks 7-10	20%	Final exam period

Further information

UNSW grading system: https://student.unsw.edu.au/grades

UNSW assessment policy: https://student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Assignment criteria and standards will be available on the course Moodle page.

5.3 Submission of assessment tasks

- Students should attend at least 80% of all classes.
- UNSW operates under a Fit to Sit/ Submit rule for all assessments. If a student wishes to submit an application for special consideration for an exam or assessment, the application must be submitted prior to the start of the exam or before an assessment is submitted. If a student sits the exam/ submits an assignment, they are declaring themselves well enough to do so. 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 governing conduct during exams are given at: https://student.unsw.edu.au/exam-rules

5.4. Feedback on assessment

Formative in-class test: Students will receive feedback on their understanding of the course in-class prior to the census date.

Assignments: Feedback will be given two weeks after submission of the assignment and take the form of the mark for the assignment, overall comments on how the class performed, any common areas that were not answered correctly. Additionally, personal feedback and how each student performed may be given.

Lab reports: Students will receive their mark and individualised feedback on the areas they excelled at and which areas of the reports that were not answered correctly. Feedback will be provided through Moodle, two weeks after submission.

Midsession exams: Students will receive their marked exams indicating what questions were answered correctly and incorrectly. Overall comments and worked solutions may be provided to the class.

Final exam: Students will receive their final mark.

6. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits**:** honesty, trust, fairness, respect, responsibility and courage.[1] At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site http://subjectguides.library.unsw.edu.au/elise/presenting

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

7. Readings and resources

- T.L. Anderson, “Fracture Mechanics: Fundamentals and Applications” NOTE: Available as E-book via UNSW library.
- Metals Handbook, 8th edition, Volumes 9 and 10, 9th edition, Volumes 11 and 12, 10th edition Volumes 11 and 19, ASM International.
- Practical Failure Analysis (journal) ASM International
- Engineering Failure Analysis (journal) Pergamon

8. Administrative matters

School Office: Room 137, Building E10 School of Materials Science and Engineering
School Website: http://www.materials.unsw.edu.au/
Faculty Office: Robert Webster Building, Room 128
Faculty Website: http://www.science.unsw.edu.au/

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: https://student.unsw.edu.au/disability-services
- UNSW IT Service Centre: https://www.it.unsw.edu.au/students/index.html
- Assessment Implementation Procedure: https://www.gs.unsw.edu.au/policy/documents/assessmentimplementationprocedure.pdf
- Special Consideration: https://student.unsw.edu.au/special-consideration