Mechanical and Manufacturing Engineering

Course Outline

Semester 2 2018

MECH4900

MECHANICS OF FRACTURE AND FATIGUE

Contact hours

	Day	Time	Location	Weeks
Lectures	Tuesdays	14:00 – 16:00	CLB 8	1 – 12
Demonstrations	Thursdays	14:00-15:00 15:00-16:00 16:00-17:00	Ainswth201 Ainswth201 Ainswth201	2 – 13
	Fridays	12:00-13:00 13:00-14:00 14:00-15:00	Ainswth201 Ainswth201 RedC M010	
Lab	Monday			

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

Learning Outcome		EA Stage 1 Competencies
1.	Correctly apply linear elastic fracture mechanics (LEFM) to predict material failure	PE 1.1, 1.2, 1.3, 2.1, 2.2
2.	Identify and describe the basic fracture and fatigue mechanisms and apply that knowledge to failure analysis	PE 1.1, 1.3, 2.1, 2.2
3.	Correctly determine the linear elastic fracture toughness,	

5. Course schedule

The below course schedule is tentative and subject to change. Please do each reading prior to the lecture.

Week	Tentative Lecture Topics	Readings Due	Tutorial	Assessments
1	Introduction, Solid Mechanics Review, Elastic Stress Concentrations, Griffith's Theory of Fracture, Strain Energy Release Rate,	Book: CH1, 2.0-2.2-2.4		
2	Stress Analysis of Cracks, Fracture Toughness, Fracture Problem Example 1, Leak before Break Example, Superposition, Connecting the fracture theories, Critical Crack Sizes & NDE	Book: 2.6-2.7	Y	
3	Critical Crack Sizes (Ductile vs. Brittle), Crack Tip Plasticity, Plane Stress/Strain, Plastic Constraint, CTODs	Book: CH2.8-2.10, 3.1	Y	
4	Mixed-mode fracture, K_{Ic} testing, R-curves, R-curve testing	Book: CH 2.5, 2.11, 7.0-7.2 ASTM Standard E399 (on Moodle)	Y	Moodle Quiz 1 Open: Friday – Sunday
5	Elastic-plastic fracture mechanics (EPFM), J-integral, J_{Ic} testing, Application Case Studies	Book: CH3.0-3.5, 7.3-7.4	Y	
6	Ductile and Brittle Fracture Mechanisms, Ductile to Brittle Transition	Book: CH5.0-5.4, 6.1	Y	
7	Scanning Electron Microscopy, Fractography Case Studies, Toughening Mechanisms			

Week	Tentative Lecture Topics	Readings Due	Tutorial	Assessments
	Example Problem, Fatigue Crack Growth Testing, Fatigue Crack Growth Mechanisms	CH10.0-10.3*, 10.8-10.10*		
11	Crack Closure Effects, Corrosion Fatigue, Failure Analysis, Fatigue Fractography Case Studies	10.4-10.5*, 11.5	Y	

6. Assessment

Assessment overview

Undergraduate Students:

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Moodle Quizzes (3x)	30 Minutes	3 x 10% = 30%	1, 2, 4	All class material prior to the quiz	Weeks 3, 7,12 via Moodle, 1 attempt allowed. Open 0:00 Friday to 23:59 Sunday	After quiz closes	After quiz closes and results have been reviewed by course convener
Laboratory Assignment	Format will be posted on Moodle	15%	3	All class material regarding K_{IC} testing	Week 9 Friday 23:59, upload to Moodle	72 Hours After Deadline	Two weeks after deadline
Final exam	2 hours	55%	1, 2, 4	All course content	Exam period, date TBC	N/A	Upon release of final results

5 7

Semester 1 and September for Semester 2

For further information on exams, please see the Exams section on the intranet.

Calculators

You will need to provide your own calculator, of a make and model approved by UNSW, for the examinations. The list of approved calculators is shown at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an "Approved" sticker for it from the School Office or the Engineering Student Centre prior to the examination. Calculators not bearing an "Approved" sticker will not be allowed into the examination room.

Special consideration and s upplementary assessment

For details of applying for special consideration and conditions for the award of supplementary assessment, see the information on UNSW's Special Consideration page.

7. Expected resources for students

Required Readings

- Anderson T L, "Fracture Mechanics: Fundamentals and Applications", 4th Edition, CRC Press, 2005.
  - (Online version of 3rd edition is available on the UNSW Library Website and that edition is fine too)
- ASTM Standard E399, "Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials," ASTM International.
  - (Available on Moodle)

Additional Suggested Readings

- Robert P. Wei, "Fracture Mechanics: Integration of Mechanics, Materials Science and Chemistry," 1st Edition, Cambridge University Press, 2010.
  - (Online version is available on the UNSW Library Website)
- Richard Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials," John Wiley and Sons.
  - (1st – 3rd editions available at UNSW Library)
- Subra Suresh, "Fatigue of Materials," Cambridge University Press.
  - (1st – 2nd editions available at UNSW Library)
- Murakami Y, "Stress Intensity Factors Handbook", Vols 1&2, Pergamon Press, 1987.
  - (Available at UNSW Library)
- Aliabadi M H, "Database of Stress Intensity Factors", UK (1996).
  - (Available at UNSW Library)

2 UNSW Library website:

10. Administrative matters and links

All students are expected to read and be familiar with School guidelines and polices, available on the intranet. In particular, students should be familiar with the following:

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support Services

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex problem solving
	PE2.2 Fluent application of engineering techniques, tools and resources
	PE2.3 Application of systematic engineering synthesis and design processes
	PE2.4 Application of systematic approaches to the conduct and