Course Outline

MATS2004

Mechanical Behaviour of Materials

Materials Science and Engineering

Science

T2, 2022

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course coordinator, Lecturer part 1	Associate Professor Sophie Primig	s.primig@unsw.edu.au	Room 346, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 5842
Tutor part 1	Michael Haines	michael.haines1@unsw.edu.au	School of Materials Science and Engineering (Building E10), by appointment	
Lecturer part 2	Professor Jianqiang Zhang	j.q.zhang@unsw.edu.au	Room 348, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 5025
Lab coordinator	Dr Pramod Koshy	koshy@unsw.edu.au	Room 120, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 6038

2. Course information and schedule

2.1 Course aims

This course is aimed to equip students with a wide-ranging knowledge of the response of solid materials to stress. The course acts as an introduction to quantitative solid mechanics and builds on the knowledge of structure of materials and its relationship to mechanical properties. Students will participate in a variety of mechanical testing measurements in the laboratory classes.

2.2 Course summary

Part 1: Quantitative Treatment of Mechanical Behaviour (Sophie Primig)

- Stresses and strains, mechanics of materials perspective
- Transformation of stresses
- Transformation of strains
- Yield and failure criteria
- Selected topics for materials science & engineering (thermal stresses, residual stresses, shear and moment diagrams, thin-walled pressure vessels)

Prescribed reading for part 1:
Mechanics of Materials, RC Hibbeler, 10th Ed. in SI units, Pearson Global edition, 2018

Print: https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781292178202

Digital: https://unswbookshop.vitalsource.com/products/-v9781292178288

OR: UNSW Library (type title into search field, electronic & hardcopy versions available)

Part 2: Description of Mechanical Behaviour (Jianqiang Zhang)

- Definitions of stress and strain, types of mechanical behaviour, atomic bonding, and elastic modulus
- Stress-strain behaviour based on tension test
- Introduction to plastic deformation and yielding, including slip systems, dislocations, and twinning
- Creep deformation, fracture and fatigue, and mechanisms
- Factors affecting mechanical behaviour: stress state, temperature and strain rate

Laboratories: Mechanical materials testing (Pramod Koshy)

- Tensile testing of metals
- Hardness testing of metals
- Strain rate dependency testing of polymers
- Charpy impact testing of metals

2.3 Teaching schedule

This course consists of ~56 hours of online contact hours per term. You are expected to take an additional ~94 hours of non-class contact hours to complete assessments, readings and exam preparation spread over the term.

Units of credit: 6

Pre-requisite(s): MATS1101 or MATS1192

Teaching schedule (online except f2f labs), live classes on Blackboard Collaborate, pre-recorded lecture parts are provided on Moodle course page, in corresponding sections.

<table>
<tr><th>Wk.</th><th>Tuesday 9-11 am</th><th>Wednesday 12-2 pm</th><th>Thursday 11 am-1 pm</th><th>Other:</th></tr>
<tr><td rowspan="2">1</td><td>Part 1 intro (live,
~1 hr @ 9:00 am SHARP)</td><td>-</td><td>-</td><td rowspan="2">-</td></tr>
<tr><td colspan="3">Pre-recorded lectures 1 & 2 and/or Hibbeler chapters 1, 2 & 3</td></tr>
<tr><td rowspan="2">2</td><td>Live tutorial 1</td><td>-</td><td>Live Q&A lectures 1-4
(extra, voluntary)</td><td rowspan="2">Quiz part 1a
due Sat 5 pm</td></tr>
<tr><td colspan="3">Pre-recorded lectures 3 & 4 and/or Hibbeler chapter 9</td></tr>
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3	Live tutorial 2	-	-	Labs
	Pre-recorded lectures 5 & 6 and/or Hibbeler chapter 10			
4	Live tutorial 3	Mini live tutorial 4, revision	Live Q&A lectures 1-7 (extra, voluntary)	**Quiz part 1b** due Sat 5 pm
	Pre-recorded lecture 7 and/or Hibbeler chapters 4.6, 4.7, 4.9, 6.1, 6.2 & 8.1			
5	**Mid-term exam part 1** (online, open book)	-	-	Labs
6	Flexibility week, no classes			
7	Stress strain & types of mechanical properties	Tension test & origin of mechanical properties	Tension test & origin of mechanical properties	Labs
8	Yielding & work hardening	Deformation & dislocation	Strengthening mechanisms	-
9	Strengthening mechanisms	Creep deformation & mechanism	Fracture and fatigue	Labs
10	Fracture and fatigue	Effects of temperature & strain rate on mechanical properties	Revision	Assignment part 2 due

Lab classes run weeks 3-9, face to face or online

Week	Lab		Tuesday	Wednesday	Thursday	Data / Video Provided on Tuesday
3	**Tensile**	**1st hour**	**Group 1** (1100-1200)	**Group 3** (1000-1100)	**Group 6** (1400-1500)	Online Group
		2nd hour	**Group 2** (1200-1300)	**Group 4** (1400-1500)	--	
		3rd hour	--	**Group 5** (1500-1600)	--	
5	**Hardness**	**1st hour**	**Group 1** (1100-1200)	**Group 3** (1000-1100)	**Group 6** (1400-1500)	Online Group
		2nd hour	**Group 2** (1200-1300)	**Group 4** (1400-1500)	--	
		3rd hour	--	**Group 5** (1500-1600)	--	
7	**Strain rate**	**1st hour**	**Group 1** (1100-1200)	**Group 3** (1000-1100)	**Group 6** (1400-1500)	Online Group
		2nd hour	**Group 2** (1200-1300)	**Group 4** (1400-1500)	--	
		3rd hour	--	**Group 5** (1500-1600)	--	
9	**Charpy**	**1st hour**	**Group 1** (1100-1200)	**Group 3** (1000-1100)	**Group 6** (1400-1500)	Online Group
		2nd hour	**Group 2** (1200-1300)	**Group 4** (1400-1500)	--	
		3rd hour	--	**Group 5** (1500-1600)	--	

2.4 Course learning outcomes (CLO)

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

1. Use critical thinking and analytical problem-solving skills to solve material science and engineering problems
2. Understand the stress strain relationship and the application of these to mechanical behaviour of a broad range of materials
3. Identify relationships between mechanical behaviours and chemical compositions, crystal structures and microstructure of materials
4. Apply various mechanical tests and the analysis of data obtained in these tests

2.5 Relationship between course and program learning outcomes and assessments

Course Learning Outcome (CLO)	LO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Use…	1.1, 1.2, 1.3 1.4, 3.2 & 3.3	1 & 2
CLO 2	Understand…	1.3 1.4, 3.2 & 3.3	1, 2, 3 & 4
CLO 3	Identify…	1.1, 1.2, 1.3 1.4, 3.2 & 3.3	1, 2 ,3 & 4
CLO 4	Apply…	1.1, 1.2, 1.3 1.4, 3.2 & 3.3	2, 3 & 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 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.

Lectures and tutorials: The core concepts will be taught in lectures (some of which are pre-recorded); students will have access to the lecture notes before class for annotation during the lecture. In tutorials, examples and problems will be worked through step-by-step. Students will be engaged in the learning process through class discussions and problem-solving questions independently and working together with partners and groups.

Labs: Experimental techniques and procedures will be taught through laboratory classes and laboratory reports which needs to be submitted after the classes. Students watch the lab demonstration either online or face-to-face, and will be required to submit a lab assignment (within one week after the lab). Questions regarding the assignment can be directed to the demonstrator or the tutor. Data will be provided to the students after the lab. Thus, students will be able to reflect on the experiments and learn to process data through the lab reports after the online class.

3.2 Expectations of students

- Students should aim to attend at least 80% of all classes and tutorials 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. Assessment

4.1 Assessment tasks

Assessment task	Description	Weight	Due date
Assignments:	Part 1: (a) Multiple choice quiz querying solutions to problems 1a provided end of week 1 (focus: pre-recorded lectures 1-3, tutorial 1)	5%	Week 2

	(b) Multiple choice quiz querying solutions to problems 1b provided end of week 3 (focus: pre-recorded lectures 4-6, tutorials 2 and 3) Part 2: Stress & strain, creep deformation, fracture, and fatigue	5% 10%	Week 4 Week 10
Laboratory reports:	1) Tensile testing: Modulus, strength and ductility 2) Hardness testing: Microhardness, Vickers 3) Strain rate effects 4) Impact testing: Charpy	20% (5% each)	1 week after the lab is held
Mid-term exam:	Covers the content taught in the first half of the course (Part 1, pre-recorded lecture 1-7, tutorials, problems 1a and 1b). Open book exam, use any tool you need (Matlab etc). Problems like the ones discussed in lectures and tutorials, and like those in the Hibbeler book.	30%	Week 5
Final Exam:	Covers all contents taught in the second half of the course (Part 2)	30%	Final exam period

Further information

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

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

4.2 Assessment criteria and standards

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

Satisfactory completion of the course includes the requirement to achieve >35% in the mid-term exam and >35% in the final exam, and >45% weighted average over the two exams. Students who fail to achieve this will be awarded an Unsatisfactory Fail (UF) grade for the course regardless if they receive over 50% in total for the course.

The course contains 4 laboratory classes. Each takes approximately 1 hour to complete. Students will be allocated into laboratory groups (face to face or online) and a detailed timetable will be posted on Moodle prior to the first lab class.

Guidelines for laboratory reports

- Reports should be as concise as possible.
- The work performed should be communicated in a manner that enables another worker in the same discipline to repeat the experiment.
- References must be acknowledged with citations, either as footnotes or endnotes.
- Details on the required sections in the report can be found in the MATS2004 Laboratory Booklet on Moodle

4.3 Submission of assessment tasks

There will be two assignments and laboratory reports to be submitted in this course:

- The assignment for the first part of the course has two parts which will be provided to students at the end of week 1 (Part 1a), and the end of week 3 (Part 1b). Both parts are problems to be solved independently. Students will be asked to provide their solutions in short multiple-choice quizzes on Moodle at the end of weeks 2 and 4. These answers will be cross checked against notes uploaded by each student. The full solutions to these problems will be provided to students after the quizzes are closed, to help with mid-term exam preparation. No late submissions of these quizzes will be accepted.
- The Assignment for part 2 will be given in Week 8. The assignments will be due two weeks after being given. Late submission without appropriate documentation will receive a penalty of 5% per day late for maximum of 5 days. Work that is more than 5 days late will not be accepted and will receive zero mark.
- Laboratory reports are compulsory and must be submitted within **one week** after completion of the laboratory. They must be submitted with a completed student declaration sheet. If reports are submitted late, a penalty of 5% per day will be applied to the mark to a maximum of 5 days, after which the report will not be accepted.

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.

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.

4.4. Feedback on assessment

Assignments 1a and 1b: Marks will be determined based on number of correct answers in multiple choice quizzes cross checked with uploaded notes. General comments and worked solutions to all problems will be provided after the quizzes are due.

Assignment 2: Feedback will be given two weeks after submission 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, 2-3 weeks after submission.

Mid-term exam: Students will receive the mark for their midterm exam. General comments and worked solutions will be provided to the class.

Final exam: Students will receive their final mark.

5. 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.

6. Readings and resources

Prescribed reading for part 1:
Mechanics of Materials, RC Hibbeler, 10th Ed. in SI units, Pearson Global edition, 2018

Print: https://www.bookshop.unsw.edu.au/details.cgi?ITEMNO=9781292178202

Digital: https://unswbookshop.vitalsource.com/products/-v9781292178288

OR: UNSW Library (type title into search field, electronic & hardcopy versions available)

- Norman E Dowling, Stephen L Kampe and Milo V Kral, Mechanical Behavior of Materials, 5th Edition, Pearson Global Edition, 2020.
- K. Bowman, Mechanical Behavior of Materials, John Wiley, 2003
- M.F. Ashby, Materials Selection in Mechanical Design, 4th Edition, Elsevier, 2011.

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

7. 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/

8. 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.myit.unsw.edu.au/services/students
- Assessment Implementation Procedure: https://www.gs.unsw.edu.au/policy/documents/assessmentimplementationprocedure.pdf
- Special Consideration: https://student.unsw.edu.au/special-consideration