UNSW Course Outline

MATS2004 Mechanical Behaviour of Materials - 2024

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General Course Information

Course Code : MATS2004
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Materials Science & Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This core course for Level 2 students in Materials Science and Engineering extends on the fundamentals of mechanical behaviour of engineering materials introduced in 'MATS1192 Design and Application of Materials in Science and Engineering'. The first part of the course

focuses on the quantitative treatment of the mechanical behaviour of materials in response to stresses and strains. Students will learn how to describe complex stress and strain states using numerical and graphical procedures such as Mohr's circle, and how to apply this knowledge to predict failure of common materials in engineering applications. The second part focuses on the description and testing of the mechanical behaviour of common engineering materials. The basic principles of plastic deformation phenomena at room temperature versus elevated temperatures will be introduced. This knowledge will be expanded to various factors affecting mechanical behaviour, such as high temperatures, complex stress states, high strain rates, and cyclic loading.

This is a blended course with online lectures and tutorials. Four laboratory classes on materials testing techniques are delivered face-to-face.

Course Aims

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

Relationship to Other Courses

This course builds up on contents from MATS1102 or MATS1101 (completion of one of those is a prerequisite).

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Critically analyse and solve problems in mechanics and failure of common engineering materials.
CLO2 : Explain the mechanical behaviour of a range of common engineering materials using the stress-strain relationships and stress-strain transformations.
CLO3 : Identify relationships between the mechanical behaviour and properties such as the chemical composition, crystal structure, and microstructure of common engineering materials.
CLO4 : Collect and analyse data to determine the mechanical properties and failure modes of common engineering materials as a function of temperature, stress state, strain rate, and under cyclic loading conditions.

Course Learning Outcomes	Assessment Item
CLO1 : Critically analyse and solve problems in mechanics and failure of common engineering materials.	• Assignments • Mid-Session Test
CLO2 : Explain the mechanical behaviour of a range of common engineering materials using the stress-strain relationships and stress-strain transformations.	• Final Exam • Assignments • Mid-Session Test
CLO3 : Identify relationships between the mechanical behaviour and properties such as the chemical composition, crystal structure, and microstructure of common engineering materials.	• Laboratory Reports • Final Exam • Assignments
CLO4 : Collect and analyse data to determine the mechanical properties and failure modes of common engineering materials as a function of temperature, stress state, strain rate, and under cyclic loading conditions.	• Laboratory Reports • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

- *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.

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

Additional Course Information

Part 1: Quantitative Treatment of Mechanical Behaviour (Vitor Rielli)

- 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)

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

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignments Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Week 2: 03 June - 09 June, Week 4: 17 June - 23 June, Week 10: 29 July - 04 August
Mid-Session Test Assessment Format: Individual	30%	Start Date: Not Applicable Due Date: Week 5: 24 June - 30 June
Laboratory Reports Assessment Format: Individual	20%	Start Date: Not Applicable Due Date: Not Applicable
Final Exam Assessment Format: Individual	30%	Start Date: Exam Period

Assessment Details

Assignments

Assessment Overview

These assessments will enable you to practice using and applying the course content as preparation for other summative assessment items (exams and labs) throughout the Term. The combined weight of each of these items is 20%.
(Part 1a: 5% + Part 1b: 5% + Part 2: 10%)

Part 1:
(a) For this assignment, you will complete multiple choice quiz-style questions, focusing on content from pre-recorded lectures 1-3 and tutorial 1.
The task will be provided to you by the end of Week 1, and due by the end of week 2
(b) For this assignment, you will complete multiple choice quiz-style questions, focusing on content from pre-recorded lectures 4-6 and tutorial 2 and 3. The task will be provided by the end of Week 3 which is due by the end of Week 4

Part 2: For this assignment, you will complete a written assignment on the content covered in Weeks 5-10. The task will be provided by the end of Week 9 which is due by the end of Week 10.

Feedback will be given to you within one week after submission of each item and take the form of worked solutions, the mark for the item, overall comments on how the class performed, any common areas that were not answered correctly. Additionally, personal feedback on how you

performed may be given.

Course Learning Outcomes

- CLO1 : Critically analyse and solve problems in mechanics and failure of common engineering materials.
- CLO2 : Explain the mechanical behaviour of a range of common engineering materials using the stress-strain relationships and stress-strain transformations.
- CLO3 : Identify relationships between the mechanical behaviour and properties such as the chemical composition, crystal structure, and microstructure of common engineering materials.

Mid-Session Test

Assessment Overview

The mid-session test is a summative assessment designed to summarise your learning and problem-solving skills on all topics delivered across the first half of the Term, including material from lectures and tutorials. This is an online open book test in Week 5, which is typically 2hrs and consists of numerical and short answer responses - details will be confirmed during the course.

Feedback will be given to you within two weeks and take the form of worked solutions, the mark for the assessment item, overall comments on how the class performed, and any common areas that were not answered correctly. Additionally, personal feedback on how you performed may be given.

Hurdle requirement: you must achieve at least 35% in the mid-term test, as well as an average of at least 45% across the mid-term test and final exam, to receive a passing grade in the course.

Course Learning Outcomes

- CLO1 : Critically analyse and solve problems in mechanics and failure of common engineering materials.
- CLO2 : Explain the mechanical behaviour of a range of common engineering materials using the stress-strain relationships and stress-strain transformations.

Hurdle rules

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.

Laboratory Reports

Assessment Overview

This is an ongoing lab-based assessment task. You will need to attend laboratory classes (in small groups) and write a laboratory report (individually) on each of the following topics:

1) Tensile testing: Modulus, strength, and ductility
2) Impact test: Charpy
3) Hardness Tests: Microhardness, Vickers
4) Tensile testing: Strain rate effects

The rationale of this assessment is to give you hands-on experience is relevant laboratory techniques and practice applying the content covered throughout the term. The combined weight of these items is 20%.
(5% for each lab report)

You will receive a mark and individualised feedback on the areas you excelled at and areas of the report that were not answered correctly. Feedback will be provided through Moodle, two weeks after submission.

Course Learning Outcomes

- CLO3 : Identify relationships between the mechanical behaviour and properties such as the chemical composition, crystal structure, and microstructure of common engineering materials.
- CLO4 : Collect and analyse data to determine the mechanical properties and failure modes of common engineering materials as a function of temperature, stress state, strain rate, and under cyclic loading conditions.

Detailed Assessment Description

The course contains 4 laboratory classes. Each takes approximately 1 hour to complete. Students will be allocated into laboratory groups.

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.

Final Exam

Assessment Overview

The final exam is a summative assessment designed to summarise your learning and problem-solving skills on all topics delivered across the second half of the Term, including material from lectures and tutorials. The exam is typically 2hrs 10 minutes and consists of short numerical and short answer responses - details will be confirmed during the course. The examination will occur during the official university examination period.

Feedback is available through inquiry with the Course Convenor.

Hurdle requirement: you must achieve at least 35% in the final exam, as well as an average of at least 45% across the mid-term test and final exam, to receive a passing grade in the course.

Course Learning Outcomes

- CLO2 : Explain the mechanical behaviour of a range of common engineering materials using the stress-strain relationships and stress-strain transformations.
- CLO3 : Identify relationships between the mechanical behaviour and properties such as the chemical composition, crystal structure, and microstructure of common engineering materials.
- CLO4 : Collect and analyse data to determine the mechanical properties and failure modes of common engineering materials as a function of temperature, stress state, strain rate, and under cyclic loading conditions.

Hurdle rules

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.

General Assessment Information

Assessments:

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.

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.

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

Feedback on assessments

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.

Grading Basis

Standard

Requirements to pass course

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.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Part 1 intro Monday 4-6 pm Business School 119 (K-E12-119)
	Lecture	Pre-recorded lectures 1 & 2 and/or Hibbeler chapters 1, 2 & 3: at your own pace
	Tutorial	Tutorial 1 Friday 9-11am Science & Engineering G05 (K-E8-G05)
Week 2 : 3 June - 9 June	Lecture	Pre-recorded lectures 3 & 4 and/or Hibbeler chapter 9: at your own pace
	Tutorial	Tutorial 2 Wednesday 9-11am Ainsworth 202 (K-J17-202)
	Assessment	Quiz part 1a: due Saturday at 5 pm
Week 3 : 10 June - 16 June	Lecture	Pre-recorded lectures 5 & 6 and/or Hibbeler chapter 10: at your own pace
	Laboratory	Tensile Testing Wednesday Group 1: 3-4 pm Group 2: 4-5 pm Friday Group 3: 12-1 pm Group 4: 1-2 pm Group 5: 2-3 pm
Week 4 : 17 June - 23 June	Tutorial	Tutorial 3 Monday 4-6 pm Business School 119 (K-E12-119)
	Lecture	Pre-recorded lectures 7 and/or Hibbeler chapters 4.6, 4.7, 4.9, 6.1, 6.2 & 8.1: at your own pace
	Assessment	Quiz part 1b: due Saturday at 5 pm
Week 5 : 24 June - 30 June	Tutorial	Tutorial 4 Monday 4-6 pm Business School 119 (K-E12-119)
	Assessment	Mid-term exam part 1 (open book) Wednesday 9-11am Ainsworth 202 (K-J17-202)
	Laboratory	Hardness lab Wednesday Group 1: 3-4 pm Group 2: 4-5 pm Friday Group 3: 12-1 pm Group 4: 1-2 pm Group 5: 2-3 pm
Week 6 : 1 July - 7 July	Other	Flexibility week
Week 7 : 8 July - 14 July	Lecture	Wednesday (K-H6-LG05 (Tyree Energy Technology Building)) 2-4 pm: Stress, strain & types of mechanical properties Thursday (K-H6-LG05 (Tyree Energy Technology Building)) 4-6 pm: Tension test & origin of mechanical properties Friday (K-H6-LG07 (Tyree Energy Technology Building)) 1-3 pm: Tension test & origin of mechanical properties
	Laboratory	Charpy lab Wednesday Group 1: 3-4 pm Group 2: 4-5 pm Friday Group 3: 12-1 pm Group 4: 1-2 pm Group 5: 2-3 pm
Week 8 : 15 July - 21 July	Lecture	Wednesday (K-H6-LG05 (Tyree Energy Technology Building)) 2-4 pm: Yielding & work hardeninbg Thursday (K-H6-LG05 (Tyree Energy Technology Building)) 4-6 pm: Deformation & dislocations Friday (K-H6-LG07 (Tyree Energy Technology Building)) 1-3 pm: Strengthening mechanisms
Week 9 : 22 July - 28 July	Lecture	Wednesday (K-H6-LG05 (Tyree Energy Technology Building)) 2-4 pm: Strengthening mechanisms Thursday (K-H6-LG05 (Tyree Energy Technology Building)) 4-6 pm: Creep & deformation mechanisms Friday (K-H6-LG07 (Tyree Energy Technology Building)) 1-3 pm: Fracture & fatigue
	Laboratory	Strain rate lab Wednesday Group 1: 3-4 pm Group 2: 4-5 pm Friday Group 3: 12-1 pm Group 4: 1-2 pm Group 5: 2-3 pm
Week 10 : 29 July - 4 August	Lecture	Wednesday (K-H6-LG05 (Tyree Energy Technology Building)) 2-4 pm: Fracture & fatigue Thursday (K-H6-LG05 (Tyree Energy Technology Building)) 4-6 pm: Effect of temperature & strain rate on mechanical properties Friday (K-H6-LG07 (Tyree Energy Technology Building)) 1-3 pm: Revision
	Assessment	Assignment part 2 due (check Moodle page for details)

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Check below schedule and monitor Announcements forum on Moodle for updates.

Course Resources

Prescribed 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)

Recommended Resources

- 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.

Additional Costs

n.a.

Course Evaluation and Development

Feedback will be gathered via myExperience process. Students are welcome to provide feedback to the lecturers at any time if they wish.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Vitor Rielli		E10, 402.32	-	Please send me an email to make an appointment	No	No
	Jianqiang Zhang		E10, room 348	61 2 9385-5025	Please send me an email to make an appointment.	No	Yes
Lab director	Pramod Koshy		E10, room 120	+61 2 9385 6038	Please send me an email to make an appointment.	No	No

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

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. 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, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

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

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for

Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines