



## UNSW Course Outline

# MATS6106 Mechanical Properties of Materials - 2024

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## General Course Information

Course Code : MATS6106

Year : 2024

Term : Term 1

Teaching Period : T1

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 : Postgraduate

Units of Credit : 6

### Useful Links

[Handbook Class Timetable](#)

## Course Details & Outcomes

### Course Description

This course provides students with an understanding of the fundamental concepts that govern the mechanical properties of metals and alloys under stress. The course curriculum provides students with a revision of crystallography and examines the behaviour of crystalline defects,

especially different types of dislocations including slip, twinning, dislocation multiplication, cross slip, climb, dislocation interactions, and deformation of single and polycrystals. The students go through lecture sessions on stress-strain curves of metal crystals, enabling students to grasp the role of crystal structure on mechanical properties of metals and their alloys.

Through interactive online tutorials, students will have the opportunity to practice applying their theoretical knowledge, solve problems, deepen their comprehension of the subject matter and receive feedback on their learning. The course extensively covers dislocation theory and theories of the yield point and flow stress. Advanced theories on strengthening of metals, including work-hardening, solid solution strengthening, precipitation hardening and grain boundary effects are covered in detail in the lectures. The course also covers temperature dependence of flow stress, as well as the deformation and creep of materials at high-temperature. The course introduces the concept of Superalloys and composite materials to the students and the theories governing their mechanical behaviour. By the end of the course, students emerge with a profound appreciation of how dislocation theory intertwines with strengthening mechanisms to dictate and allow control over the mechanical properties of materials. This knowledge equips them to analyse and design materials with improved mechanical performance for real-world applications in industries ranging from aerospace to advanced manufacturing.

## **Course Aims**

This course aims to provide students with a foundational knowledge to relate dislocation theory and strengthening mechanisms to the mechanical behaviour of metals under stress. Systematic lectures deliver the theoretical background of the advanced theories of strengthening and introduce superalloys and composites, while the online tutorials and assignments allow students to apply the knowledge to practical problems and scenarios. This equips students to recognise and apply diverse strengthening mechanisms, preparing them to contribute effectively to materials engineering across various industries, including advanced manufacturing.

# Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the principles underlying the deformation of materials and correlate the mechanical behaviour of materials to dislocation theories.
CLO2 : Apply various strategies including work-hardening, solid solution strengthening, precipitation hardening and grain boundary to improve the mechanical strength of metals and alloys.
CLO3 : Evaluate the stress-strain curves of metals and alloys and relate their crystal structures to their mechanical behaviour under stress.
CLO4 : Explain the strengthening mechanisms at different temperature and creep resistance in materials.
CLO5 : Communicate information regarding the mechanical behaviour of metals in written format using precise scientific terminology.

Course Learning Outcomes	Assessment Item
CLO1 : Explain the principles underlying the deformation of materials and correlate the mechanical behaviour of materials to dislocation theories.	<ul style="list-style-type: none"><li>• Assignment 1</li><li>• Mid Term Test</li><li>• Final Exam</li></ul>
CLO2 : Apply various strategies including work-hardening, solid solution strengthening, precipitation hardening and grain boundary to improve the mechanical strength of metals and alloys.	<ul style="list-style-type: none"><li>• Assignment 2</li><li>• Assignment 1</li><li>• Mid Term Test</li><li>• Final Exam</li></ul>
CLO3 : Evaluate the stress-strain curves of metals and alloys and relate their crystal structures to their mechanical behaviour under stress.	<ul style="list-style-type: none"><li>• Assignment 2</li><li>• Assignment 1</li><li>• Final Exam</li></ul>
CLO4 : Explain the strengthening mechanisms at different temperature and creep resistance in materials.	<ul style="list-style-type: none"><li>• Final Exam</li></ul>
CLO5 : Communicate information regarding the mechanical behaviour of metals in written format using precise scientific terminology.	<ul style="list-style-type: none"><li>• Final Exam</li></ul>

## Learning and Teaching Technologies

Moodle - Learning Management System | Zoom | Echo 360

## Learning and Teaching in this course

You are expected to undertake a total of approximately 150 hours of work for this course,

including working through the online lessons, attending classes, completing assessments, reading the textbooks and other resources, and revising and preparing for the exam.

# Assessments

## Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment 1 Assessment Format: Individual	10%	Start Date: Week 2 Due Date: Week 5
Assignment 2 Assessment Format: Individual	10%	
Mid Term Test Assessment Format: Individual	40%	Start Date: Week 7 Due Date: Week 7: 25 March - 31 March
Final Exam Assessment Format: Individual	40%	Due Date: Exam Period

## Assessment Details

### Assignment 1

#### Assessment Overview

#### ASSIGNMENT 1:

You will complete an assignment in which you will answer questions with written explanations of phenomena related to mechanical behaviour of metals based on the theory of dislocations.

You will then submit your work for peer feedback and will also provide feedback to your peers on the clarity, correctness and completeness of their answers.

Finally, you will have an opportunity to modify your own work based on the peer feedback received before submitting your work for final assessment. The length of your submission should be ~500 words.

The aim of this assignment is to develop your understanding of, and ability to explain in writing using correct technical language, the concepts covered in Weeks 1-4. The peer feedback component will also develop your ability to think critically through assessing the clarity and correctness of other students' submissions.

The final submission for the assignment will typically be due in Weeks 5.

You will be assessed on your own submission as well as the quality of the peer feedback you provided.

Feedback will be given two weeks after submission of the assignment and take the form of the mark for the assignment, and either overall comments on how the class performed and common areas that were not answered correctly, or personal feedback on your individual performance.

#### **Course Learning Outcomes**

- CL01 : Explain the principles underlying the deformation of materials and correlate the mechanical behaviour of materials to dislocation theories.
- CL02 : Apply various strategies including work-hardening, solid solution strengthening, precipitation hardening and grain boundary to improve the mechanical strength of metals and alloys.
- CL03 : Evaluate the stress-strain curves of metals and alloys and relate their crystal structures to their mechanical behaviour under stress.

#### **Assignment submission Turnitin type**

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

## **Assignment 2**

#### **Assessment Overview**

You will be required to complete a number of number-based and theoretical problems to demonstrate the stress-strain behaviour of single and polycrystalline materials and various strengthening mechanisms. The assignment questions will be provided in Week 7 or 8 and you will be given two weeks to complete this assignment. Feedback will be given one week after submission of the assignment and take the form of the mark for the assignment, and either overall comments on how the class performed and common areas that were not answered correctly, or personal feedback on your individual performance.

#### **Course Learning Outcomes**

- CL02 : Apply various strategies including work-hardening, solid solution strengthening, precipitation hardening and grain boundary to improve the mechanical strength of metals and alloys.
- CL03 : Evaluate the stress-strain curves of metals and alloys and relate their crystal structures to their mechanical behaviour under stress.

# Mid Term Test

## Assessment Overview

This test will be held in Week 7 covering content taught in Weeks 1-5. The test is typically of two hours' duration. Questions typically include calculations, short answers and problem solving. The test is designed to assess your understanding of the behaviour of crystalline defects and their influence on metal plasticity.

Prior to the Week 7 test, there will be 3 short online practice quizzes, typically due in Weeks 2, 4 and 5. These quizzes will provide you with feedback on your learning and preparedness for the Week 7 test. The quizzes will each contribute 2% of the course mark.

You will receive your mark within two weeks of the test. Overall comments may be provided to the class.

Hurdle requirement: To pass this course you are required to achieve a 45% weighted average over the mid-term test and final exam, with a minimum of 35% achieved in each of these tasks.

## Course Learning Outcomes

- CL01 : Explain the principles underlying the deformation of materials and correlate the mechanical behaviour of materials to dislocation theories.
- CL02 : Apply various strategies including work-hardening, solid solution strengthening, precipitation hardening and grain boundary to improve the mechanical strength of metals and alloys.

## Assignment submission Turnitin type

This is not a Turnitin assignment

## Hurdle rules

To pass this course you are required to achieve a 45% weighted average over the mid-term test and final exam, with a minimum of 35% achieved in each of these tasks.

# Final Exam

## Assessment Overview

The exam will be held during the end of term examination period, covering the content taught in Weeks 5-10. The test is typically of two hours' duration with 10 minutes reading time. You will be expected to answer a number of short answer questions, including calculations, to demonstrate an understanding of strategies used to strengthen materials, as well as their application in the design of advanced alloys. You will be expected to analyse experimental research data and use

this to predict material behaviour and suggest strengthening strategies.

You will receive your final course mark; feedback is available through inquiry with the course convenor.

Hurdle requirement: To pass this course you are required to achieve a 45% weighted average over the mid-term test and final exam, with a minimum of 35% achieved in each of these tasks.

### Course Learning Outcomes

- CLO1 : Explain the principles underlying the deformation of materials and correlate the mechanical behaviour of materials to dislocation theories.
- CLO2 : Apply various strategies including work-hardening, solid solution strengthening, precipitation hardening and grain boundary to improve the mechanical strength of metals and alloys.
- CLO3 : Evaluate the stress-strain curves of metals and alloys and relate their crystal structures to their mechanical behaviour under stress.
- CLO4 : Explain the strengthening mechanisms at different temperature and creep resistance in materials.
- CLO5 : Communicate information regarding the mechanical behaviour of metals in written format using precise scientific terminology.

### Assignment submission Turnitin type

This is not a Turnitin assignment

### Hurdle rules

To pass this course you are required to achieve a 45% weighted average over the mid-term test and final exam, with a minimum of 35% achieved in each of these tasks.

## **General Assessment Information**

### **Short Extensions:**

The School of Materials Science and Engineering has reviewed its range of assignments and projects to determine their suitability for automatic short extensions as set out by the UNSW Short Extension Policy. After consultation with teaching staff and examination of our course offerings, we consider our current deadline structures already accommodate the possibility of unexpected circumstances that may lead students to require additional days for submission. Consequently, the School does not offer the Short Extension provision in its MATS courses but students, if needed, can apply for formal Special Consideration via the usual procedure.

## Grading Basis

### Standard

## Requirements to pass course

To pass the course, you must:

- 1) achieve an overall grade of at least 50%;
- 2) achieve at least 35% in both the mid-term test (Week 7 component) and the final exam, as well as an average of at least 45% across the mid-term test and final exam

# Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 5 February - 11 February	Online Activity	Complete "Module 0" revision tutorials - <a href="https://mats3001.teaching.unsw.edu.au/">https://mats3001.teaching.unsw.edu.au/</a>
Week 1 : 12 February - 18 February	Lecture	Monday, 12pm-2pm: Introduction to the course; Revision of crystallography Wednesday, 1pm-3pm: Revision of Miller indices (optional) Friday, 10am-11am: Q&A drop-in session (optional)
	Online Activity	Complete "Module 1" online lessons, 1A, 1B and 1C - <a href="https://mats3001.teaching.unsw.edu.au/">https://mats3001.teaching.unsw.edu.au/</a>
Week 2 : 19 February - 25 February	Lecture	Wednesday, 1pm-3pm: Theoretical and actual strength of metals, Defects in crystal Friday, 10am-11am: Dislocations practice questions, Q&A drop-in session (optional)
	Online Activity	Complete "Module 1" online lessons, 1D and 1E - <a href="https://mats3001.teaching.unsw.edu.au/">https://mats3001.teaching.unsw.edu.au/</a>
	Assessment	Assignment 1 released
Week 3 : 26 February - 3 March	Lecture	Monday, 12pm-2pm: Energy of dislocations Wednesday, 1pm-3pm: Forces between dislocations Friday, 10am-11am: Q&A drop-in session (optional)
	Online Activity	Complete "Module 1" online lesson 1F, and "Module 2" online lesson 2A - <a href="https://mats3001.teaching.unsw.edu.au/">https://mats3001.teaching.unsw.edu.au/</a>
Week 4 : 4 March - 10 March	Lecture	Wednesday, 1pm-3pm: Macroscopic phenomena Friday, 10am-11am: Q&A drop-in session (optional)
	Online Activity	Complete "Module 2" online lessons, 2B and 2C - <a href="https://mats3001.teaching.unsw.edu.au/">https://mats3001.teaching.unsw.edu.au/</a>
Week 5 : 11 March - 17 March	Lecture	Monday, 12pm-1pm: Q&A drop-in session (optional) Wednesday, 1pm-3pm: Comparison of metals with different crystal structures
	Online Activity	Complete "Module 2" online lesson 2D - <a href="https://mats3001.teaching.unsw.edu.au/">https://mats3001.teaching.unsw.edu.au/</a>
	Assessment	Assignment 1 due
Week 6 : 18 March - 24 March	Lecture	Wednesday, 1pm-3pm: Revision class (optional)
	Assessment	Assignment 1 peer assessment due
Week 7 : 25 March - 31 March	Assessment	Monday, 12pm-2pm: Mid-term test
Week 8 : 1 April - 7 April	Lecture	
Week 9 : 8 April - 14 April	Lecture	
Week 10 : 15 April - 21 April	Lecture	



# Attendance Requirements

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

## Course Resources

### Recommended Resources

- D. Hull and D.J. Bacon, Introduction to Dislocations, 5th Ed., 2011
- M.A. Meyers and K.K. Chawla, Mechanical Behavior of Materials, 2nd Ed., 2008
- W.K. Honeycombe, The Plastic Deformation of Metals, 1968
- G.E. Dieter, Mechanical Metallurgy, 3rd Ed., 1988
- R.E. Reed-Hill and R. Abbaschian, Physical Metallurgy Principles, 1994
- R.E. Smallman and R. Bishop, Metals and Materials, 1996
- D.N. Duhl., G. Maurer, S. Antolovich, C. Lund and S. Reichman, Superalloys 1988, The Metallurgical Society, Warrendale, PA, USA, 1988
- E.A. Loria Superalloys 718, 625 and various derivatives. The Minerals, Metals & Materials Society, Warrendale, PA, USA, 1989

## Course Evaluation and Development

Feedback will be gathered through the myExperience process at the end of the term. Students should make their feedback as specific as possible so the action required to improve the course is clear. Often the feedback received from myExperience is too general or non-specific to allow course improvements to be made.

While the myExperience process will help to improve the course for future cohorts, we also want to make the learning experience the best possible for current students. Students are welcome to provide feedback to the lecturers at any time they wish, either by email, discussing in person or using the anonymous feedback forum in Moodle. There are many changes that can be made during the term to improve the students' learning experience, but improvements can only be made if students make staff aware of the issues that are affecting their learning experience.

An example of a change made to MATS6106 based on previous feedback: Additional classes have been included to allow time to cover content at a slower pace and to provide more opportunities to review content from the online lessons. Also, the 3 formative quizzes in the first part of the course were introduced to provide additional feedback to help students prepare for the mid-term exam.

# Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Lecturer	Judy Hart		Room 339, Hilmer Building	02 9385 7998	By email and appointment	No	No
Convenor	Tushar Kumeria		Hilmer, 242		By email and appointment	Yes	Yes

## 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 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. 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](#)