



Course Outline

MATS6106

Mechanical Properties of Materials

Materials Science and Engineering

Science

T1, 2021

1. Staff

| Position | Name | Email | Consultation times and locations | Contact Details |
|-----------------|---------------------------|--|--|------------------|
| Course Convenor | Professor Jianqiang Zhang | j.q.zhang@unsw.edu.au | Room 348, School of Materials Science and Engineering (Building E10), by appointment | Phone: 9385 5025 |
| Lecturer | Dr Judy Hart | j.hart@unsw.edu.au | Room 339, School of Materials Science and Engineering (Building E10), by appointment | Phone: 9385 5386 |

2. Course information

Units of credit: 6

Pre-requisite(s): None

Timetabling website: <http://timetable.unsw.edu.au/2021/MATS6106.html>

Teaching times and locations:

| | Lecture | Lecture | Lecture |
|----------|----------------|----------------|----------------|
| Day | Monday* | Tuesday* | Thursday |
| Location | Virtual online | Virtual online | Virtual online |
| Time | 11:00-13:00 | 9:00-11:00 | 14:00-16:00 |
| Weeks | 1-5, 7, 9, 10 | 1-5, 7-10 | 1-5, 7-10 |

*Note that the majority of content for this course in Weeks 1-5 will be delivered asynchronously, through online tutorials, which you will complete in your own time. There will be a live, online class on Thursdays each week for Q&A and problem solving. There may be some extra live classes scheduled using the timetabled sessions on Mondays and Tuesdays, as required – these will be advised in class and through Moodle.

2.1 Course summary

Crystallography revision. Theoretical strength; slip; twinning; deformation of single and polycrystals; dislocation multiplication; cross slip; climb; dislocation interactions. Strain-strain curves of different metal crystals. Theories of the yield point and flow stress. Temperature dependence of flow stress, high-temperature deformation and creep. Advanced theories on strengthening mechanisms of metals. Superalloys and composite materials to be taught illustrating some of the principles involved.

2.2 Course aims

To relate dislocation theory and strengthening mechanisms to the mechanical behaviour of materials. Advanced theories of strengthening will be introduced in the course. These principles will be illustrated with respect to superalloys and composite materials.

2.3 Course learning outcomes (CLO)

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

1. Understand the principles underlying the deformation and strengthening of materials
2. Articulate the common strategies used to strengthen materials
3. Understand strengthening mechanisms at different temperature and creep resistance in materials

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 | Understand... | 5 | Assignment 1, Mid-term exam, Assignment 2 & Final exam |
| CLO 2 | Articulate... | 1 | Assignment 2 & Final exam |
| CLO 3 | Understand... | 5 | Assignment 2 & Final exam |

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 on the deformation and strengthening behaviour of materials, and in analysis and evaluation of the mechanical behaviour of metals.

- Effective learning is supported by a climate of inquiry where students feel appropriately challenged.
- Problems involving dislocation theory are challenging; students will be given assignments that will motivate deep analysis of various deformation and strengthening phenomena in materials science and engineering.
- Learning is more effective when students' prior experience and knowledge are recognised and built on.

This course is built on prior courses in mathematics, physics and materials science.

- Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts

Students will be asked to analyse the role of dislocations in understanding various strengthening mechanism of metals and how properties such as strength, ductility and high temperature deformation are affected by dislocation.

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 online tutorials, 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.

| Week | Topics | Activity |
|------|--|---|
| 1 | Revision of crystallography Defects in materials Properties of dislocations | Online tutorials |
| 2 | Movement of dislocations Dislocation interactions | Online tutorials |
| 3 | Sources of dislocations Relating dislocation behaviour to macroscopic effects Dislocations in FCC crystals | Online tutorials Formative online quiz |
| 4 | Dislocations in HCP and BCC crystals | Online tutorials |
| 5 | Dislocations in covalent and ionic crystals Stress-strain curves for single crystals | Online tutorials Assignment 1 due |
| 6 | Flexibility week – revision class | |
| 7 | Stress-strain curves for polycrystals Theories of the yield point – Johnston and Gilman mechanism, Cottrell and Bilby Mechanism for solid solution, Proterin-Le Chatelier Effect; significance of Lüders band in metal working Flow Stress – Bauschinger effect, short range and long-range obstacles, effect of temperature on flow stress. | Mid-term exam (Monday) |
| 8 | Flow stresses- Rate-controlling deformation mechanisms in metals at different temperatures Advanced theories on strengthening mechanisms - Taylor and Mott theories vs modern work hardening theories; factors affecting solid solution; theories of solid solution strengthening; | |
| 9 | Advanced theories on strengthening mechanisms - effect of particle size and work hardening of two phase alloys, collapses of Orowan loop; The role of grain boundaries in different crystal forms on Hall-Petch relationship | Assignment 2 |
| 10 | Aging hardening and strengthening at high temperature to resist creep. | |

5. Assessment

5.1 Assessment tasks

| Assessment task | Description | Weight | Due date |
|-----------------------|--|--------|-------------------|
| Online quiz: | You will be required to undertake calculations involving the application of dislocation theory to topics covered in Weeks 1-3 | 0% | Week 3 |
| Assignment 1: | You will work in groups to answer questions relating to the key concepts covered in Weeks 1-3 | 10% | Week 5 |
| Midterm exam*: | You will answer questions and solve problems relating to information learnt in Weeks 1-5 | 40% | Week 7 |
| Assignment 2: | Students will be required to complete a problem-based assignment in the second half (Week 6 – Week 10) of the course. | 10% | Week 10 |
| Final exam: | The exam will be 2hrs in duration and held in the final exam period. It will cover topics taught in the second half of the course. | 40% | Final exam period |

* Mid-term exam will be held on Monday, Week 7, 11.00-13.00.

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 standards will be available on the course Moodle page.

Students who fail to achieve a score of at least 40% of the maximum marks for either the Mid-term Examination and/or Final Examination but achieve a final mark >50% for the course, may still be awarded a UF (Unsatisfactory Fail) for the course.

5.3 Submission of assessment tasks

- 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.

5.4. Feedback on assessment

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 mark and overall comments on the midsession exam will 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.

Referencing style: Students should use the **Harvard method** for referencing in their assignments.

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>.

7. Readings and 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

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

- 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

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>