Course Outline

MATS6106

Mechanical Properties of Materials

Materials Science and Engineering

Science

T1, 2022

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/2022/MATS6106.html

Teaching times and locations:

	Lecture	Lecture	Lecture
Day	Tuesday*	Wednesday*	Friday*
Location	Virtual online	Virtual online	Virtual online
Time	10:00-12:00	14:00-16:00	15:00-17:00
Weeks	1-5, 7-10	1-5, 7-10	1-5, 7, 8, 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 Wednesdays each week for Q&A, problem solving and some additional content not covered in the online tutorials. In addition, Dr Hart will be available online to answer questions on Fridays at 15:00 in Weeks 1-6. There may be some extra live classes scheduled using the timetabled sessions on Tuesdays and Fridays, 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

You are expected to undertake a total of approximately 150 hours of work for this course, including working through the online tutorials, attending live online classes, completing assessments, reading the textbooks and other resources, and revising and preparing for the exam.

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	Online tutorials Assignment 1 due
6	Flexibility week – revision class	
7	Stress-strain curves for single crystals and polycrystals Theories of the yield point – Johnston and Gilman mechanism, Cottrell and Bilby Mechanism for solid solution, Protevin-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 (Tuesday)
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 Tuesday, Week 7, 10.00-12.00.**

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.

NOTE: 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.

Please refer to the UNSW guide to grades: https://student.unsw.edu.au/grades

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.

- Online exams will be opened for a limited amount of time; students must complete the exam during the allocated time and only have one attempt.
- Unless otherwise specified in the task criteria, all assignments/assessment tasks must be completed prior to the due date.
- Where late submissions are accepted, assignments submitted after the due date for submission will receive a penalty of 5% of the maximum grade for every day late, or part thereof. Assignments will not be accepted if they are more than 5 days late.
- 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 an Equitable Learning Advisor in Equitable Learning Services: https://student.unsw.edu.au/els. 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.

Mid-term exams: Students will receive their mark and overall comments on the mid-term 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

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

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
- 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