Course Outline

MATS3005

Phase Transformations

Materials Science and Engineering

Science

T1, 2022

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor and Lecturer	Prof. Michael Ferry	m.ferry@unsw.edu.au	Room 341, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 4453
Lecturer	Prof. Nagarajan Valanoor	nagarajan@unsw.edu.au	Room 247, School of Materials Science and Engineering (Building E10), by appointment	Phone: 9385 4263

2. Course information

Units of credit: 6

Pre-requisite(s): MATS2003, MATS2006 and MATS2008

Timetabling website: http://timetable.unsw.edu.au/2022/MATS3005.html

Teaching times and locations:

	Lecture	Lecture	Lecture
Day	Monday	Wednesday	Friday
Location	Online	Online	Online
Time	16:00-18:00	12:00-14:00	12:00-14:00
Weeks	1-5, 7-9	1-5, 7-10	7-8,10

2.1 Course summary

Nucleation in the liquid and solid states; thermodynamics of phase transformations; solidification of pure metals and alloys; thermal supercooling; constitutional supercooling; interface stability; solute redistribution; glass formation; crystal growth techniques.

Solid-state transformations: nucleation and growth of phases; diffusion mechanisms; transformation kinetics; transformation diagrams. Diffusional and diffusionless transformations: decomposition of solid solutions; ordering reactions, spinodal decomposition; eutectoid, bainitic and martensitic transformations. Ferroic phase transformations. Ginzburg Landau Devonshire phenomenological theory. Applications of phase transformations in functional materials.

2.2 Course aims

The aim of this course is to gain an understanding of the role of phase transformations on the development of microstructure and properties of metallic, ceramic and polymeric materials. The course will highlight a number of commercially-significant applications where phase transformations are important.

2.3 Course learning outcomes (CLO)

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

1. Demonstrate high-level critical thinking, analytical and problem-solving skills in approaching materials science and engineering practice
2. Identify the principles underlying liquid-to-solid and solid-state phase transformations in a range of materials
3. Apply the principles of phase transformations to control microstructure and properties in engineering alloys

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	Demonstrate…	1.3, 1.4, 3.2, 3.3 & 3.4	1, 2, 3 & 4
CLO 2	Display…	1.3, 1.4, 3.2, 3.3 & 3.4	1, 2, 3 & 4
CLO 3	Show…	1.3, 1.4, 3.2, 3.3 & 3.4	1, 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: The core concepts will be taught in lectures; students will have access to the lectures notes before class for annotation during the lecture. Students will be engaged in the learning process through class discussions and problem-solving questions both independently and working together with partners and groups.

3.2 Expectations of students

- Students must attend at least 80% of all online classes 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. Course schedule and structure

This course consists of 52 hours of class contact hours. You are expected to take an additional 98 hours of non-class contact hours to complete assessments, readings and exam preparation spread over the term.

Week	Topics	Activity
1	Classification of phase transformations Solidification of pure and impure materials	
2	Solidification of pure and impure materials Solute redistribution and coring	
3	Generation of as-cast structures during solidification Single crystal growth techniques	Assignment Part 1A
4	Rapid solidification processing, glass formation and crystallization Summary of Part 1	
5	Mid-term exam (Friday, week 5) Monday, Week 5 - Part 2 commenced by Prof. Valanoor Revision of Fick's Laws/Diffusion controlled growth	Mid-term exam
6	Study break	
7	Diffusion controlled growth/tutorial Revision of content/tutorial style questions	Assignment Part 1B
8	Spinodal decomposition Martensitic phase transitions Tutorial on spinodal decomposition/Revision of content	
9	Introduction to dielectrics/ferroelectrics Landau Theory/applications of ferroelectrics	
10	Summary and revision for exam of Part 2	Research paper

5. Assessment

5.1 Assessment tasks

Assessment task	Description	Weight	Due date
Assignment:	Assignments will include ONE problem sheet for weeks 1-5 (Part 1) of the course in order to achieve learning outcomes and develop the various graduate attributes.	25%	Part 1: Week 3 Part 2: Week 7
Mid-term exam:	The aim of this multiple-choice quiz is to assess students' skills in solving problems concerning basic phase transformation phenomena and solidification processing, and their importance and applications in materials science and engineering (Part 1).	25%	Week 5
Assignment:	Research paper	20%	Week 10
Final Assessment:	**Final exam:** Final exam will cover week 8-10 of the course conducted via Moodle. It will be open book and consist of a combination of essay-style answers and calculations. Any derivations will assume knowledge of the material rather than memorizing equations: relevant background equations will always be provided. This exam will be held in final exam period.	30%	Scheduled during final exam period.

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

Assessment criteria and standards for each assessment tasks are available on the course Moodle page.

Each assignment in Part 1 of the course will be graded on a rating scale of (1)-(5), where the highest rating (1) denotes: (i) a correct mathematical solution to the problem together with a logical 2-5 line written explanation of the meaning of the result, or (ii) a thorough written explanation of the question if it is an essay-type one (full marks), through to (5), which indicates that no attempt was made to answer the question (no marks). This rating is converted to the value of the mark for each question.
All assessment criteria and standards are available on the course Moodle page.

For the Part 2 Research Paper, the marking criteria is provided on page 7.

Important Note on Unsatisfactory Fail (UF) Grades

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 the above will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of receiving ≥ 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

- Completed Assignments 1A and 1B (Part 1) must be emailed directly to the course coordinator's EA, Nicole Cooney (n.cooney@unsw.edu.au).
- Students completing the Part 2 Research Paper are required to submit the paper electronically via Moodle.

NOTE: Please use your UNSW email, including zID, when submitting. Lecturers will not be responsible for checking emails sent via private servers.

- UNSW operates under a Fit to Sit/ Submit rule for all assessments. If a student wishes to apply 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.
- Submission of an assignment after the agreed deadline is permitted for up to five days (120 hours) after the deadline, but work submitted after this time will not be accepted.
- Late submissions will attract a penalty of 5% per day.
- 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.
- Rules governing conduct during exams are given at: https://student.unsw.edu.au/exam-rules

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.

Mid-term quiz: Students will not receive their marked multiple-choice quiz but will receive their total mark. Overall comments and solutions may be provided in class.

Final assessment: Students only receive their final mark.

MARKING SHEET for MATS3005 Part 2 Research Paper

Abstract (~200 words)

1.	Quality of Abstract.....	/20		
2.	English expression and spelling	/10		
3.	Formatting & general impression.....	/10		
	Mark:	/40	_____	**/10**

Introduction and Literature Review (~ 1.5 page)

1.	Level of presentation, extent and relevance.....	/10		
2.	Critical assessment of the literature.....	/10		
3.	Clarity of report goals.....	/10		
	Mark:	/40	_____	**/20**

Experimental Procedure (~1 page)

1.	Completeness and clarity of experimental outline (Note you should also compare and contrast the experimental procedures with other cases available in literature)	/10	_____	**/5**

Discussion and Conclusions (~3.5 pages)

1.	Level of understanding	/10		
2.	Interpretation of results and sophistication of analysis	/10		
3.	Handling and identification of errors	/10		
4.	Comparison with other data.....	/10		
5.	Achievements with respect to project aims.....	/10		
	Mark:	/50	_____	**/35**

Overall report quality

1.	Completeness of report.....	/10		
3.	Quality, logic and organisation of arguments	/10		
4.	Use of graphs, figures and tables to summarise results.....	/10		
5.	Referencing (~1 page).....	/30		

TOTAL MARK: _____ **/100**

Note:

(1) Your report should be a maximum of 10 pages (including references) with two to three figure panels. Make sure the figures are in high quality and simply not copy and paste. Figures may be embedded within text. The font size should be 12 and margins should be set at 2.5 cm for left and right, and 1.75 cm for top and bottom. The text must be double-spaced.

(2) The references must be in the style format given by AIP Manual . For references I recommend using the software Endnote available to all UNSW students. All references must be peer reviewed publications and not URLs. Marks will be deducted if using URLs. References can be in Font size 10 and single spaced

(3) Captions may be in font size 10 and single spaced. Pls **bold** captions

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. If you compare a calculated result in an assignment with an experimental value taken from the literature, please reference the source: Authors, publication & date.

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

Preferred textbook:

- Phase Transformations in Metals and Alloys, Third Edition. D.A. Porter, K.E. Easterling, M. Sherif ISBN-13: 978-1420062106

Other suitable books at elementary level:

- Physical Metallurgy Principles, R.E. Reed-Hill and R. Abbaschian (1992).
- Direct Strip Casting of Metals and Alloys, M. Ferry, CRC Press (2006).
- Modern Physical Metallurgy: R.E. Smallman (1985).
- Light Alloys: I.J. Polmear, 3rd edition, Edward Arnold (1995).
- Steels – Microstructure and Properties, R.W.K. Honeycombe and H.K.D.H. Bhadeshia, Edward Arnold (1995).
- Principles and applications of Ferroelectrics and related materials, M.E. Lines and A.M. Glass (Oxford University Press)

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/

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

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