Course Outline

MATS3005

Phase Transformations

Materials Science and Engineering

Science

T1, 2020

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 and MATS2006 and MATS2008

Timetabling website: http://timetable.unsw.edu.au/2020/MATS3005.html#S1-8530

Teaching times and locations:

	Lecture	Lecture	Lecture
Day	Monday	Wednesday	Thursday
Location	Science & Engineering B24	Science & Engineering G02	Science & Engineering G02
Time	11:00-13:00	15:00-17:00	13:00-15:00
Weeks	1-5, 7-10	1-5, 7-10	1-5, 7-10

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 independently and working together with partners and groups.

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 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 A
4	Rapid solidification processing, glass formation and crystallization	
5	Summary of Part 1 & mid-term exam Week 5 Thursday- Part 2 given by Prof. Valanoor commences 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 B
8	Spinodal decomposition Martensitic phase transitions Tutorial on spinodal decomposition/Revision of content	
9	Mid-session Quiz (20%-open book) (Monday) Introduction to dielectrics/ferroelectrics Landau Theory	Quiz
10	Piezoresponse Force Microscopy Neutron diffraction Summary of Part 2	

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 exam is to assess students' skills in solving problems concerning solidification processing and its application to materials science and engineering (Part 1). It will consist of a combination of essay-style questions and calculations.	25%	Week 5
Quiz:	The quiz will be held in class and cover the content taught in weeks 7-8	20%	Week 8
Final Assessment:	**Final exam:** Open book exam will cover week 9-10 of the course. It will 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. 1 hour. This exam will be invigilated by school although it will be held in final exam period.	30%	Final Exam-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 and mid-term exam questions 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.

See next page for optional research paper marking criteria.

NOTE: Students who fail to achieve an average score of at least 40% for the overall exam component (i.e., average mark of the mid-session exam, week 10 exam and final exam combined), but achieve a final mark >50% for the course, will be awarded a UF (Unsatisfactory Fail) for the course.

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

5.3 Submission of assessment tasks

Students completing the Optional Research Paper are required to submit the paper electronically via email and Moodle. Every day late after the deadline will attract a 10% penalty.

1. Submit it directly to
   nagarajan@unsw.edu.au
   Use subject: Final_report_[Topic]MATS3005_LastName2019. The report must be a pdf file.
2. Also upload it to the Moodle course page so that your assignment is not lost in my email. The Moodle link will close at 6.00 pm May 6th 2019.

NOTE: Please use your UNSW email id when submitting. I 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 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 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.
- 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.

Midsession exams/ quizzes: Students will receive their marked exams indicating what questions were answered correctly and incorrectly. Overall comments and worked solutions may be provided to the class.

Final assessment: 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. 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/

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

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