UNSW Course Outline

MATS3005 Phase Transformations - 2024

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General Course Information

Course Code : MATS3005
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 : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course introduces students to the various transformations that occur in metals, ceramics, and polymers, emphasising how transformations may be exploited to manipulate the microstructure of these materials, thereby enhancing their processability, properties, and performance.

The course begins by discussing the limitations of phase equilibria and introducing key concepts such as time, driving force, and interfaces to explain transformation mechanisms. It utilises fundamental principles of thermodynamics, diffusion, and reaction kinetics to elucidate phase nucleation and growth, overall transformation kinetics, microstructural development, non-equilibrium phase formation, and the origin of isothermal and continuous cooling transformation diagrams.

The course then covers the principles of solidification, including cast structure development, microsegregation, interface stability, single crystal growth, glass formation, and devitrification, through to the mechanisms of solid-state, diffusional and non-diffusional transformations and the formation of precipitates, pearlite, bainite, martensite, ordered domains, and recrystallized microstructures.

Students will learn throughout the course how transformations play a vital role in modern materials manufacturing, such as continuous casting of metals, semiconductor fabrication, polymer processing, glass manufacturing, materials welding, additive manufacturing, and thermal and mechanical processing.

The course includes lectures, problem-solving sessions, assignments, and tests.

Previous knowledge of thermodynamics, phase equilibria, and transport phenomena is required.

Course Aims

The aim of this course is to provide students with a comprehensive understanding of the role of phase and other structural transformations in the development of microstructure and properties of metallic, ceramic, and polymeric materials. The course will also highlight various technologically significant processes and engineering applications where transformations are important.

Relationship to Other Courses

The course requires background knowledge of elementary calculus, thermodynamics, phase equilibria, crystallography, diffusion and kinetics.

Prerequisites: MATS2003 and MATS2006 and MATS2008

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the key thermodynamic and kinetic criteria required for a phase transformation to occur, and their influence on overall transformation kinetics and final microstructure.
CLO2 : Solve quantitative problems relating to phase transformations by employing advanced critical thinking and analytical skills.
CLO3 : Design simple thermal and mechanical processing routes to optimise the microstructure and properties in a diverse range of materials.
CLO4 : Review published literature on a selected topic on solid-state transformations and critically analyse the information via a written report.
CLO5 : Discuss how phase transformations play an important role in the industrial processing of engineering materials.

Course Learning Outcomes	Assessment Item
CLO1 : Explain the key thermodynamic and kinetic criteria required for a phase transformation to occur, and their influence on overall transformation kinetics and final microstructure.	• Mid-Term Test • Final Exam
CLO2 : Solve quantitative problems relating to phase transformations by employing advanced critical thinking and analytical skills.	• Assignments • Mid-Term Test • Final Exam
CLO3 : Design simple thermal and mechanical processing routes to optimise the microstructure and properties in a diverse range of materials.	• Assignments
CLO4 : Review published literature on a selected topic on solid-state transformations and critically analyse the information via a written report.	• Term Paper
CLO5 : Discuss how phase transformations play an important role in the industrial processing of engineering materials.	• Term Paper • Mid-Term Test • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | Echo 360

Learning and Teaching in this course

(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, 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.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignments Assessment Format: Individual	25%	Start Date: Weeks 1 and 4 Due Date: Weeks 3 and 5
Mid-Term Test Assessment Format: Individual	25%	Start Date: 13/03/2024 03:00 PM Due Date: 13/03/2024 04:00 PM
Term Paper Assessment Format: Individual	20%	Start Date: Week 8 Due Date: Week 10
Final Exam Assessment Format: Individual	30%	Start Date: Formal exam period. Due Date: Formal exam period.

Assessment Details

Assignments

Assessment Overview

You will complete a problem sheet that covers the first five weeks of the course. This problem sheet will test your skills in solving quantitative problems concerning basic phase transformation phenomena and designing simple processing routes for optimising material structure and properties. The problem sheet contains two equally-weighted components that will be released on Moodle in Weeks 2 and 5, respectively, and must be completed two weeks after their release.

Feedback: You will receive your marks two weeks after submission of each component of the problem sheet. The marked components will include overall comments on how you performed, and comments in areas that were not answered correctly. A detailed answer sheet will also be provided showing the correct working for each question.

Course Learning Outcomes

- CLO2 : Solve quantitative problems relating to phase transformations by employing advanced critical thinking and analytical skills.
- CLO3 : Design simple thermal and mechanical processing routes to optimise the microstructure and properties in a diverse range of materials.

Detailed Assessment Description

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.

Assessment Length

Assignment questions are mainly calculations.

Submission notes

Please email completed assignment to Michael Ferry.

Assignment submission Turnitin type

Not Applicable

Mid-Term Test

Assessment Overview

This 1-hour multiple-choice test in Week 5 will assess your understanding of the theory of phase transformations, your skills in solving problems concerning basic phase transformation phenomena and solidification processing, and the importance and applications of phase transformations in materials science and engineering (Part 1). Approximately 25% of the multiple-choice questions involve calculations. Relevant background equations will be provided in a single equation sheet prior to the test.

Feedback: You will receive your test grade within two weeks of completing the test.

Hurdle requirement: Satisfactory completion of the course includes the requirement that you achieve at least 35% in the mid-term test and at least 35% in the final exam, and at least 45% weighted average over the two tests. If you fail to achieve these hurdles, you will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of receiving at least 50% in total for the course.

Course Learning Outcomes

- CLO1 : Explain the key thermodynamic and kinetic criteria required for a phase transformation to occur, and their influence on overall transformation kinetics and final microstructure.
- CLO2 : Solve quantitative problems relating to phase transformations by employing advanced critical thinking and analytical skills.
- CLO5 : Discuss how phase transformations play an important role in the industrial processing of engineering materials.

Assessment Length

1-hour

Submission notes

Online submission

Assignment submission Turnitin type

Not Applicable

Hurdle rules

See overview.

Term Paper

Assessment Overview

You will present an 8-page individual report involving a critical literature review of one of the provided list of topics on phase transformations. . The assessment criteria will be provided in detail on the term paper cover sheet. The term paper will be submitted and assessed electronically and will be checked for similarity with other students' work and internet sources including the use of generative AI. The assignment will open for submission in Week 8 and close in Week 10. The topics will be made available in Moodle.

Feedback: You will receive your marked term paper. Overall comments and feedback will be provided in writing two weeks after submission.

Course Learning Outcomes

- CLO4 : Review published literature on a selected topic on solid-state transformations and critically analyse the information via a written report.
- CLO5 : Discuss how phase transformations play an important role in the industrial processing of engineering materials.

Assessment Length

8-page assignment.

Assignment submission Turnitin type

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

Final Exam

Assessment Overview

The final exam, covering content on solid-state transformation in Weeks 7-10 of the course, will consist of a combination of essay-style answers and calculations. Any derivations will assume knowledge of the material rather than memorising equations: relevant background equations will always be provided. This exam is held in the final exam period.

Hurdle requirement: Satisfactory completion of the course includes the requirement that you achieve at least 35% in the mid-term test and at least 35% in the final exam, and at least 45% weighted average over the two tests. If you fail to achieve these hurdles, you will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of receiving at least 50% in total for the course.

Feedback is available through inquiry with the course convenor.

Course Learning Outcomes

- CLO1 : Explain the key thermodynamic and kinetic criteria required for a phase transformation to occur, and their influence on overall transformation kinetics and final microstructure.
- CLO2 : Solve quantitative problems relating to phase transformations by employing advanced critical thinking and analytical skills.
- CLO5 : Discuss how phase transformations play an important role in the industrial processing of engineering materials.

Assessment Length

1-hour

Assignment submission Turnitin type

Not Applicable

Hurdle rules

See overview.

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

Satisfactory completion of the course includes the requirement that you achieve at least 35% in the mid-term test and at least 35% in the final exam, and at least 45% weighted average over the two tests. If you fail to achieve these hurdles, you will be awarded an Unsatisfactory Fail (UF) grade for the course regardless of receiving at least 50% in total for the course.

Course Schedule

Attendance Requirements

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

General Schedule Information

Please refer to the Course Schedule on Moodle.

Course Resources

Prescribed Resources

Lecture notes, PowerPoint slides and backround reading material will be posed on Moodle prior to each lecture.

Recommended 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)

Course Evaluation and Development

The myTeaching and myCourse comments from the previous year's course will be analysed and feedback provided on Moodle.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Michael Fe rry		School of Materials Science and Engineering. Hilmer Building (E10), Room 343.		Please email for my availability.	No	Yes
Lecturer	Nagy Vala noor		School of Materials Science and Engineering. Hilmer Building (E10), Room 247.		Please email for my availability.	No	No

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 Plagarism

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