Course Outline

MATS3005
Phase Transformations
Materials Science and Engineering
Science
T1, 2019
1. Staff

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Email</th>
<th>Consultation times and locations</th>
<th>Contact Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Convenor</td>
<td>Prof. Michael Ferry</td>
<td><a href="mailto:m.ferry@unsw.edu.au">m.ferry@unsw.edu.au</a></td>
<td>Room 341, School of Materials Science and Engineering (Building E10), by appointment</td>
<td>Phone: 9385 4453</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Dr Chunguang Tang</td>
<td><a href="mailto:chunguang.tang@unsw.edu.au">chunguang.tang@unsw.edu.au</a></td>
<td>Room 341, School of Materials Science and Engineering (Building E10), by appointment</td>
<td></td>
</tr>
<tr>
<td>Lecturer</td>
<td>Prof. Nagarajan Valanoor</td>
<td><a href="mailto:nagarajan@unsw.edu.au">nagarajan@unsw.edu.au</a></td>
<td>Room 247, School of Materials Science and Engineering (Building E10), by appointment</td>
<td>Phone: 9385 4263</td>
</tr>
</tbody>
</table>

2. Course information

Units of credit: 6

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


Teaching times and locations:

<table>
<thead>
<tr>
<th>Day</th>
<th>Lecture Location</th>
<th>Lecture Time</th>
<th>Lecture Location</th>
<th>Lecture Time</th>
<th>Lecture Location</th>
<th>Lecture Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monday</td>
<td>15:00-17:00</td>
<td>Tuesday</td>
<td>12:00-14:00</td>
<td>Wednesday</td>
<td>16:00-18:00</td>
</tr>
<tr>
<td></td>
<td>UNSW Business School 119</td>
<td></td>
<td>Red Centre Theatre</td>
<td></td>
<td>Chemical Sciences M10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-4, 6-9, 11</td>
<td></td>
<td>1-4, 6-9</td>
<td></td>
<td>1-9</td>
<td></td>
</tr>
</tbody>
</table>

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.

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

<table>
<thead>
<tr>
<th>Course Learning Outcome (CLO)</th>
<th>LO Statement</th>
<th>Program Learning Outcome (PLO)</th>
<th>Related Tasks &amp; Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLO 1</td>
<td>Demonstrate…</td>
<td>1.3, 1.4, 3.2, 3.3 &amp; 3.4</td>
<td>1, 2, 3 &amp; 4</td>
</tr>
<tr>
<td>CLO 2</td>
<td>Display…</td>
<td>1.3, 1.4, 3.2, 3.3 &amp; 3.4</td>
<td>1, 2, 3 &amp; 4</td>
</tr>
<tr>
<td>CLO 3</td>
<td>Show…</td>
<td>1.3, 1.4, 3.2, 3.3 &amp; 3.4</td>
<td>1, 2, 3 &amp; 4</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Classification of phase transformations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solidification of pure and impure materials</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Solidification of pure and impure materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solute redistribution and coring</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Generation of as-cast structures during solidification</td>
<td>Assignment part A</td>
</tr>
<tr>
<td></td>
<td>Single crystal growth techniques</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Single crystal growth techniques</td>
<td>Assignment part A</td>
</tr>
<tr>
<td></td>
<td>Rapid solidification processing</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Revision of Ficks Laws/Diffusion controlled growth</td>
<td>Assignment part B</td>
</tr>
<tr>
<td></td>
<td>Diffusion controlled growth/tutorial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Revision of content/tutorial style questions/</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Mid-term exam</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Spinodal decomposition</td>
<td>Quiz</td>
</tr>
<tr>
<td></td>
<td>Martensitic phase transitions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tutorial on spinodal decomposition/Revision of content</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Mid-session Quiz (20%)</td>
<td>Quiz</td>
</tr>
<tr>
<td></td>
<td>Introduction to dielectrics/ferroelectrics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feedback on quiz</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Landau Theory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piezoresponse Force Microscopy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Neutron diffraction</td>
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</tr>
<tr>
<td>10</td>
<td>Revision for final/question bank</td>
<td></td>
</tr>
</tbody>
</table>
5. Assessment

5.1 Assessment tasks

<table>
<thead>
<tr>
<th>Assessment task</th>
<th>Description</th>
<th>Weight</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment:</td>
<td>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.</td>
<td>25%</td>
<td>Part 1: Week 3</td>
</tr>
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<td></td>
<td>Part 2: Week 6</td>
</tr>
<tr>
<td>Mid-term exam:</td>
<td>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 I). It will consist of a combination of essay-style questions and calculations.</td>
<td>25%</td>
<td>Week 5</td>
</tr>
<tr>
<td>Quiz:</td>
<td>The quiz will be held in class and cover the content taught in weeks 6-8</td>
<td>20%</td>
<td>Week 8</td>
</tr>
<tr>
<td>Final Assessment:</td>
<td>For the final assessment task students who achieve a mark greater than 75% in the week, 8 Quiz will have the option of completing a research paper instead of sitting the exam. Students who achieve a mark of less than 75% will be required to sit the final exam. Details of both are below.</td>
<td></td>
<td>Final Exam-Final exam period Research Paper-May 6th 2019 6:00 pm</td>
</tr>
<tr>
<td></td>
<td><strong>Final exam:</strong> will cover week 8-9 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.</td>
<td>30%</td>
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<td></td>
<td>OR</td>
<td></td>
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<td></td>
<td><strong>Optional Research Paper:</strong> The research paper will be 10 pages long and based on critical assessment of a set topic based on phase transformations in ferroelectric thin films.</td>
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</tbody>
</table>

Further information

UNSW grading system: [https://student.unsw.edu.au/grades](https://student.unsw.edu.au/grades)


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](https://student.unsw.edu.au/grades)
MARKING SHEET for MATS3005 final assignment

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
2. Quality, logic and organisation of arguments .................... /10
3. Use of graphs, figures and tables to summarise results ........ /10
4. 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
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

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.

- Students unable to submit assignments on time or attend the mid-session quizzes or final exams on health grounds should make a request for special consideration. 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. 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](https://student.unsw.edu.au/plagiarism), and
- The ELISE training site [http://subjectguides.library.unsw.edu.au/elise/presenting](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](https://student.unsw.edu.au/conduct).

7. Readings and resources

Preferred textbook:


Other suitable books at elementary level:

- 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/](http://www.materials.unsw.edu.au/)
Faculty Office: Robert Webster Building, Room 128
Faculty Website: [http://www.science.unsw.edu.au/](http://www.science.unsw.edu.au/)

9. Additional support for students

- The Current Students Gateway: [https://student.unsw.edu.au/](https://student.unsw.edu.au/)
- Academic Skills and Support: [https://student.unsw.edu.au/academic-skills](https://student.unsw.edu.au/academic-skills)
- Student Wellbeing, Health and Safety: [https://student.unsw.edu.au/wellbeing](https://student.unsw.edu.au/wellbeing)
- UNSW IT Service Centre: [https://www.it.unsw.edu.au/students/index.html](https://www.it.unsw.edu.au/students/index.html)

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